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ORIGINAL ARTICLE

Francophone and Anglophone perinatal health: temporal and regional inequalities in a Canadian setting, 1981–2008

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Abstract
Objectives We evaluated temporal and regional inequalities in adverse birth outcomes between Anglophones and Francophones of a Canadian province.
Methods Odds ratios and rate differences in preterm birth (PTB, <37 gestational weeks) and small-for-gestational-age (SGA) birth were computed for Anglophones relative to Francophones for singleton live births in Québec from 1981 to 2008 ($N = 2{,}292{,}237$), adjusting for maternal characteristics. Trends over time and residential region were evaluated.
Results Rates of PTB and SGA birth overall were lower for Anglophones relative to Francophones, but temporal and regional trends varied by outcome. Although PTB rates increased over time, inequalities between Francophones and Anglophones were relatively stable. In contrast, inequalities in SGA birth narrowed over time as Francophone rates declined more than Anglophones. Inequalities in SGA birth favored Anglophones overall, but the gap gradually reversed in Montréal (the largest metropolitan center) to currently favor Francophones.
Conclusions PTB and SGA birth rates favored Anglophones over Francophones. The linguistic gap was generally stable over time for PTB, but narrowed or reversed for SGA birth. Language may be used to capture inequalities in perinatal health in countries where different linguistic groups predominate.

Keywords Language groups · Ethnicity · Infant, premature · Infant, small for gestational age · Disparities

Résumé
Objectif Nous avons évalué les tendances temporelles et régionales de la santé périnatale d'une province canadienne entre anglophones et francophones.
Méthodes Les rapports de cotes et les différences de taux pour la prématurité et le retard de croissance intra-utérin (RCI) entre anglophones et francophones ont été calculés par période et par région pour 2,292,237 naissances simples au Québec de 1981 à 2008.
Résultats Les taux de prématurité et de RCI étaient plus faibles pour les anglophones comparativement aux francophones, par contre les tendances temporelles et régionales variaient. Les taux de prématurité augmentaient dans le temps, mais les inégalités linguistiques sont restés stables. Les inégalités linguistiques pour le RCI se sont rétrécies dans le temps à cause d'une réduction plus rapide des taux francophones. Les taux de RCI favorisaient néanmoins globalement les anglophones, à l'exception de Montréal où les inégalités se sont inversées.

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Conclusions Les issues de naissance étaient généralement plus favorables chez les Anglophones. Les inégalités linguistiques étaient stables pour la prématurité et se sont réduites ou inversées pour le RCI. L'appartenance linguistique pourrait être utilisée pour identifier les inégalités de santé périnatale dans d'autres pays.

Introduction

Studies suggest that ethnic inequalities in perinatal health are widespread, especially for African-Americans who have some of the highest rates of adverse birth outcomes among ethnic groups in the US (Bryant et al. 2010; Sparks 2009; Stein et al. 2009). Ethnic inequalities between African-Americans and Whites also vary by place of residence, potentially due to stronger area effects for African-Americans compared with Whites (Kramer and Hogue 2008; Osypuk and Acevedo-Garcia 2008; Pickett et al. 2005). Although there is evidence that the overall ethnic gap in perinatal health may have narrowed over time (Branum and Schoendorf 2002; Vahratian et al. 2006), little is known on how area differences in ethnic inequalities may have changed temporally, despite the importance of understanding such trends for health policy. Most area-based research has focused on how urban residential segregation or ethnic density influence birth outcomes in different ethnic groups (Kramer and Hogue 2008; Mason et al. 2011; Osypuk and Acevedo-Garcia 2008; Pickett et al. 2005), without considering patterns over time.

Trends in ethnic inequalities for adverse birth outcomes are even less well understood in other countries where markers of ethnicity are not readily available in population data. Canada, for example, is increasingly ethnically diverse (Statistics Canada 2007), but does not use the race/ethnicity classification commonly applied in US research. Researchers have argued that ethnicity should be assigned in a place-, time- and context-specific manner, based on group characteristics (e.g., language) and social relations (e.g., minority vs. majority status) (Ford and Harawa 2010). In settings such as Canada, other markers of ethnicity such as linguistic minority status may therefore be useful for understanding population variation in adverse birth outcomes. Canada's origins date back to the period of European colonization, when most migrants were Anglophone or Francophone. English and French are the two official languages of Canada, and 80 % of the population reports one or both as their mother tongue (Statistics Canada 2007). This is particularly true in the province of Québec where French is the predominant mother tongue, although individuals with English mother tongue constitute as much as a fifth of the population in some regions (Warnke 2008). Historically, marked societal tensions have existed between the Francophone majority and Anglophone minority of Québec, and temporal and regional inequalities in access to health services or other social determinants of health in the province may be associated with perinatal outcomes (Pocock et al. 2010).

To our knowledge, no study has investigated perinatal health outcomes for the two major linguistic groups of Québec. The objective of this study, therefore, was to evaluate temporal and regional trends in preterm birth (PTB) and small-for-gestational-age (SGA) birth for Anglophones and Francophones of Québec. These adverse birth outcomes were selected based on their population health impact (Barker 2006; Kramer and Hogue 2008; Saigal and Doyle 2008).

Methods

Data and variables

Singleton live-born infants from the Québec birth file were extracted for 1981 through 2008 ($N = 2{,}310{,}466$). The file is compiled from live birth registration certificates and the ascertainment of births is considered complete (Institut national de santé publique du Québec 2006). Cases missing gestational age were excluded ($N = 18{,}229$, 0.8 %), leaving 2,292,237 births for analysis. Stillbirths were not included in analyses to avoid potentially biasing the association between language and PTB (which could occur if language was more, or less, strongly associated with preterm antepartum stillbirth than PTB) (Auger et al. 2012a).

PTB was defined as deliveries that occurred before 37 completed gestational weeks, expressed categorically according to severity of gestational age at delivery (Auger et al. 2011; Moutquin 2003): (1) extreme, ≤27 weeks; (2) very, 28–31 weeks; (3) moderate, 32–36 weeks. Research suggests that associations between ethnicity and PTB may vary by gestational age (Stein et al. 2009). Gestational age estimates in Québec are primarily based on ultrasound rather than recall of last menstruation, although ultrasound was likely only gradually implemented in the 1980s.

SGA birth was used as a marker of fetal growth, defined as birth weight less than the 10th percentile for gestational age and sex (Kramer et al. 2001). SGA birth was expressed according to the available categories of severity in fetal growth restriction: (1) extreme, <3rd percentile; (2) very, 3rd to <5th percentile; (3) moderate, 5th to <10th percentile (Kramer et al. 2001). SGA reference curves were available for births from 22 to 43 gestational weeks ($N = 2{,}281{,}737$).

Linguistic status was determined with self-reported maternal mother tongue [French (78.6 %), English (8.1 %),

bilingual French–English (0.3 %), Indigenous (0.8 %), other foreign language (10.0 %), unknown (2.2 %)]. To ensure that potential time trends were not masked, period was assessed in 5-year intervals, except for the first and last periods when fewer years were available (1981–1984, 1985–1989, 1990–1994, 1995–1999, 2000–2004, 2005–2008). Four residential regions were available for 1990 onward (metropolitan Montréal, other census metropolitan areas with ≥100,000 inhabitants, mid-sized cities with 10,000–99,999 inhabitants, rest of Québec) (McNiven et al. 2000). Montréal is the largest metropolitan center of Québec and contains approximately 80 % of Anglophone Quebecers. The rest of Québec includes small cities with <10,000 inhabitants and rural areas where fewer Anglophones reside.

Covariates included maternal age, education, marital status, immigrant status, and parity (Online Resource 1). Previous studies have identified these factors as potentially associated with language and adverse birth outcomes (Bryant et al. 2010; Sparks 2009).

Statistical analysis

We computed descriptive statistics and calculated odds ratios (OR) and 95 % confidence intervals (CI) for the association between linguistic status and PTB (or SGA birth) in models that were unadjusted, and adjusted for maternal age, education, marital status, immigrant status, parity, and period. We used multivariable ordinal logistic regression (SGA birth), or polytomous logistic regression when the proportional odds assumption was violated (PTB). Rate differences were computed using the identity link for binary distributions in generalized linear models with outcomes expressed dichotomously, adjusted for the same covariates. Francophones constituted the largest language grouping, and all language categories were compared with Francophones as the referent.

Time trends were examined by including a language-by-period interaction term, and area trends with a language-by-region interaction term, in separate models. Effect measure modification by time and region of the association between linguistic status and PTB (or SGA birth) was investigated using Francophones in 1981–1984 (time trends) or Francophones in Montréal (regional trends) as the referent. Regional trend analyses were restricted to 1990 onwards, since area of residence was not available beforehand. Three-way interactions between linguistic status, period, and region were assessed with a language-by-period-by-region interaction term, and associations between language and adverse birth outcomes by region were computed relative to 1990–1994.

Analyses were performed using SAS 9.2 (SAS Institute Inc., Cary, North Carolina). Research ethics approval was waived by the institutional review board of the University of Montréal Hospital Centre. This study conformed to the 2010 Tri-Council Policy Statement for ethical conduct of research involving humans in Canada.

Results

The overall PTB rate was similar between Francophones (5.8 %) and Anglophones (5.7 %), but the prevalence of SGA birth was nearly 2 percentage points greater for Francophones (11.5 vs. 9.7 %, respectively; Online Resource 1). Without considering language, the PTB rate increased by 1 percentage point over the 27-year period, while the prevalence of SGA birth decreased by 7.6 percentage points. The increase in PTB was greater for Francophones than Anglophones (1.0 vs. 0.5 percentage points, respectively), and most of the increase was due to rising rates of moderate PTB in both groups (Table 1). Similarly, the decrease in SGA birth was greater for Francophones than Anglophones (8.7 vs. 5.2 percentage points, respectively) and was more pronounced for extreme than very or moderate SGA birth. Both PTB and SGA birth were most common in mid-sized cities. Area-based patterns in PTB for Francophones resembled those of Anglophones, even considering severity of gestational age (Table 1). In the rest of Québec, however, Anglophones had a much lower prevalence of SGA birth compared with Francophones (7.7 vs. 10.1 %, respectively), and similar patterns were observed across extreme, very and moderate cases.

Compared with Francophones, Anglophones had lower likelihoods of overall PTB and SGA birth in unadjusted and adjusted models, though odds were more protective against SGA birth (adjusted OR 0.86) than PTB (adjusted OR 0.98) (Table 2). Similarly, the rate differences were greater for SGA birth than PTB. There was little evidence of important differences in ORs across the different categories of severity (extreme, very, moderate) for PTB or SGA birth, but rate differences tended to be greater for moderate outcomes.

Language-by-period interaction terms suggested a change in ORs over time (P value <0.05) for extreme and very (not moderate) PTB, but no change in rate differences (Table 3). Relative to 1981–1984, Francophones had progressively higher odds of extreme and moderate PTB and lower odds of very PTB over time. Time trends tended to be similar for Anglophones, but an increase in odds of extreme PTB was not apparent. Inequalities in PTB between Anglophones and Francophones over time were thus not present, except for extreme PTB where there was potentially some widening of the relative gap in favor of Anglophones. Language-by-region interaction terms for

Table 1 Severity of adverse birth outcomes according to language, period and region, Québec, Canada, 1981–2008

	Preterm birth %[a]					Small-for-gestational-age birth %[b]				
	Extreme	Very	Moderate	All	*N*	Extreme	Very	Moderate	All	*N*
Language by period										
Francophone										
1981–1984	0.2	0.5	4.4	5.1	296,759	6.2	3.2	7.3	16.7	296,677
1985–1989	0.2	0.5	4.8	5.5	341,264	5.5	2.7	6.6	14.8	341,188
1990–1994	0.3	0.4	5.2	5.8	360,247	4.1	2.2	5.6	11.9	360,153
1995–1999	0.3	0.4	5.5	6.3	301,047	2.9	2.0	5.1	10.0	300,918
2000–2004	0.3	0.4	5.7	6.4	267,321	2.1	1.6	4.4	8.0	267,153
2005–2008	0.3	0.4	5.4	6.1	235,783	2.1	1.6	4.4	8.0	235,612
Total	0.3	0.4	5.1	5.8	1,802,421	4.0	2.3	5.6	11.8	1,801,701
Anglophone										
1981–1984	0.3	0.6	4.3	5.2	27,645	4.9	2.5	5.9	13.3	27,637
1985–1989	0.3	0.5	4.7	5.4	34,500	4.8	2.2	5.6	12.6	34,486
1990–1994	0.4	0.5	4.9	5.8	35,575	3.5	1.9	4.8	10.3	35,565
1995–1999	0.3	0.5	5.2	6.0	32,030	2.5	1.7	4.4	8.5	32,016
2000–2004	0.4	0.5	5.1	6.0	29,191	2.0	1.4	4.2	7.5	29,168
2005–2008	0.3	0.3	5.1	5.7	27,013	2.2	1.7	4.3	8.1	26,999
Total	0.3	0.5	4.9	5.7	185,954	3.4	1.9	4.9	10.1	185,871
Language by region[c]										
Francophone										
Montréal	0.3	0.4	5.3	6.1	475,453	3.0	1.9	4.9	9.7	475,244
Other metropolitan	0.3	0.4	5.3	6.0	248,160	2.6	1.8	4.6	9.0	248,005
Mid-sized cities	0.3	0.5	5.9	6.6	161,211	3.0	1.9	5.1	10.1	161,135
Rest of Québec	0.3	0.4	5.4	6.1	275,643	3.1	2.0	5.1	10.1	275,522
Total	0.3	0.4	5.4	6.1	1,164,398	2.9	1.9	4.9	9.7	1,163,836
Anglophone										
Montréal	0.4	0.5	5.1	5.9	97,498	2.6	1.7	4.5	8.8	97,449
Other metropolitan	0.3	0.3	4.6	5.2	7,430	2.7	1.6	4.7	9.0	7,425
Mid-sized cities	0.4	0.5	6.0	6.9	2,975	2.8	1.9	4.7	9.4	2,972
Rest of Québec	0.3	0.4	5.1	5.7	15,480	2.6	1.5	3.6	7.7	15,476
Total	0.4	0.5	5.1	5.9	123,809	2.6	1.7	4.4	8.7	123,748

Descriptive statistics for other covariates and language categories not shown to conserve space (available upon request)

[a] Extreme (≤27 weeks), Very (28–31 weeks), Moderate (32–36 weeks), All (<37 weeks)

[b] Extreme (<3rd percentile), Very (≥3rd to <5th percentile), Moderate (≥5th to <10th percentile), All (<10th percentile)

[c] Data for 1990–2008

ORs and rate differences were only statistically significant for moderate (but not extreme and very) PTB. Relative to Francophones in Montréal, Francophones in mid-sized cities were more likely to have moderate PTB, and Anglophones in the rest of Québec and other metropolitan centers (but not Montréal) were less likely.

For SGA birth, temporal and regional trends were similar across the categories of severity (only cumulative associations for overall SGA birth are shown, Table 4). Language-by-period and language-by-region interaction terms were statistically significant. Relative to Francophones in 1981–1984, the odds of SGA birth decreased over time for both Francophones and Anglophones, but the decline was slightly steeper for Francophones, leading to a decrease in Francophone-Anglophone inequalities over time. Though precision varied, SGA birth was less likely for Anglophones in all areas relative to Francophones in Montréal. Only Francophones in other metropolitan centers were less likely to have SGA birth relative to those in Montréal.

A three-way language-by-period-by-region interaction term was also statistically significant for overall SGA birth (P value <0.0001). In fact, the odds of SGA birth reversed over time in Montréal, where, relative to Francophones, the

Table 2 Association between linguistic status (Anglophone versus Francophone) and adverse birth outcomes, Québec, Canada, 1981–2008

	Unadjusted OR (95 % CI)	Adjusted OR (95 % CI)[a]	Unadjusted rate difference (95 % CI)	Adjusted rate difference (95 % CI)[a]
Preterm birth				
All[b]	0.97 (0.95, 0.99)	0.98 (0.96, 1.00)	−0.17 (−0.28, −0.06)	−0.15 (−0.27, −0.04)
Moderate	0.95 (0.93, 0.97)	0.97 (0.95, 0.99)	−0.25 (−0.36, −0.15)	−0.17 (−0.27, −0.06)
Very	1.04 (0.97, 1.12)	1.03 (0.96, 1.11)	0.02 (−0.01, 0.05)	0.01 (−0.02, 0.04)
Extreme	1.23 (1.13, 1.34)	1.03 (0.94, 1.12)	0.07 (0.04, 0.09)	0.02 (−0.01, 0.05)
Small-for-gestational-age birth				
All	0.84 (0.83, 0.85)	0.86 (0.85, 0.87)	−1.78 (−1.93, −1.64)	−0.73 (−0.86, −0.59)
Moderate	0.85 (0.83, 0.87)	0.89 (0.87, 0.91)	−0.87 (−0.98, −0.76)	−0.43 (−0.53, −0.32)
Very	0.83 (0.80, 0.86)	0.87 (0.84, 0.90)	−0.43 (−0.50, −0.35)	−0.17 (−0.23, −0.10)
Extreme	0.83 (0.81, 0.85)	0.89 (0.86, 0.91)	−0.70 (−0.79, −0.61)	−0.17 (−0.27, −0.08)

Results for other language categories available upon request

[a] Adjusted for maternal age, education, marital status, immigrant status, parity, and period

[b] ORs obtained using binary logistic regression with PTB expressed dichotomously

initially protective odds for Anglophones in the 1990s disappeared by 2005–2008. In the last study period (2005–2008), Anglophones had 10 % higher odds of SGA birth relative to Francophones (95 % CI 1.04–1.16) (Fig. 1). The corresponding prevalence of SGA birth fell from 11.6 to 8.0 % for Francophones from 1990 to 2008, but from 9.5 % to only 8.6 % for Anglophones. The adjusted prevalence was 0.77 percentage points higher for Anglophones relative to Francophones (95 % CI 0.36–1.18) in the last period. In contrast, odds of SGA birth for Anglophones in the rest of Québec decreased over time relative to Francophones, indicating that linguistic inequalities widened in favor of Anglophones. The corresponding prevalence of SGA birth fell from 9.9 to 5.5 % for Anglophones from 1990 to 2008, but from 11.7 % to only 8.4 % for Francophones. Similar time trends were observed when SGA birth was examined by severity. Effect measure modification was not present for other metropolitan centers and mid-sized cities where associations were stable over time (data not shown). Three-way interactions between language, period, and region were not apparent for PTB.

Discussion

We evaluated perinatal health inequalities between the Francophone majority and Anglophone minority of Québec, Canada. To our knowledge, this is the first study to demonstrate that temporal and regional inequalities in perinatal outcomes can be captured with language, a potential marker of individual sociocultural or ethnic status. We found that Anglophones had lower odds of adverse birth outcomes relative to Francophones overall, though odds were more protective for SGA birth than PTB. Furthermore, temporal and regional trends in linguistic inequalities varied by outcome and severity. Although odds of very PTB decreased and moderate PTB increased over time, relative inequalities between Anglophones and Francophones did not change. Extreme PTB appeared to increase for Francophones (a clear pattern over time was not apparent among Anglophones). In contrast, odds of SGA birth decreased more for Francophones over time than Anglophones, such that Francophones gradually caught up to Anglophones. In Montréal, the largest metropolitan area of Québec, the gap between Francophones and Anglophones reversed, and Anglophone Montrealers currently have a higher prevalence of SGA birth than Francophones. In the rest of Québec, however, Anglophones continued to have a lower likelihood of SGA birth relative to Francophones, and the gap appeared to widen. These findings indicate that linguistic inequalities in perinatal health have gradually changed across the regions of Québec over a 27-year span.

Few studies have investigated linguistic inequalities in perinatal health. Lack of research in this area may be related to the uncertainty of language as a potential marker of ethnicity. Language may in some settings indicate foreign-born status rather than ethnicity per se (Hyyppa and Maki 2001; Sipila and Martikainen 2010), especially if socioeconomic opportunities depend on the ability to speak the country's official language. However, in nations where inter-generational transfer of language is encouraged, linguistic status may be an identifying feature of ethnicity. Indigenous language, for example, has been used to capture Aboriginal ethnicity in Québec (Luo et al. 2004). In other officially multilingual countries such as Finland and Belgium, linguistic status has long identified ethnicity and is correlated with social, economic, and political status. The Swedish-speaking minority of Finland has enjoyed higher social status than the Finnish-speaking majority (Sipila and

Table 3 Association between linguistic status and preterm birth by period and region, Québec, Canada, 1981–2008

	OR (95 % CI)			Rate difference[a]		
	Extreme	Very	Moderate	Extreme	Very	Moderate
By period						
Francophone						
1981–1984	Referent	Referent	Referent	Referent	Referent	Referent
1985–1989	1.02 (0.92, 1.13)	0.93 (0.86, 1.00)	1.11 (1.08, 1.13)	0.00	−0.04	0.44
1990–1994	1.07 (0.96, 1.19)	0.86 (0.80, 0.92)	1.19 (1.16, 1.22)	0.00	−0.07	0.75
1995–1999	1.17 (1.05, 1.30)	0.84 (0.78, 0.91)	1.26 (1.23, 1.29)	0.02	−0.08	1.04
2000–2004	1.27 (1.14, 1.41)	0.84 (0.77, 0.91)	1.29 (1.26, 1.33)	0.05	−0.08	1.17
2005–2008	1.18 (1.05, 1.32)	0.75 (0.68, 0.82)	1.22 (1.19, 1.25)	0.05	−0.12	0.89
Anglophone						
1981–11984	1.11 (0.88, 1.40)	1.07 (0.91, 1.27)	1.00 (0.94, 1.07)	0.03	0.02	-0.02
1985–1989	0.99 (0.80, 1.23)	0.90 (0.76, 1.06)	1.10 (1.04, 1.16)	−0.02	−0.04	0.34
1990–1994	1.44 (1.20, 1.74)	1.01 (0.86, 1.18)	1.15 (1.09, 1.21)	0.10	−0.01	0.53
1995–1999	1.11 (0.90, 1.38)	0.96 (0.81, 1.13)	1.22 (1.16, 1.29)	0.03	−0.03	0.85
2000–2004	1.19 (0.97, 1.46)	0.84 (0.70, 1.00)	1.20 (1.14, 1.27)	0.05	−0.08	0.76
2005–2008	0.99 (0.79, 1.25)	0.57 (0.46, 0.72)	1.20 (1.13, 1.27)	0.04	−0.17	0.78
Language-by-period interaction term *P* value	0.016	0.039	0.51	0.10	0.32	0.37
By region[b]						
Francophone						
Montréal	Referent	Referent	Referent	Referent	Referent	Referent
Other metropolitan	0.97 (0.88, 1.06)	1.00 (0.93, 1.08)	1.02 (0.99, 1.04)	0.00	0.00	0.10
Mid-sized city	0.97 (0.87, 1.08)	1.11 (1.02, 1.20)	1.09 (1.07, 1.12)	0.00	0.03	0.44
Rest of Québec	0.93 (0.85, 1.02)	1.02 (0.95, 1.10)	1.00 (0.98, 1.02)	−0.01	−0.01	−0.02
Anglophone						
Montréal	1.10 (0.97, 1.23)	1.09 (0.98, 1.21)	0.99 (0.96, 1.02)	0.03	0.02	−0.04
Other metropolitan	0.88 (0.57, 1.38)	0.69 (0.45, 1.06)	0.89 (0.80, 1.00)	−0.02	−0.09	−0.47
Mid-sized city	1.26 (0.71, 2.23)	1.17 (0.70, 1.95)	1.11 (0.95, 1.29)	0.07	0.06	0.37
Rest of Québec	0.75 (0.55, 1.04)	0.96 (0.75, 1.23)	0.90 (0.83, 0.96)	−0.07	−0.03	−0.56
Language-by-area interaction term *P* value	0.29	0.19	0.019	0.26	0.25	0.049

Adjusted for maternal age, education, marital status, immigrant status, and parity. Results for other language categories available upon request

[a] To conserve space, confidence intervals are not shown, but an estimate of precision is provided by confidence intervals for ORs

[b] Data for 1990–2008

Table 4 Association between linguistic status and small-for-gestational-age birth by period and region, Québec, Canada, 1981–2008

	OR (95 % CI)	Rate difference (95 % CI)
By period		
Francophone		
1981–1984	Referent	Referent
1985–1989	0.86 (0.85, 0.88)	−2.01 (−2.18, −1.83)
1990–1994	0.67 (0.66, 0.68)	−4.42 (−4.59, −4.26)
1995–1999	0.54 (0.53, 0.55)	−5.88 (−6.05, −5.71)
2000–2004	0.42 (0.41, 0.43)	−7.64 (−7.81, −7.46)
2005–2008	0.42 (0.41, 0.43)	−7.65 (−7.83, −7.48)
Anglophone		
1981–1984	0.77 (0.75, 0.80)	−3.08 (−3.49, −2.67)
1985–1989	0.74 (0.71, 0.76)	−4.07 (−4.43, −3.72)
1990–1994	0.59 (0.57, 0.61)	−5.75 (−6.07, −5.43)
1995–1999	0.48 (0.46, 0.50)	−6.66 (−6.98, −6.35)
2000–2004	0.42 (0.40, 0.44)	−7.54 (−7.85, −7.23)
2005–2008	0.45 (0.43, 0.48)	−6.92 (−7.25, −6.58)
Language-by-period interaction term *P* value	<0.0001	<0.0001
By region[a]		
Francophone		
Montréal	Referent	Referent
Other metropolitan	0.95 (0.94, 0.97)	−0.32 (−0.45, −0.20)
Mid-sized city	1.02 (1.00, 1.04)	0.11 (−0.05, 0.26)
Rest of Québec	1.03 (1.01, 1.05)	0.14 (0.01, 0.27)
Anglophone		
Montréal	0.92 (0.90, 0.94)	−0.37 (−0.55, −0.19)
Other metropolitan	0.96 (0.88, 1.04)	−0.47 (−1.05, 0.11)
Mid-sized city	0.94 (0.83, 1.07)	−0.75 (−1.70, 0.20)
Rest of Québec	0.74 (0.70, 0.79)	−2.22 (−2.57, −1.86)
Language-by-area interaction term *P* value	<0.0001	<0.0001

Adjusted for maternal age, education, marital status, immigrant status, and parity. Results for other language categories available upon request

[a] Data for 1990–2008

Martikainen 2010), as well as higher self-rated health and lower mortality (Hyyppa and Maki 2001; Nyqvist et al. 2008; Sipila and Martikainen 2010). This is reminiscent of Québec where Anglophones have historically also had higher social status, as well as higher life expectancy relative to Francophones (Auger et al. 2012c). However, perinatal health inequalities between Swedish- and Finnish-speakers of Finland have to our knowledge not been published.

Interestingly, the majority of literature on ethnic inequalities reports worse perinatal health outcomes for ethnic minorities in countries such as the US (Bryant et al. 2010), UK (Dearden et al. 2006), Netherlands (Troe et al. 2007), Finland (Malin and Gissler 2009), Australia (Thomas et al. 2010), and Brazil (Barros et al. 2001). Though it is not clear that ethnic minority is conceptually comparable to linguistic minority, these findings nonetheless contrast with the better perinatal outcomes observed in the Anglophone minority of Québec, even in regions where the concentration of Anglophones is low (<1 % in some areas) (Warnke 2008). Although these results are at first glance somewhat unexpected, they may be related to the past political and socioeconomic advantage of Anglophones (Floch and Pocock 2008). High education, income and occupational status are associated with healthy behaviors, particularly less smoking, which may explain why Anglophones were more protected against SGA birth than PTB (as smoking is a stronger risk factor for fetal growth than short gestation) (Kramer et al. 2000; Salihu and Wilson 2007). Although Francophone women, a population known to have been especially targeted by tobacco industry marketing (Rudy 2005), smoked more than Anglophone women in the past (Health Canada 2008), Francophone smoking rates have declined more quickly (Health Canada 2008; Pocock 2008; Smith et al. 2005), which may have contributed to the convergence in SGA birth rates over time. Regional smoking data are not available, and it is not clear if the reversal in inequalities observed in Montréal is related underlying patterns in smoking.

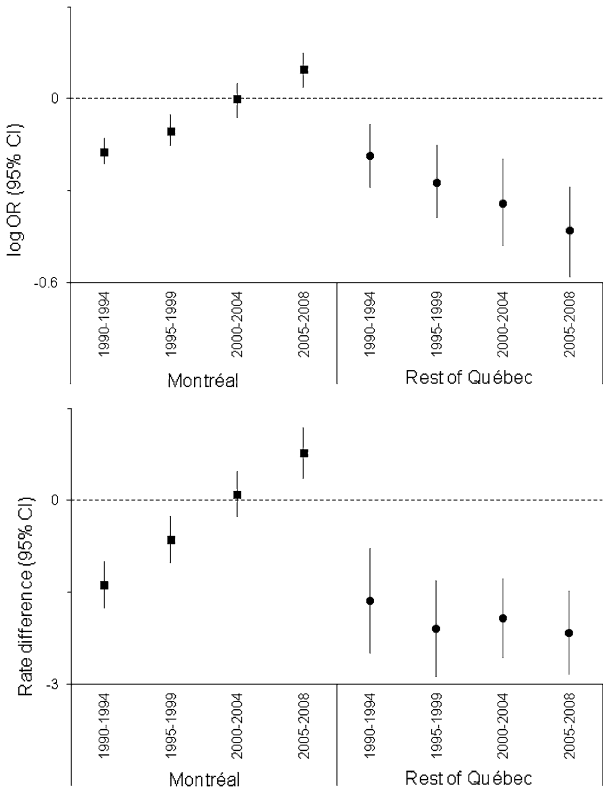

Fig. 1 Time trends in associations for small-for-gestational-age birth (Anglophone versus Francophone) by region, Québec, Canada, 1990–2008. Associations for other metropolitan centers and mid-sized cities were stable over time, and are therefore not shown

There is also evidence that Anglophone socioeconomic status has declined in recent decades (Floch and Pocock 2008), especially outside of Montréal and among young adults aged 25–44 years (Pocock 2008). Gradual convergence in socioeconomic status of Francophones and Anglophones occurred subsequent to sociopolitical empowerment of the Francophone majority in the 1970s, which was associated with the migration of Anglophones to other provinces due to the threat of Québec's separation from Canada. The Anglophones who remained tended to be less educated, and may have faced fewer socioeconomic opportunities (Floch and Pocock 2008). Nonetheless, the potential for such selection factors to influence the patterns is unclear, especially since Anglophones in Québec remain more educated than Francophones (though they may have fewer employment opportunities). Although a greater proportion of Anglophones appear to be immigrants compared with Francophones (Pocock 2008), we adjusted for immigration therefore our findings are unlikely to reflect a healthy immigrant effect (wherein PTB and SGA birth rates would be expectedly lower among Anglophones due to selection).

Unmeasured changes in obstetric interventions that differed between Francophones and Anglophones may also have contributed to time trends. Greater use of ultrasound dating of gestational age over time may have resulted in higher rates of PTB and lower rates of SGA birth (Yang et al. 2002), but the extent to which this accounts for linguistic differences in these birth outcomes cannot be determined, since data on language-based differences in ultrasound dating were not available. Increased registration of live births at the borderline of viability over time may have increased extreme PTB rates (Ananth et al. 2001; Kramer et al. 1998), but we do not know if this practice differed between Francophones and Anglophones. Similarly, we did not have data on trends in caesarean section or labor induction by language, two obstetric interventions that could influence rates of PTB or SGA birth, though evidence suggests that these interventions increased over time (Institut national de santé publique du Québec 2006).

This study has limitations. We did not have data on time-varying covariates, or other factors helpful for interpreting time trends such as changes in socio-cultural context that may influence the association between language and adverse birth outcomes (Platt and Zeitlin 2009). We lacked data on maternal risk factors, such as smoking and alcohol use, which may have led to the inequalities in PTB and SGA birth (Kramer et al. 2000), but adjustment for such mediators would be potentially unnecessary. We adjusted for education, but did not have data on other socioeconomic factors such as income and occupation (but such factors may also be mediators). Inequalities in SGA birth over time should be interpreted in light of the higher prevalence of the outcome in early study periods which slightly overestimated the steepness of risk gradient, though this would not influence study interpretations. We used maternal mother tongue, and it is not clear if other measures of language may have resulted in different findings (Jedwab 2008). Neonatal and postneonatal mortality could not be evaluated, because individual-level data on maternal mother tongue and other covariates were not available for these outcomes. Data on stillbirths were available (Auger and Denis 2012), but temporal and regional trends could not be evaluated due to insufficient sample size. Generalizability of our findings to settings with other linguistic groups, dissimilar historical and social contexts, or that are officially unilingual, is not clear.

In summary, this study found that the Anglophone minority of Québec tended to have better birth outcomes than the Francophone majority, but linguistic inequalities in fetal growth have narrowed or reversed over time, depending on region. Linguistic inequalities in extreme PTB (in favor of Anglophones) are potentially emerging. More research and attention to linguistic status for prevention of adverse birth outcomes may be warranted. Linguistic status may be a useful marker of social or ethnic status to capture inequalities in perinatal health, particularly

in countries (including Europe) where multiple linguistic groups are present and several official languages are recognized.

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Conflict of interest The authors declare that they have no conflict of interest.

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