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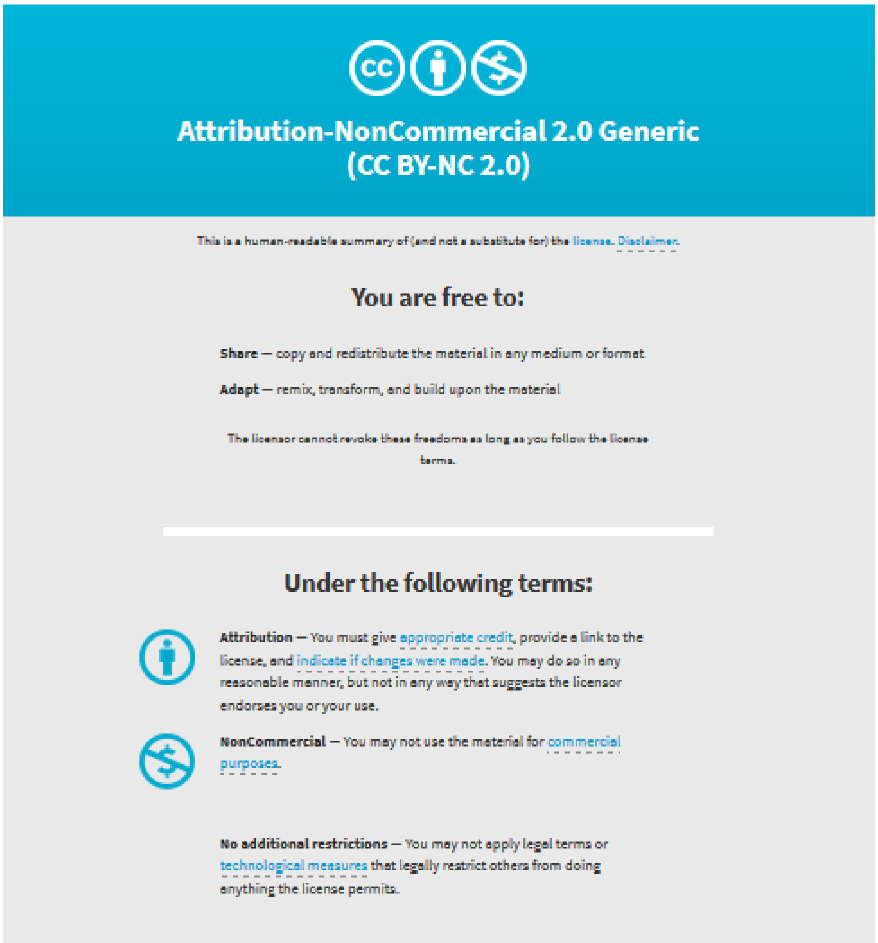

Association of socioeconomic position with maternal pregnancy and infant health outcomes in birth cohort studies from Brazil and the UK

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ABSTRACT

Background Socioeconomic inequalities in health outcomes are dynamic and vary over time. Differences between countries can provide useful insights into the causes of health inequalities. The study aims to compare the associations between two measures of socioeconomic position (SEP)—maternal education and family income—and maternal and infant health outcomes between ALSPAC and Pelotas cohorts.

Methods Birth cohort studies were started in Avon, UK, in 1991 (ALSPAC) and in the city of Pelotas, Brazil, in 1982, 1993 and 2004. Maternal outcomes included smoking during pregnancy, caesarean section and delivery not attended by a doctor. Infant outcomes were preterm birth, intra-uterine growth restriction (IUGR) and breast feeding for <3 months. The relative index of inequality was used for each measure of SEP so that results were comparable between cohorts.

Results An inverse association (higher prevalence among the poorest and less educated) was observed for almost all outcomes, with the exception of caesarean sections where a positive association was found. Stronger income-related inequalities for smoking and education-related inequalities for breast feeding were found in the ALSPAC study. However, greater inequalities in caesarean section and education-related inequalities in preterm birth were observed in the Pelotas cohorts.

Conclusions Mothers and infants have more adverse health outcomes if they are from poorer and less well-educated socioeconomic backgrounds in both Brazil and the UK. However, our findings demonstrate the dynamic nature of the association between SEP and health outcomes. Examining differential socioeconomic patterning of maternal and infant health outcomes might help understanding of mechanisms underlying such inequalities.

INTRODUCTION

Socioeconomic position (SEP) refers to the social and economic factors that influence a person's status within the structure of a society.[1] Education and income are frequently used as generic indicators of SEP. However, while education is thought to capture knowledge-related assets of an individual, income is the indicator that most directly measures the material resources component.[1 2]

SEP indicators have been related to a range of adult health outcomes, including morbidity,[3 4] poor self-rated health[5] and mortality.[6 7] SEP indicators are associated with health at different stages in the life course via a number of, possibly interacting, mechanisms. Even though socioeconomic disadvantage is often related to poorer health, this general tendency hides important heterogeneity.[8]

Pregnancy and early childhood are particularly vulnerable periods of time at which adverse socioeconomic circumstances have long lasting effects. Some of the most consistent findings in public health research are the large SEP disparities in pregnancy outcomes such as intrauterine growth restriction (IUGR) and preterm birth. IUGR and preterm birth are considered key outcomes due to their strong association with infant mortality, long-term morbidity and high healthcare cost.[9]

Inequalities in health outcomes are frequently consequence of inequalities among factors that determine health outcomes. Smoking during pregnancy and nutrition play an important role in relation to health inequalities in pregnancy and early childhood. The marked social gradient in smoking during pregnancy is a major determinant of impaired fetal growth and the social gradient in breast feeding contributes to higher rates of illness in childhood among children from low-income families.[10] The relation between specific SEP indicators and specific health outcomes can vary between countries due to differences in the cultural contexts of the SEP indicators. Such differences can provide useful insights into the causes of health inequalities.

In the present study we examine the associations of two measures of SEP—maternal education and family income—with maternal and infant health outcomes in a birth cohort study from a high-income country (the Avon Longitudinal Study of Parents and Children, ALSPAC, in Britain) and in three birth cohorts from a middle-income country (the Pelotas 1982, 1993 and 2004, in Brazil). These studies were chosen to reflect populations with different levels of wealth and of socioeconomic inequalities as well as their similarity in variable definitions and the availability of comparable questions. Our aim is to compare the relative magnitudes of these associations between the ALSPAC and Pelotas birth cohorts as well to study trends of those associations across the Pelotas studies.

METHODS

Research setting and study design

The ALSPAC study started during pregnancy and aimed to enroll all women who were resident in the three Bristol-based health districts of the county of Avon and who had an expected date of delivery between 1 April 1991 and 31 December 1992.[11]

A total of 14 541 pregnant women (approximately 85% of those eligible) were recruited and 13 678 had a live born, singleton child. Information was obtained both from self-completion questionnaires and from clinical records.[11 12]

During the years of 1982, 1993 and 2004, birth cohort studies representing all births to mothers residing in the urban area of the city of Pelotas, Brazil, were carried out through primary data collection and using much of the same methodology.[13–15] The present paper uses perinatal data obtained soon after delivery and data from 12-month follow-up. With the exception of the 2004 cohort, where the whole cohort was studied at the 12-month follow-up (3907 individuals),[13] a systematic sample of each birth cohort was followed-up at 12 months in 1982 and 1993 (1457 and 1364 individuals, respectively).[14 15] The analyses were restricted to live births, because several indicators (eg, IUGR or preterm birth) do not include stillbirths. The same variable definitions and comparable questions were used in the ALSPAC and Pelotas birth cohort studies.

Outcome and covariates

Smoking habits during pregnancy were based on maternal self-assessment and those women who smoked at least one cigarette per day in any trimester of pregnancy were classified as 'ever smoked during pregnancy'.

Delivery not attended by a doctor was defined as when the newborn was delivered by a midwife, medical student, a student midwife or another person not specified as a doctor and where there was no indication that a doctor had been present. Home births represented less than 1% of all births in the four cohorts and were included in the analyses if data were available. Information about method of delivery (vaginal or caesarean section) was extracted from maternal hospital records in the ALSPAC study and informed by women in the perinatal interview in the Pelotas cohort studies.

Preterm birth was defined as birth that occurred before 37 complete weeks of gestation. Gestational age was recorded using last menstrual period (LMP) in the 1982 Pelotas cohort study and cases with implausible birthweight-gestational age combinations[16] were considered missing data. In the 1993 and 2004 Pelotas cohorts, as well in the ALSPAC study, gestational age was estimated based on the LMP. If the LMP date was considered unreliable or unknown, then the paediatric/obstetric assessment of the newborn was used.

IUGR was defined as birth weight <10th percentile for gestational age and gender according to the reference curve developed by Kramer *et al*[17]

Any type of breast feeding (exclusive, partial or complementary breast feeding) was used to create the variable breast feeding for less than 3 months; those who never breast fed were included in this category. information was collected at the age of 12 months and, therefore, was not assessed for children who died in the first year of life.

The following variables were considered as potential confounders or mediators in the association between SEPs and maternal and infant outcomes: mothers' ethnic origin (white and black/mixed ethnic origin), maternal age (<20, 20–34 and ≥35 y), marital status, parity (0, 1, 2+), pre-pregnancy body mass index (<18.5, 18.5–<25, 25–<30 and ≥30 kg/m^2)[18] and information on urinary tract infection, hypertension (pre-eclampsia or eclampsia) and hospital admission during pregnancy.

Measures of socioeconomic position

Two SEP indicators were used: family income and maternal education. In the Pelotas cohort studies, family income of the month prior to delivery was collected in the perinatal interview. In the ALSPAC study, family income per week was collected at 33 months after delivery. Because of the different currencies used in ALSPAC and Pelotas studies, quintiles of family income were calculated in each study.

In the Pelotas cohort studies, maternal schooling at the time of delivery was collected as a continuous variable and categorised in 0–4, 5–8, 9–11 and ≥12 completed years of formal education. Education levels used in England are not based on the number of years of schooling, because the highest level of education can be obtained after school. In the ALSPAC study, maternal education was collected at 32 weeks of pregnancy as a grouped variable according to increasing levels of achievement: CSE (certificate of secondary education—subject-specific qualifications of a lower level than O-levels that were generally obtained at age 16 y (the minimal school leaving age from 1974 in England))/none, vocational, O-level (ordinary-level—subject-specific qualifications generally obtained at age 16 y) and A-level (advanced-level—subject-specific qualifications generally obtained at age 18 y and required for university entry)/university degree.

Indices of inequality

For each measure of SEP, a relative index of inequality (RII) was derived.[19] This takes account of differences in the proportion of participants in each category for the different measures and between the four cohorts. Results are interpreted as a comparison of the extremes—those at the bottom with those at the top of the income or educational hierarchy. The larger the RII the greater the degree of inequality across the socioeconomic hierarchy.

Data analysis

We used χ^2 tests to compare the distribution of maternal characteristics between ALSPAC and Pelotas studies. Whenever possible, χ^2 tests of trend were used to compare the distribution of maternal characteristics between the three Pelotas cohort studies.

Multiple logistic regression analyses were used to assess the associations of the socioeconomic and educational indices of inequality with each of the maternal and infant health outcomes for each cohort separately. Variables were introduced in the adjusted analysis in sequential steps. In the final model of each outcome we further adjusted for the other SEP indicator to determine the independent contributions of maternal education and family income.

The proportion of missing values for family income in the ALSPAC database was 37% so we used multivariate multiple imputation analysis to assess the impact of missing values on the adjusted estimates.[20] All the analyses were repeated with no imputation for missing values and these results are given as online supplementary material.

All analyses were performed with Stata V.11.0.

RESULTS

The core ALSPAC study consisted of 14 541 pregnancies and, after excluding stillbirths, abortions and multiple births, there remained 13 678 women for analysis. The 1982, 1993 and 2004 Pelotas cohort studies consisted of 6011, 5304 and 4287 births and, after excluding stillbirths and multiple births, there remained 5816, 5168 and 4147 women in each cohort for analysis, respectively.

Marked differences in maternal and infant's characteristics were observed between the four cohort studies (table 1). The Pelotas cohort studies had higher frequencies of women of black/mixed ethnic origin, with extremes in ages, single mothers and

Table 1 Maternal and infant's characteristics in the ALSPAC and Pelotas birth cohort studies

Variables	ALSPAC 1991/92 n (%)	Pelotas 1982 n (%)	Pelotas 1993 n (%)	Pelotas 2004 n (%)	p*	p†
Ethnic origin						
White	11737 (97.4)	4773 (82.1)	3996 (77.3)	3030 (73.1)	<0.001	<0.001
Black/mixed	314 (2.6)	1040 (17.9)	1170 (22.7)	1117 (26.9)		
Family income (quintils)						
1st (poorest)	1727 (20.0)	1159 (19.9)	1037 (20.1)	846 (20.4)	0.001	–
2nd	1726 (20.0)	1166 (20.1)	1161 (22.5)	841 (20.3)		
3rd	1727 (20.0)	1166 (20.1)	922 (17.8)	802 (19.3)		
4th	1726 (20.0)	1162 (20.0)	1029 (19.9)	846 (20.4)		
5th (better-off)	1726 (20.0)	1163 (20.0)	1019 (19.7)	812 (19.6)		
Maternal education (achievement)						
CSE/none	2447 (20.2)				–	–
Vocational	1198 (9.9)					
O-level	4205 (34.6)					
A-leve/degree	4290 (35.3)					
Maternal schooling (y)						
0–4		1922 (33.1)	1441 (27.9)	639 (15.6)		
5–8		2425 (41.8)	2392 (46.4)	1691 (41.2)		
9–11		646 (11.1)	911 (17.7)	1362 (33.2)		
≥12		816 (14.1)	417 (8.1)	414 (10.1)		
Age (y)						
<20	653 (4.8)	908 (15.6)	910 (17.6)	792 (19.1)	<0.001	–
20–34	11669 (85.3)	4339 (74.6)	3692 (71.5)	2800 (67.6)		
≥35	1356 (9.9)	568 (9.8)	565 (10.9)	553 (13.3)		
Marital status						
With partner	11327 (97.5)	5336 (91.8)	4528 (87.6)	3468 (83.6)	<0.001	<0.001
Single mother	288 (2.5)	475 (8.2)	640 (12.4)	679 (16.4)		
Parity						
0	5644 (45.2)	2299 (39.5)	1826 (35.3)	1644 (39.7)	<0.001	–
1	4330 (34.7)	1642 (28.2)	1429 (27.7)	1085 (26.1)		
≥ 2	2502 (20.1)	1873 (32.2)	1913 (37.0)	1417 (34.2)		
Pre-pregnancy body mass index (kg/m^2)						
<18.5	567 (5.0)	384 (7.9)	444 (8.9)	187 (4.9)	<0.001	–
18.5–24.9	8387 (74.4)	3428 (70.1)	3459 (68.9)	2342 (61.5)		
25.0–29.9	1704 (15.1)	867 (17.7)	877 (17.5)	871 (22.9)		
≥30	621 (5.5)	213 (4.4)	239 (4.8)	408 (10.7)		
Ever smoked during pregnancy						
No	8092 (75.9)	3747 (64.4)	3453 (66.8)	3005 (72.5)	<0.001	<0.001
Yes	2572 (24.1)	2069 (35.6)	1715 (33.2)	1142 (27.5)		
Urinary infection during pregnancy						
No	8689 (86.1)	NA	3365 (66.5)	2598 (62.9)	<0.001	–
Yes	1403 (13.9)		1695 (33.5)	1535 (37.1)		
Hypertension during pregnancy						
No	10658 (89.3)	NA	4268 (84.3)	3157 (76.3)	<0.001	–
Yes	1281 (10.7)		793 (15.7)	982 (23.7)		
Hospital admission during pregnancy						
No	9853 (90.4)	NA	4733 (91.6)	3694 (89.1)	<0.001	–
Yes	1044 (9.6)		434 (8.4)	453 (10.9)		
Delivery attended by a doctor						
Yes	2008 (17.7)	3521 (60.6)	4505 (88.2)	3674 (89.1)	<0.001	<0.001
No	9344 (82.3)	2289 (39.4)	603 (11.8)	447 (10.9)		

Continued

Table 1 Continued

Variables	ALSPAC 1991/92 n (%)	Pelotas 1982 n (%)	Pelotas 1993 n (%)	Pelotas 2004 n (%)	p*	p†
Type of delivery						
Vaginal	10330 (89.9)	4224 (72.6)	3609 (69.8)	2291 (55.2)	<0.001	<0.001
Caesarean section	1157 (10.1)	1592 (27.4)	1559 (30.2)	1856 (44.8)		
Intra-uterine growth restriction						
No	11958 (88.5)	3614 (78.7)	4401 (86.6)	3427 (82.9)	<0.001	<0.001
Yes	1547 (11.5)	976 (21.3)	684 (13.4)	708 (17.1)		
Preterm birth (<37 weeks of gestational age)						
No	12962 (94.8)	4330 (94.2)	4535 (89.1)	3574 (86.4)	<0.001	<0.001
Yes	716 (5.2)	265 (5.8)	557 (10.9)	561 (13.6)		
Breast feeding (months)						
≥3	4738 (43.5)	746 (51.5)	825 (62.7)	2860 (74.7)	<0.001	<0.001
<3	6149 (56.5)	703 (48.5)	492 (37.3)	967 (25.3)		

*x^2 test.
†x^2 test for linear trend in the Pelotas cohort studies.
NA, not available.

multiparae than the ALSPAC study. Urinary infection and hypertension during pregnancy were more prevalent in the 1993 and 2004 Pelotas cohorts than in the ALSPAC study. Deliveries not assisted by a doctor were more prevalent among the ALSPAC women and caesarean sections were more frequent in the Pelotas cohorts.

Over the last two decades trends in maternal and infant's characteristics were demonstrated across the Pelotas cohort studies. An increase in black/mixed ethnic origin women, with extremes in ages, single mothers and an almost twofold increase in pre-pregnancy obesity and caesarean sections were observed. Rates of preterm birth increased by nearly three times in the Pelotas cohorts over time. Negative trends in smoking during pregnancy, deliveries not attended by a doctor and breast feeding for less than 3 months were observed in the Pelotas studies.

In general, for income and education RII and in all birth cohorts, the odds of ever having smoked during pregnancy, delivery non-assisted by a doctor and IUGR were higher in the least advantaged compared to the most advantaged group. (tables 2 and 3). However, the odds of having a caesarean section were lower among the least advantaged compared to those at the top of the income and educational hierarchy. In the 2004 Pelotas cohort study, the poorest women and those with less schooling were more likely to deliver a preterm newborn. No differences in preterm birth were observed in any of the other cohorts. Less-educated women from the ALSPAC and the 2004 Pelotas cohort studies showed higher risk of breast feeding their infants for less than 3 months compared to those with the highest levels of educational attainment. The effect of adjustment for confounders/mediators in most cases reduced the magnitude of SEP—maternal and infant's outcome association without changing its direction.

Higher income-related inequalities were observed for ever smoked during pregnancy in the ALSPAC study than in the Pelotas cohorts (table 4). Greater inequalities in caesarean section were observed in the three Pelotas cohorts than in the ALSPAC study. Higher education-related inequalities in preterm birth were observed in the 2004 Pelotas cohort than in the ALSPAC study. Education had a much more marked effect on breast feeding than income in ASPAC study. While there were no income-related inequalities in breast feeding in the 1982 and 1993 Pelotas cohort studies, the magnitude of education-related inequalities in breast feeding for less than 3 months was almost three times higher in the ALSPAC than in the 2004 Pelotas cohort study.

Trends of stronger education-related inequalities over time were observed in the Pelotas cohorts for smoking during pregnancy, preterm birth and breast feeding for less than 3 months. Decreasing trends in income-related inequalities for IUGR as well as decreasing trends in both income and education-related inequalities for deliveries not attended by a doctor were observed in the Pelotas cohort studies.

DISCUSSION

In general, in both the UK based and all of the Brazil based birth cohorts, mothers and infants from poorer and less-educated backgrounds had more adverse health outcomes than those from richer and better-educated background. The magnitudes of income and education-related inequalities were outcome and setting specific and were assessed using the RII—a ratio-type measure. Stronger income-related inequalities for smoking and education-related inequalities for breast feeding were observed in the ALSPAC than in the Pelotas cohorts. However, stronger income and education-related inequalities in caesarean section and higher education-related inequalities in preterm birth were observed in the Pelotas cohorts than in the ALSPAC study. Education-related inequalities became wider over time (ie, stronger in more contemporary birth cohorts) in the Pelotas cohorts for smoking, preterm birth and breast feeding.

The main strengths of the study derived from the use of prospective information obtained among large unselected populations with a high response rate and the availability of comparable variables between ALSPAC and the Pelotas cohort studies. However, some methodological difficulties need to be discussed. First, SEP is a complex phenomenon and different indicators have been described to capture its dimensions. Education and occupation, household income and household conditions are frequently used SEP indicators, each reflecting somewhat different individual and societal forces associated with health and disease. In our study, only maternal education and family income were available both in the ALSPAC and the Pelotas cohort studies databases, and it was not possible to

Table 2 Crude and multivariable associations of economic and educational position with maternal outcomes among the ALSPAC and Pelotas birth cohort studies

	Relative index of inequality: OR for each outcome comparing those at the bottom to those at the top of the income or educational hierarchy (95% CI)							
	Income				Education			
Models	**ALSPAC 1991/92**	**Pelotas 1982**	**Pelotas 1993**	**Pelotas 2004**	**ALSPAC 1991/92**	**Pelotas 1982**	**Pelotas 1993**	**Pelotas 2004**
Ever smoked during pregnancy								
Crude	12.4 (10.0 to 15.3)	2.5 (2.1 to 3.0)	2.3 (1.9 to 2.9)	4.9 (3.8 to 6.3)	7.4 (6.2 to 8.7)	1.7 (1.4 to 2.1)	3.5 (2.8 to 4.4)	7.8 (5.9 to 10.2)
Model 1	12.6 (10.0 to 15.7)	2.6 (2.1 to 3.2)	2.3 (1.8 to 2.8)	4.9 (3.8 to 6.4)	7.8 (6.5 to 9.4)	1.8 (1.4 to 2.2)	3.8 (3.1 to 4.8)	8.0 (5.9 to 10.7)
Model 2	9.5 (7.5 to 12.0)	2.3 (1.8 to 2.9)	2.0 (1.6 to 2.5)	3.6 (2.7 to 4.7)	6.3 (5.2 to 7.7)	1.6 (1.3 to 2.0)	3.2 (2.5 to 4.1)	5.2 (3.8 to 7.2)
Model 2+other SEP score	5.9 (4.6 to 7.7)	2.4 (1.8 to 3.3)	1.4 (1.1 to 1.8)	2.3 (1.7 to 3.1)	3.8 (3.0 to 4.9)	0.9 (0.7 to 1.3)	2.8 (2.1 to 3.6)	3.8 (2.7 to 5.3)
Caesarean section								
Crude	0.6 (0.5 to 0.8)	0.2 (0.1 to 0.3)	0.3 (0.2 to 0.3)	0.3 (0.2 to 0.3)	0.8 (0.7 to 1.1)	0.2 (0.2 to 0.3)	0.2 (0.2 to 0.3)	0.2 (0.1 to 0.2)
Model 1	0.6 (0.4 to 0.7)	0.2 (0.1 to 0.3)	0.3 (0.2 to 0.3)	0.3 (0.2 to 0.4)	0.8 (0.6 to 1.0)	0.2 (0.2 to 0.3)	0.2 (0.2 to 0.3)	0.2 (0.1 to 0.2)
Model 2	0.6 (0.5 to 0.9)	0.2 (0.2 to 0.3)	0.3 (0.2 to 0.4)	0.4 (0.3 to 0.5)	0.9 (0.7 to 1.2)	0.3 (0.2 to 0.3)	0.3 (0.2 to 0.3)	0.2 (0.2 to 0.3)
Model 3	0.6 (0.4 to 0.8)	—	0.3 (0.2 to 0.4)	0.4 (0.3 to 0.5)	0.8 (0.6 to 1.1)	—	0.2 (0.2 to 0.3)	0.3 (0.2 to 0.3)
Model 4	0.6 (0.4 to 0.8)	0.2 (0.2 to 0.3)	0.3 (0.2 to 0.4)	0.4 (0.3 to 0.5)	0.8 (0.6 to 1.1)	0.3 (0.2 to 0.3)	0.3 (0.2 to 0.3)	0.2 (0.2 to 0.3)
Model 4+other SEP score	0.6 (0.4 to 0.9)	0.4 (0.3 to 0.6)	0.4 (0.3 to 0.6)	0.6 (0.4 to 0.7)	0.9 (0.7 to 1.4)	0.5 (0.3 to 0.6)	0.4 (0.3 to 0.5)	0.3 (0.2 to 0.4)
Delivery not assisted by doctor								
Crude	1.8 (1.5 to 2.3)	6.6 (5.4 to 8.0)	3.0 (2.2 to 4.0)	3.2 (2.2 to 4.6)	2.5 (2.1 to 3.0)	5.4 (4.4 to 6.6)	3.2 (2.3 to 4.4)	2.5 (1.7 to 3.6)
Model 1	2.0 (1.6 to 2.5)	6.7 (5.4 to 8.3)	2.9 (2.1 to 4.0)	2.8 (1.9 to 4.1)	2.6 (2.1 to 3.1)	5.5 (4.3 to 6.8)	3.2 (2.3 to 4.4)	2.4 (1.6 to 3.6)
Model 2	1.9 (1.5 to 2.4)	6.1 (4.8 to 7.8)	2.6 (1.8 to 3.5)	2.2 (1.5 to 3.3)	1.9 (1.5 to 2.3)	4.3 (3.4 to 5.5)	2.6 (1.8 to 3.6)	1.6 (1.0 to 2.5)
Model 3	1.9 (1.5 to 2.5)	—	2.6 (1.9 to 3.6)	2.4 (1.6 to 3.5)	2.0 (1.6 to 2.6)	—	2.7 (1.9 to 3.9)	1.7 (1.1 to 2.7)
Model 4	1.8 (1.4 to 2.3)	5.9 (4.7 to 7.6)	2.5 (1.8 to 3.5)	2.2 (1.5 to 3.3)	1.9 (1.5 to 2.4)	4.3 (3.4 to 5.4)	2.6 (1.8 to 3.8)	1.5 (1.0 to 2.4)
Model 5	1.6 (1.2 to 2.1)	4.6 (3.5 to 6.1)	1.9 (1.3 to 2.7)	1.6 (1.0 to 2.5)	2.0 (1.5 to 2.6)	3.0 (2.3 to 4.0)	1.9 (1.3 to 2.7)	0.9 (0.6 to 1.4)
Model 5+other SEP score	1.3 (1.0 to 1.8)	3.8 (2.7 to 5.3)	1.7 (1.1 to 2.4)	1.8 (1.1 to 2.8)	1.8 (1.3 to 2.5)	1.4 (1.0 to 2.0)	1.6 (1.1 to 2.3)	0.7 (0.4 to 1.2)

Model 1: adjusted for pre-pregnancy body mass index.
Model 2: Model 1+ethnic origin, maternal age, marital status and parity.
Model 3: Model 2+urinary infection, hypertension, hospital admission during pregnancy.
Model 4: Model 3+ever smoked during pregnancy for the ALSPAC and Pelotas 1993 and 2004; Model 2 + ever smoked during pregnancy for the Pelotas 1982 cohort study.
Model 5: Model 4+caesarean section.

Table 3 Crude and multivariable associations of economic and educational position with infants' outcomes among the ALSPAC and Pelotas birth cohort studies

	Relative index of inequality: OR for each outcome comparing those at the bottom to those at the top of the income or educational hierarchy (95% CI)							
	Income				Education			
Models	ALSPAC 1991/92	Pelotas 1982	Pelotas 1993	Pelotas 2004	ALSPAC 1991/92	Pelotas 1982	Pelotas 1993	Pelotas 2004
Intra-uterine growth restriction								
Crude	2.2 (1.7 to 2.8)	3.3 (2.5 to 4.2)	2.0 (1.5 to 2.6)	2.3 (1.7 to 3.1)	2.0 (1.6 to 2.4)	2.2 (1.7 to 2.9)	2.2 (1.6 to 3.0)	1.9 (1.4 to 2.6)
Model 1	2.2 (1.7 to 2.8)	3.5 (2.6 to 4.6)	2.0 (1.5 to 2.7)	2.3 (1.7 to 3.2)	2.0 (1.6 to 2.5)	2.5 (1.8 to 3.3)	2.2 (1.6 to 3.1)	2.2 (1.6 to 3.0)
Model 2	2.0 (1.5 to 2.7)	3.7 (2.7 to 5.1)	2.0 (1.5 to 2.7)	2.5 (1.8 to 3.5)	2.3 (1.8 to 3.0)	2.6 (1.9 to 3.5)	2.2 (1.6 to 3.1)	2.9 (2.0 to 4.2)
Model 3	1.7 (1.2 to 2.3)	—	1.9 (1.4 to 2.6)	2.5 (1.8 to 3.5)	2.1 (1.6 to 2.7)	—	2.1 (1.5 to 3.0)	3.0 (2.0 to 4.3)
Model 4	1.4 (1.0 to 1.9)	3.5 (2.5 to 4.7)	1.7 (1.3 to 2.4)	2.2 (1.6 to 3.1)	1.7 (1.3 to 2.2)	2.4 (1.8 to 3.4)	1.8 (1.3 to 2.6)	2.5 (1.7 to 3.6)
Model 4+SEP score	1.2 (0.8 to 1.7)	3.1 (2.1 to 4.6)	1.5 (1.1 to 2.1)	1.8 (1.3 to 2.6)	1.8 (1.3 to 2.6)	1.2 (0.8 to 1.8)	1.6 (1.1 to 2.3)	2.0 (1.3 to 3.0)
Preterm birth								
Crude	1.8 (1.3 to 2.6)	1.3 (0.8 to 2.0)	1.6 (1.2 to 2.2)	2.4 (1.7 to 3.3)	1.6 (1.2 to 2.1)	1.3 (0.8 to 2.1)	1.9 (1.3 to 2.6)	2.3 (1.6 to 3.2)
Model 1	1.8 (1.2 to 2.6)	1.1 (0.7 to 1.8)	1.6 (1.1 to 2.1)	2.1 (1.5 to 2.9)	1.6 (1.1 to 2.2)	1.3 (0.8 to 2.1)	1.9 (1.4 to 2.7)	2.2 (1.6 to 3.2)
Model 2	1.8 (1.2 to 2.8)	1.1 (0.6 to 1.9)	1.3 (1.0 to 1.9)	1.9 (1.3 to 2.8)	1.6 (1.1 to 2.3)	1.1 (0.6 to 1.9)	1.6 (1.1 to 2.3)	2.3 (1.5 to 3.4)
Model 3	1.6 (1.0 to 2.6)	—	1.2 (0.8 to 1.7)	1.8 (1.2 to 2.5)	1.2 (0.8 to 1.9)	—	1.4 (1.0 to 2.1)	2.2 (1.4 to 3.3)
Model 4	1.7 (1.1 to 2.9)	1.1 (0.6 to 1.8)	1.2 (0.8 to 1.7)	1.7 (1.2 to 2.4)	1.3 (0.8 to 1.9)	1.1 (0.6 to 1.8)	1.4 (1.0 to 2.0)	2.0 (1.3 to 3.1)
Model 5	1.7 (1.0 to 2.9)	1.1 (0.7 to 1.9)	1.2 (0.9 to 1.8)	1.7 (1.2 to 2.5)	1.2 (0.8 to 1.9)	1.1 (0.6 to 1.9)	1.5 (1.0 to 2.1)	2.0 (1.3 to 3.1)
Model 6	1.7 (1.0 to 2.8)	1.3 (0.8 to 2.3)	1.3 (0.9 to 1.8)	1.8 (1.2 to 2.6)	1.2 (0.8 to 2.0)	1.2 (0.7 to 2.2)	1.5 (1.0 to 2.2)	2.2 (1.4 to 3.4)
Model 6+SEP score	1.7 (1.0 to 3.0)	1.2 (0.6 to 2.5)	1.1 (0.8 to 1.6)	1.5 (1.0 to 2.3)	0.9 (0.5 to 1.7)	1.1 (0.5 to 2.2)	1.4 (1.0 to 2.2)	1.9 (1.2 to 3.0)
Breast feeding for less than 3 months								
Crude	3.4 (2.8 to 4.1)	1.1 (0.7 to 1.6)	0.9 (0.6 to 1.4)	1.6 (1.2 to 2.1)	6.9 (5.8 to 8.3)	0.8 (0.5 to 1.2)	1.2 (0.8 to 1.9)	1.8 (1.4 to 2.4)
Model 1	3.3 (2.7 to 4.0)	1.1 (0.7 to 1.6)	0.9 (0.6 to 1.4)	1.5 (1.1 to 1.9)	6.6 (5.5 to 8.0)	0.9 (0.6 to 1.4)	1.3 (0.8 to 2.0)	1.7 (1.3 to 2.4)
Model 2	3.0 (2.4 to 3.7)	1.2 (0.8 to 2.0)	0.9 (0.6 to 1.4)	1.3 (1.0 to 1.8)	6.6 (5.4 to 8.1)	0.9 (0.6 to 1.5)	1.5 (0.9 to 2.5)	1.8 (1.3 to 2.5)
Model 3	3.1 (2.5 to 3.8)	—	0.9 (0.5 to 1.4)	1.3 (0.9 to 1.7)	7.0 (5.6 to 8.6)	—	1.5 (0.9 to 2.5)	1.8 (1.3 to 2.6)
Model 4	2.6 (2.0 to 3.2)	1.1 (0.7 to 1.8)	0.8 (0.5 to 1.3)	1.2 (0.9 to 1.7)	6.1 (4.9 to 7.6)	0.9 (0.6 to 1.4)	1.4 (0.8 to 2.3)	1.7 (1.2 to 2.5)
Model 5	2.5 (2.0 to 3.2)	1.1 (0.7 to 1.8)	0.8 (0.5 to 1.2)	1.2 (0.9 to 1.7)	6.3 (5.0 to 7.9)	0.9 (0.5 to 1.4)	1.3 (0.8 to 2.1)	1.7 (1.2 to 2.5)
Model 6	2.5 (2.0 to 3.2)	1.1 (0.6 to 1.9)	0.8 (0.5 to 1.2)	1.2 (0.9 to 1.6)	6.2 (4.9 to 7.7)	0.8 (0.5 to 1.3)	1.3 (0.8 to 2.1)	1.7 (1.2 to 2.5)
Model 7	2.5 (2.0 to 3.2)	1.1 (0.6 to 1.9)	0.8 (0.5 to 1.2)	1.2 (0.9 to 1.6)	6.1 (4.9 to 7.7)	0.8 (0.5 to 1.3)	1.2 (0.7 to 2.0)	1.7 (1.2 to 2.4)
Model 7+SEP score	1.4 (1.1 to 1.8)	1.7 (0.8 to 3.5)	0.7 (0.4 to 1.1)	1.0 (0.7 to 1.4)	5.7 (4.3 to 7.4)	0.6 (0.3 to 1.2)	1.4 (0.8 to 2.5)	1.7 (1.2 to 2.5)

Model 1: adjusted for pre-pregnancy body mass index.
Model 2: Model 1+ethnic origin, maternal age, marital status and parity.
Model 3: Model 2+urinary infection, hypertension, hospital admission during pregnancy.
Model 4: Model 3+ever smoked during pregnancy for the ALSPAC and Pelotas 1993 and 2004; Model 2+ever smoked during pregnancy for the Pelotas 1982 cohort study.
Model 5: Model 4+caesarean section and delivery assisted by doctor.
Model 6: Model 5+intra-uterine growth restriction.
Model 7: Model 6+preterm birth.
SEP, socioeconomic position.

examine the role of other SEP indicators. Second, maternal education in the Pelotas studies was measured as complete years of schooling while in the ALSPAC study it was measured as educational achievement. Schooling and educational achievement do not mean exactly the same thing. It is possible that stronger education-related inequalities would exist between women who do and do not have higher qualifications. Third, the meaning of family income may vary between settings and may be influenced by family size, but information on the latter was not collected in the perinatal interview for the 1982 Pelotas cohort. Finally, although the proportion of missing values in family income in the ALSPAC database was relatively high, the use of multiple imputation analysis to assess the impact of missing values resulted in effect estimates that were essentially the same as those without imputation, which provides some assurance against substantial selection bias.[20]

We found higher income-related inequalities for smoking during pregnancy in the ALSPAC than in the Pelotas cohort studies. The disadvantages of being poor in a rich and prosperous country compared to being in the same condition in a low or middle-income country have been raised before.[21] In the Pelotas studies, even though prevalence rates of smoking during pregnancy have declined, inequalities in education-related inequalities are increasing, showing that tobacco control policies and programmes have been reaching the better-educated in a more effective way than the less-educated pregnant women during the last decades.

Patterns of professional attendance at birth varied in the two countries. While midwives deliver over 75% of UK newborns, in southern Brazil virtually all deliveries are carried out by obstetricians.[22] This is why deliveries not attended by a doctor are more frequent in the ALSPAC than in Pelotas. Several studies have documented large differences in the use of delivery care according to women's wealth and/or educational levels.[23 24] In ALSPAC, while low income-related inequalities were found for deliveries not attended by a doctor, education-related inequalities were as high as in the 2004 Pelotas cohort study. Among the Pelotas studies, the largest income-related inequalities were found in the 1982 cohort. Health services could have been inaccessible or unaffordable to women with few economic resources in 1982. The substantial expansion of healthcare services during the early 1990s, as well as an increase in the availability of trained professionals, could explain why trends in both income and education-related inequalities decreased in Pelotas cohort studies throughout the last decades.

Despite continuing debate on the appropriate level of population-based caesarean rates, rates of no less than 5% and no

Table 4 Summary of SEP indicators' association with maternal and infant's outcomes, effect of adjustment on each association, income and education-related inequalities in the ALSPAC 1991/92 and in the 1982, 1993 and 2004 Pelotas cohorts and trends in inequalities in the Pelotas cohort studies

	Crude association between SEP indicator and outcome		Effect of adjustment in the association between SEP indicator and outcome				Trends in inequalities in Pelotas cohorts	
Outcomes	**Income**	**Education**	**Income**	**Education**	**Income-related inequalities**	**Education-related inequalities**	**Income**	**Education**
Ever smoked during pregnancy	Inverse (higher among the poorest)	Inverse	Moderate effect: ALSPAC & 2004 Small effect: 1982 & 1993	Moderate effect: ALSPAC & 2004 Small effect: 1982 & 1993	ALSPAC >> Pelotas	ALSPAC ≈ 2004 ALSPAC & 2004 > 1993	No trends	Increasing
Caesarean section	Positive (higher among richest)	Positive	Almost no effect in all cohorts	Almost no effect in all cohorts	Pelotas>ALSPAC	Ø ALSPAC 1982 ≈ 1993 ≈ 2004	No trends	No trends
Delivery not attended by a doctor	Inverse	Inverse	Almost no effect in ALSPAC Some effect in Pelotas cohorts	Almost no effect in ALSPAC. Moderate effect in Pelotas cohorts	Pelotas>ALSPAC	Pelotas 1982 & 1993>ALSPAC	Decreasing	Decreasing
Intrauterine growth restriction	Inverse	Inverse	Almost no effect in all cohorts	Almost no effect in all cohorts	1982 > other cohorts ALSPAC ≈ 1993 & 2004	ALSPAC ≈ Pelotas	Decreasing	No trends
Preterm birth	Inverse (no association in 1982 cohort)	Inverse (no association in 1982 cohort)	Almost no effect in ALSPAC Small effect in Pelotas cohorts	Moderate effect in ALSPAC. No effect in Pelotas cohorts	Ø in 1982 ALSPAC ≈ 1993 & 2004	Ø in 1982 Pelotas 2004 > ALSPAC	Increasing	Increasing
Breast feeding for less than 3 months	Inverse (no association in 1982 & 1993 cohorts)	Inverse (no association in 1982 & 1993 cohorts)	Moderate effect in ALSPAC Almost no effect in Pelotas cohorts	Almost no effect in any cohort	Ø in 1982 & 1993 ALSPAC > Pelotas 2004	Ø 1982 & 1993 ALSPAC >> 2004	No trends	Increasing

Ø, no inequalities; ≈, similar magnitude; >, high; >>, much higher; SEP, socioeconomic position.

more than 15% have been recommended.[25] In the ALSPAC study, the prevalence of caesarean sections was below the recommended upper limit[25] and no educational-related inequalities were found. In the Pelotas studies, rates of caesarean section were high both in the public and private sector. For private patients, the current rate in Pelotas is at the striking level of 82%.[26] These differences likely reflect the fact that obstetricians carry out most deliveries in Pelotas, whereas midwives do so in the UK. Higher caesarean sections rates do not mean better quality healthcare and, paradoxically, at least in terms of caesarean section rates, the Latin-American poor may be receiving healthcare of better quality than the rich.[27] However, targets for this indicator should be determined to assure that those most in need are served and that overuse without health need is actively discouraged.

Poor intrauterine growth and preterm birth are not only predictors for perinatal and neonatal mortality and morbidity but also determine human susceptibility to disease and quality of life later on.[28] The risk of delivering an IUGR infant was higher among poor and less-educated women, as has been described in previous studies,[29 30] and the magnitude of income and education-inequalities was similar in the ALSPAC and the Pelotas studies. Rates of preterm births, which were almost the same in the ALSPAC and the 1982 Pelotas study, increased in the Pelotas cohorts nearly three-times during the studied period—a finding that was reported in a previous publication.[26] Neither income nor education-related inequalities were observed in the 1982 Pelotas cohort. In the 2004 Pelotas cohort, education-related inequalities in preterm birth become more evident and higher than in the ALSPAC study even after adjustment for maternal and newborn characteristics. These findings are in accordance with other investigations that showed the importance of maternal educational level among other SEP measures as a strong predictor of inequalities in preterm birth.[31]

Breast feeding is the best way of feeding an infant and provides well-known benefits to the infant and the mother.[32 33] Income-related inequalities in breast feeding were observed in the ALSPAC study but not in the 1982 and 1993 Pelotas cohort studies. High education-related inequalities were found in the ALSPAC study, with magnitudes almost three-times higher than in the 2004 Pelotas cohort study. Our findings are consistent with previously reported observations of substantial inequalities in breast feeding practices within UK.[34 35] Brazil has, for more than 20 y, implemented several strategies to promote breast feeding[36 37] and, specifically, the city of Pelotas was a participating centre in the Multicenter Growth Reference Study (MGRS) where a breast feeding support programme was implemented from 1997–1998. After the MGRS, several interventions promoting breast feeding continued to be carried out in the city, which may underlie increasing trends in breast feeding in the last decades.[38] However, breast feeding interventions and programmes seemed to have better-reached women with higher schooling, widening the gap between women at the bottom and at the top of the educational hierarchy.

Finally, it should be noted that whereas income and education-related inequalities were evident in both populations, the poorest in the UK were in a better situation than those in Pelotas for all studied health indicators with the exception of breast feeding duration.

CONCLUSION

The present study was able to make comparisons of the scale of health inequalities in maternal and infant outcomes between populations from a high and a middle-income country and also to asses how health inequalities change over time. Our findings showed that socioeconomic inequalities in health are dynamic and vary between countries, over time and between generations within the same country.[3 39] Maternal education and family income reflect different aspects of the SEP construct and were related to health outcomes in different ways among the studied populations, also altering their effect over time. Even though the SEP indicators used in this study have proved very useful in describing and evaluating health inequalities, they provide only a partial view of socioeconomic inequalities in health. Investigations using SEP at different points in the life course should be useful in pointing to specific mechanisms to explain the development and maintenance of health inequalities.

What is already known on this subject

The relation between specific socioeconomic position (SEP) indicators and specific health outcomes can vary between countries due to differences in the cultural contexts of the SEP indicators. Comparisons between high and middle or low-income countries could provide useful insights into the causes of health inequalities.

What this study adds

Our findings showed that socioeconomic inequalities in health are dynamic and vary between countries, over time and between generations within the same country. Investigations using SEP at different points in the life course should be useful in pointing to specific mechanisms to explain the development and maintenance of health inequalities.

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Competing interests None.

Ethics approval Ethics approval for the study was obtained from the ALSPAC Law and Ethics Committee and the Local Research Ethics Committees. The study protocol of 1982, 1993 and 2004 Pelotas cohort studies was approved by the Medical Ethics Committee of the Federal University of Pelotas, affiliated with the Brazilian Federal Medical Council.

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Association of socioeconomic position with maternal pregnancy and infant health outcomes in birth cohort studies from Brazil and the UK

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