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The relationship between educational outcomes and family socioeconomic position in Scotland: the role of low birthweight and child development.

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LSCS longitudinal studies centre Scotland — LINKING LIVES THROUGH TIME

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Abstract

There is a long-standing association between family socioeconomic position and educational outcomes. This study seeks to explore whether variation in low birthweight and child development by family background explain these differences. The relationship between socioeconomic position, birth outcomes and pre-school child development is complex and requires an interdisciplinary assessment. Using linked administrative data from Scotland, our findings suggest that birthweight and child development partially explain this variation but cannot entirely account for socioeconomic differences in educational outcomes.

1. Introduction

Attainment in national qualifications at the end of compulsory schooling influences the post-school routes that young people take and their subsequent life chances (Howieson and Iannelli 2008, Croxford 2009, Playford and Gayle 2016). Educational attainment is strongly associated with a number of indicators of socioeconomic background. Parental socioeconomic position is highly predictive of educational attainment of children (Anderson et al. 2004, Breen 2005, Croxford 2009, Bukodi and Goldthorpe 2013, Gayle, Murray, and Connelly 2016, Croxford 2015). Stratification in filial educational attainment by parental education is similarly patterned (Björklund and Salvanes 2011, Bukodi and Goldthorpe 2013, Chevalier et al. 2013). Persistent differences in the educational attainment of boys and girls has also been studied extensively (see Croxford et al. 2003, Younger and Warrington 2005, Gayle, Lambert, and Murray 2009, Calvin et al. 2010). This paper is concerned with better understanding the role of biological pathways through which intergenerational socioeconomic disadvantage is reproduced (see Feinstein, Duckworth, and Sabates 2008). This study examines how inequalities in birthweight and child development can further reproduce and reinforce social inequalities in educational attainment. As Bradshaw (2011: 22) notes:

"Compared with children whose parents are degree-educated, those whose parents have no qualifications are more likely, amongst other things, to have younger mothers, live in lone parent families, experience lower levels of home learning activities and household rules, to have had a low birth weight, poorer general health, and a mother who smokes."

The influence of birthweight on educational outcomes is complicated by socioeconomic differences in birthweights (Blumenshine et al. 2010). Children of parents in manual occupations are more likely to have low or very low birthweight (Dibben, Sigala, and Macfarlane 2006, Macfarlane and Mugford 2000, Moser, Li, and Power 2003, Macfarlane, Stafford, and Moser 2004, Maher and Macfarlane 2004). Maternal education has also identified as having an (albeit small) effect on birthweight (Chevalier and O' Sullivan

2007). Smoking during pregnancy is also associated with low birthweight (Flower et al. 2013). These findings would suggest that part of the socioeconomic differences in educational outcomes may be explained by variation in birthweight.

Investigating biological factors and how these affect educational attainment is challenging because of the complex manner in which factors such as birthweight, premature birth and child development are inter-related. In studies of twins (which seek to control for socioeconomic background) low birthweight has been associated with negative impacts on educational attainment, income and health in adulthood (Behrman and Rosenzweig 2004, Black, Devereux, and Salvanes 2007, Almond and Currie 2011, Royer 2009). This suggests that there is a direct effect of birthweight on educational outcomes.

Low birthweight is also predictive of impaired child development (Hack, Klein, and Taylor 1995). This is consequential because educational outcomes are associated with a number of child development indicators including gross motor skills (Son and Meisels 2006, Viholainen et al. 2006, Westendorp et al. 2011, Lopes et al. 2013), fine motor skills (Potter, Mashburn, and Grissmer 2013), hearing (Teasdale and Sorensen 2007) and emotional and behavioural problems (McLeod and Kaiser 2004). This would suggest that there may be an indirect of low birthweight on educational outcomes via impaired child development.

Birthweight is often a consequence of premature birth[1]. Low birthweight is predictive of a range of subsequent detrimental health outcomes (Barker 1995, Spencer 2003, Kuh and Ben-Shlomo 2004, Collingwood Bakeo and Clarke 2006). It is therefore unsurprising that negative health outcomes are also associated with increasing prematurity (Boyle et al. 2012). Extremely preterm children had lower scores in measures of education attainment, with a high risk of being classified as Special Educational Needs (SEN, see Johnson et al. 2009, MacKay et al. 2010). Therefore, the investigation of the relationship between low birthweight on educational outcomes must take account of the gestational age of the infant at birth. In this study we therefore seek to investigate the role that low birthweight has on educational outcomes net of the influence of socioeconomic position whilst controlling for factors that may confound our associations, such as variation in child development and gestational age of infants. The following research questions are the subject of this paper:

1. To what extend do childhood development indicators attenuate the relationship between family socioeconomic position and educational attainment?

[1] http://www.who.int/maternal_child_adolescent/topics/newborn/care_of_preterm/en/ accessed 24th November 2015.

2. To what extend does being born Small for Gestational Age (SGA) attenuate the relationship between family socioeconomic position and educational attainment?

2. Materials and methods

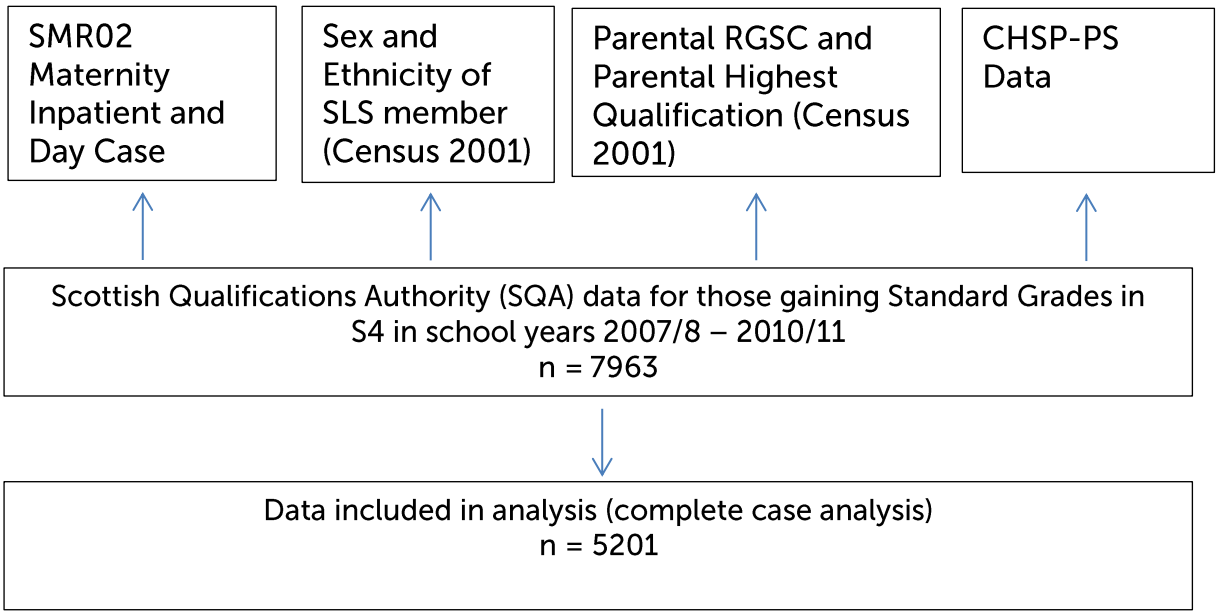
2.1. Data sources and study population

The data analysed includes a number of administrative datasets linked to the Scottish Longitudinal Study (SLS) by NHS Scotland Information Services Division (ISD). The SLS is a 5.3% representative sample of the Scottish population which links Census records (from 1991, 2001 and 2011) to other administrative data resources (Boyle et al. 2009). In this study, the linked administrative datasets include:

- *Scottish Qualifications Authority (SQA) attainment data*
- *Scottish Morbidity Record maternity inpatient and day case dataset (SMR02)*
- *Child Health Surveillance Programme – Pre School (CHSP-PS)*

Figure 1 describes the schema by which the data were linked. The educational outcome measures were available within the SQA attainment data. The mothers of SLS members were identified in the SMR maternity dataset (SMR02). Using the relationships between SLS members identified through the Census, it was then possible to include information relating the sex and ethnicity of respondent and parental socioeconomic position and parental highest qualification.

Figure 1 Data Linkage Schema



Source: Scottish Longitudinal Study

1.1. Outcome measure

Two measures of attainment in Standard Grades were used. The first inverted the Standard Grade scheme awarding 7 points for a grade 1 and 1 point for a grade 7. This method is used by Croxford, Iannelli, and Shapira (2007). Five or more GCSEs at grades A* to C is a well-recognized benchmark employed in official statistics and social research (Leckie and Goldstein 2009), but there is not a similar benchmark in Scotland. The second measure was whether a young person gained 5 or more Credit passes (grades 1 or 2), which is consistent with measures used by the Scottish Credit and Qualification Framework (see Anderson et al. 2004).

1.2. Measures

The Maternity Inpatient and Day Case data contains variables recorded at the birth of the SLS member including maternal marital status, maternal height, maternal age, maternal smoking status, mode of deliver, parity, APGAR, birthweight, and estimated gestation. The measure of low birthweight that we have chosen to use in these analyses is Small for Gestational Age (SGA). SGA was calculated as the bottom 10th percentile of birthweights for each completed week of estimated gestational age for each sex for infants born after 32 weeks (World Health Organisation 1995, see Royal College of Obstetricians and Gynaecologists 2013).

Parental occupation is classified using Registrar General's Social Class (RGSC, see Rose 1995). Analysis has been restricted to natural parents, with legal step-parents excluded. As a consequence, it was decided to use the higher ranking of father's or mother's occupation. Parental education is classified using the highest qualification gained, based on the 2001 census[2]. Sex[3] and ethnicity[4] are recorded in the core tables from the 2001 census. Ethnicity was not included as an independent variable in the models as the number of non-white individuals was too low and the diversity of ethnic groups within this category too great to ensure meaningful comparison.

The Child Health Surveillance Programme – Pre-School (CHSP-PS) contains indicators of child development which are based on the Woodside system (Barber, Boothman, and Paget-Stanfield 1976). These relate to gross motor skills, fine motor skills, hearing, social skills and vision. Participants are classified as either normal, incomplete, doubtful/uncertain or abnormal. The number of CHSP-PS reviews varies by individual and local authority over time (see Wood et al. 2012). More details of linked CHSP-PS review

[2] See http://www.lscs.ac.uk/dictionary/index.php?tables,C20_C21,HLQP0 accessed 21/08/14
[3] See http://www.lscs.ac.uk/dictionary/index.php?tables,A01_E01_E02_E03_E04,SEX accessed 21/08/14
[4] See http://www.lscs.ac.uk/dictionary/index.php?tables,C20_C21,ETHP0 accessed 21/08/14

data with the SLS will be included in a forthcoming paper by the Scottish Longitudinal Study Development & Support Unit.

1.3. Method

Linear and logistic regression models have been estimated using Stata v13 (StataCorp 2013). To model the differing number of CHSP-PS reviews that an individual may have participated in, the data were modelled as a panel with multiple observations per person. The educational outcomes are recorded at age 15-16, so estimates were adjusted for clustering to account for multiple observations per individual. This has the advantage of retaining the maximum amount of information.

2. Results

2.1. Descriptive statistics

Table 1 reports the characteristics of babies born Small for Gestational Age (SGA) and those were not. There are notable differences by parental highest RGSC: 17 percent of the children with a parent in partly skilled occupation (RGSC IV) were SGA. This compares to 7 percent of children whose parental highest occupation was professional (RGSC I). Similarly, babies born to parents without educational qualifications were more likely to be SGA. A higher percentage of babies born with either abnormal or doubtful gross or fine motor skills were SGA, although the subsamples were relatively small. Babies born to mothers who had a history of smoking (current at the time of booking) and those born to mothers with a height below 155cm were also more likely to be SGA.

Mean Standard Grade points scores by explanatory variables are reported in table 2. Variation in attainment is consistent with expected patterns with girls outperforming boys. Pupils with parents in more advantaged occupations had higher attainment than those in less advantaged occupations. Similarly, children who had a parent with a degree did better than those whose parents did not have educational qualifications.
There are differing levels of attainment by maternal marital status and household type, which we suggest is because these variables are socially patterned (Galobardes et al. 2006). Attainment by a number of the birth variables also appears to be socially patterned (for example, maternal smoking history, maternal age and maternal height). Lower attainment is reported for those with abnormal or doubtful development in gross motor, fine motor, social and hearing measures.

The percentage of pupils gaining five or more Standard Grade credit passes are reported in table 3. These broadly follow the descriptive patterns observed in table 2. Thirty four percent of pupils gain five or more credit passes. The differences in attainment between the most advantaged and least advantaged pupils are striking. For example, 67 percent of those with parents in professional occupations gained five or more credit passes,

compared to 13 percent of those with parents in unskilled occupations. Similarly, 59 percent of children with a parent who has a degree gain 5 or more credit passes whilst for children whose parents are without qualifications, this figure is 11 percent. Attainment is lower for children with abnormal or doubtful development measures. Children who were born SGA are less likely to gain five or more credit passes than children who are not (23 percent compared to 35 percent).

The social patterning of the variables recorded at birth reinforces the need to control for parental socioeconomic position and measures recorded at birth when seeking to evaluate variation in educational attainment at age 15/16 (school year S4). The next section presents models of attainment which reflect this.

Table 1 Characteristics of babies born Small for Gestational Age (SGA)

Variable	Not Small for Gestational Age *(row %)* n= 4,650	Small for Gestational Age *(row %)* n= 551		n
Sex (2001)				
Female	89	11	100%	2,507
Male	90	10	100%	2,694
Parental RGSC (2001)				
I Professional Occupations	93	7	100%	322
II Managerial and Technical Occupations	91	9	100%	1,856
IIIN Skilled Non-manual Occupations	89	11	100%	1,477
IIIM Skilled Manual Occupations	89	11	100%	723
IV Partly Skilled Occupations	83	17	100%	550
V Unskilled Occupations	89	11	100%	167
No job			100%	106
Parental Highest Qualification (2001)				
Degree	92	8	100%	1,276
HNC/HND	91	9	100%	583
Highers/CSYS	91	9	100%	916
O Grade/S Grade	88	12	100%	1,673
No Qualifications	86	14	100%	753
Maternal Marital Status (at Birth)				
Married	91	9	100%	3,745
Other	86	14	100%	1,456
Household Type (2001)				
Lives with Both Parents	90	10	100%	3,363
Lives with Mother Only	89	11	100%	1,532
Lives with Father Only	89	11	100%	306
Gross Motor Skills				
Normal or Incomplete	90	10	100%	5,080
Abnormal or Doubtful	85	15	100%	121
Vision & Fine Motor Skills				
Normal or Incomplete	90	10	100%	4,974
Abnormal or Doubtful	87	13	100%	227
Social				
Normal or Incomplete	89	11	100%	5,040
Abnormal or Doubtful	88	12	100%	161
Hearing & Language				
Normal or Incomplete	90	11	100%	4,619
Abnormal or Doubtful	89	11	100%	582
Smoking History at Booking				
Never	92	8	100%	3,127
Current	81	19	100%	1,471
Former	95	5	100%	458
Not known	88	12	100%	145
Mode of Delivery				
Normal	89	11	100%	3,610
Other	89	11	100%	1,591
Maternal Age				
Below 24	88	12	100%	1,384
25-29	90	10	100%	1,917
Above 30	90	10	100%	1,900
Parity				
Nulliparous	87	13	100%	2,460
Multiparous	92	8	100%	2,741
Maternal Height				
Below 155cm	83	17	100%	553
155-169cm	90	10	100%	3,946
Above 170cm	92	8	100%	702

Source: Scottish Longitudinal Study

Table 2 Mean Standard Grade Points Score by explanatory variables

Variable	Mean	Standard Error	Lower CI	Upper CI	n
Sex (2001)					
Female	33.9	0.3	33.4	34.4	2,507
Male	32.5	0.2	32.0	32.9	2,694
Parental RGSC (2001)					
I Professional Occupations	41.7	0.6	40.5	42.9	322
II Managerial and Technical Occupations	36.8	0.3	36.3	37.4	1,856
IIIN Skilled Non-manual Occupations	32.3	0.3	31.7	32.9	1,477
IIIM Skilled Manual Occupations	28.9	0.5	28.0	29.8	723
IV Partly Skilled Occupations	27.7	0.5	26.6	28.7	550
V Unskilled Occupations	26.3	1.0	24.4	28.2	167
NCR No job in last 10 years or aged	22.7	1.2	20.4	25.1	106
Parental Highest Qualification (2001)					
Degree	39.5	0.3	38.8	40.1	1,276
HNC/HND	35.5	0.5	34.5	36.5	583
Highers/CSYS	34.6	0.4	33.8	35.4	916
O Grade/S Grade	30.3	0.3	29.7	30.9	1,673
No Qualifications	25.0	0.4	24.2	25.9	753
Maternal Marital Status (at Birth)					
Married	34.9	0.2	34.5	35.3	3,745
Other	28.6	0.3	28.0	29.3	1,456
Household Type (2001)					
Lives with Both Parents	35.2	0.2	34.8	35.6	3,363
Lives with Mother Only	28.9	0.3	28.3	29.6	1,532
Lives with Father Only	31.5	0.7	30.1	33.0	306
Gross Motor Skills					
Normal or Incomplete	33.2	0.2	32.9	33.6	5,080
Abnormal or Doubtful	29.1	1.3	26.7	31.6	121
Vision & Fine Motor Skills					
Normal or Incomplete	33.4	0.2	33.1	33.8	4,974
Abnormal or Doubtful	26.4	0.9	24.6	28.2	227
Social					
Normal or Incomplete	33.3	0.2	32.9	33.6	5,040
Abnormal or Doubtful	28.2	1.1	26.0	30.5	161
Hearing & Language					
Normal or Incomplete	33.6	0.2	33.2	34.0	4,619
Abnormal or Doubtful	29.4	0.6	28.4	30.5	582
SGA					
Not SGA	33.6	0.2	33.2	33.9	4,650
SGA	29.4	0.6	28.3	30.5	551
Smoking History at Booking					
Never	35.1	0.2	34.7	35.5	3,127
Current	28.8	0.3	28.1	29.4	1,471
Former	32.7	0.6	31.6	33.8	458
Not known	36.5	1.0	34.5	38.5	145
Mode of Delivery					
Normal	32.7	0.2	32.3	33.1	3,610
Other	34.1	0.3	33.5	34.7	1,591
Maternal Age					
Below 24	29.3	0.3	28.7	30.0	1,384
25-29	33.4	0.3	32.8	33.9	1,917
Above 30	35.7	0.3	35.1	36.3	1,900
Parity					
Nulliparous	34.2	0.3	33.7	34.7	2,460
Multiparous	32.2	0.2	31.7	32.6	2,741
Maternal Height					
Below 155cm	31.7	0.6	30.6	32.8	553
155-169cm	33.1	0.2	32.7	33.5	3,946
Above 170cm	34.3	0.5	33.4	35.3	702

Source: Scottish Longitudinal Study

Table 3 Characteristics of pupils gaining five or more Standard Grade credit passes

Variable	Did not gain 5+ Credit Passes *(row %)* n= 3,435	Gained 5+ Credit Passes *(row %)* n= 1,766		n
Sex (2001)				
Female	62	38	100%	2,507
Male	70	30	100%	2,694
Parental RGSC (2001)				
I Professional Occupations	33	67	100%	322
II Managerial and Technical Occupations	52	48	100%	1,856
IIIN Skilled Non-manual Occupations	72	28	100%	1,477
IIIM Skilled Manual Occupations	81	19	100%	723
IV Partly Skilled Occupations	83	17	100%	550
V Unskilled Occupations	87	13	100%	167
No job			100%	106
Parental Highest Qualification (2001)				
Degree	41	59	100%	1,276
HNC/HND	61	39	100%	583
Highers/CSYS	64	36	100%	916
O Grade/S Grade	78	22	100%	1,673
No Qualifications	89	11	100%	753
Maternal Marital Status (at Birth)				
Married	61	39	100%	3,745
Other	79	21	100%	1,456
Household Type (2001)				
Lives with Both Parents	59	41	100%	3,363
Lives with Mother Only	81	19	100%	1,532
Lives with Father Only	74	26	100%	306
Gross Motor Skills				
Normal or Incomplete	66	34	100%	5,080
Abnormal or Doubtful	78	22	100%	121
Vision & Fine Motor Skills				
Normal or Incomplete	65	35	100%	4,974
Abnormal or Doubtful	80	20	100%	227
Social				
Normal or Incomplete	66	34	100%	5,040
Abnormal or Doubtful	80	21	100%	161
Hearing & Language				
Normal or Incomplete	65	35	100%	4,619
Abnormal or Doubtful	75	25	100%	582
SGA				
Not SGA	65	35	100%	4,650
SGA	77	23	100%	551
Smoking History at Booking				
Never	59	41	100%	3,127
Current	80	20	100%	1,471
Former	71	29	100%	458
Not known	56	44	100%	145
Mode of Delivery				
Normal	67	33	100%	3,610
Other	65	35	100%	1,591
Maternal Age				
Below 24	79	21	100%	1,384
25-29	66	34	100%	1,917
Above 30	56	44	100%	1,900
Parity				
Nulliparous	63	37	100%	2,460
Multiparous	69	31	100%	2,741
Maternal Height				
Below 155cm	72	28	100%	553
155-169cm	66	34	100%	3,946
Above 170cm	61	39	100%	702

Source: Scottish Longitudinal Study

3.2 Small for Gestational Age, Socioeconomic position and educational outcomes

Table 4 reports the results of a series of linear regression models with the outcome being points score in Standard Grades. Model 1 includes independent variables relating to sex and parental socioeconomic position. In model 2, child development measures are added to those in model 1. Variables recorded at birth are included in model 3, in addition to those used in the previous two models.

The patterns of inequality reported in model are as would be expected. Girls outperform boys, which is consistent with previous studies (see Biggart 2000, Younger and Warrington 2005). The effect of parental occupation on standard grade attainment is clear and indicates a well-known pattern of disadvantage (Croxford 2015). The association between parental education and filial educational outcomes is also well-established (Drew, Gray, and Sime 1992, Drew 1995, Korupp, Ganzeboom, and Van der Lippe 2002, Gayle, Berridge, and Davies 2003, Ermisch and Pronzato 2010, Dickson, Gregg, and Robinson 2013). Children whose mothers were not married when they were born do less well. There is also a less well established association between household type and filial educational outcomes (Drew, Gray, and Sime 1992, Gayle, Murray, and Connelly 2016).

The inclusion of child development indicators in model 2 has little effect on the reported coefficients relating to socioeconomic position. When compared with model 1, little additional variance is explained and the models are very similar. This is largely attributable to the small number of children with reported development problems. Whilst the educational attainment of children with abnormal or doubtful vision & fine motor skills or hearing & language skills is lower, there no significant differences are noted for those with abnormal or doubtful gross motor or social skills. We suggest that this is because of the larger standard errors around these estimates, a consequence of these conditions being rarer in the sample.

Variables recorded at birth are included in model 3. Children born SGA have lower attainment than those who are not SGA on average by 3 grades (2.94) controlling for sex, parental socioeconomic position, child development measures and other variables recorded at birth. Standard grade attainment is also lower for children whose mothers were recorded as smokers at the time of booking or were multiparous (i.e. lived in larger families and were not the first born child). There was a clear association with height with children born to mothers of less than 155cm having lower standard grade attainment. As has been previously noted, maternal age, maternal smoking and maternal marital status at birth are potentially all strongly

socioeconomically patterned. Parity is also likely to be social patterned, although the lower attainment noted for children who were younger siblings is notable (this is a similar finding to Härkönen 2014). The coefficients in model 3 control for these factors (recorded after birth) suggesting that this may be additional socioeconomic variation that was not captured in model 1. The overall model fit (indicated by r-squared) increases from 0.17 in model 2 to 0.20 in model 3 suggesting that inclusion of variables recorded at birth explain more of the variation observed. The magnitude of change in r squared that we observed when we add the birth variables to the socioeconomic position variables is broadly similar to those identified by Case, Fertig, and Paxson (2005) using the NCDS 1958.

Models 4 to 6 repeat the analysis using logistic regression models of gaining 5 or more credit passes. This is to check for sensitivity of the findings to the outcome measure used. This is equivalent to attaining gaining five or more awards at Scottish Credit and Qualifications Framework level 5, a measure used by the Scottish Government (see Scottish Executive 2006). The findings are consistent with those reported in models 1-3. Direct comparison of the logistic regression coefficients for the nested models is not possible due to the rescaling that occurs in non-linear models (Breen, Karlson, and Holm 2013). However, the association between parental socioeconomic position and educational attainment persists after controlling for the birth variables, as is the case in the linear regression models 1-3. There also appears to be little difference in attainment between children with parental RGSC IIIM, IV and V.

Table 4 Linear Regression Models for Standard Grade Points Score

	Model 1		Model 2		Model 3	
	B	*SE*	*B*	*SE*	*B*	*SE*
Sex (2001)						
Female	0.00	(0.00)	0.00	(0.00)	0.00	(0.00)
Male	-1.58***	(0.35)	-1.42***	(0.35)	-1.46***	(0.34)
Parental RGSC (2001)						
I	0.00	(0.00)	0.00	(0.00)	0.00	(0.00)
II	-2.65***	(0.74)	-2.64***	(0.73)	-2.39***	(0.73)
IIIN	-4.40***	(0.82)	-4.37***	(0.82)	-3.74***	(0.81)
IIIM	-7.06***	(0.90)	-7.00***	(0.89)	-6.01***	(0.89)
IV	-6.24***	(1.00)	-6.20***	(0.99)	-5.03***	(0.99)
V	-6.04***	(1.35)	-5.90***	(1.36)	-4.72***	(1.34)
No Job	-8.65***	(1.51)	-8.46***	(1.48)	-6.90***	(1.49)
Parental Highest Qualification (2001)						
Degree	0.00	(0.00)	0.00	(0.00)	0.00	(0.00)
HNC/HND	-2.34***	(0.63)	-2.37***	(0.62)	-2.02**	(0.62)
Highers/CSYS	-2.87***	(0.59)	-2.86***	(0.59)	-2.38***	(0.58)
O Grade/S Grade	-5.49***	(0.55)	-5.44***	(0.55)	-4.53***	(0.54)
No Qualifications	-9.30***	(0.70)	-9.21***	(0.70)	-8.13***	(0.70)
Maternal Marital Status (at birth)						
Married	0.00	(0.00)	0.00	(0.00)	0.00	(0.00)
Other	-2.65***	(0.44)	-2.62***	(0.44)	-2.03***	(0.47)
Household Type (2001)						
Lives with Both Parents	0.00	(0.00)	0.00	(0.00)	0.00	(0.00)
Lives with Mother Only	-1.35**	(0.47)	-1.37**	(0.47)	-1.16*	(0.46)
Lives with Father Only	1.09	(0.81)	1.08	(0.80)	1.20	(0.79)
Gross Motor Skills						
Normal or Incomplete			0.00	(0.00)	0.00	(0.00)
Abnormal or Doubtful			-1.46	(1.31)	-1.74	(1.30)
Vision & Fine Motor Skills						
Normal or Incomplete			0.00	(0.00)	0.00	(0.00)
Abnormal or Doubtful			-3.47***	(0.91)	-3.33***	(0.90)
Social						
Normal or Incomplete			0.00	(0.00)	0.00	(0.00)
Abnormal or Doubtful			-2.07	(1.16)	-2.10	(1.15)
Hearing & Language						
Normal or Incomplete			0.00	(0.00)	0.00	(0.00)
Abnormal or Doubtful			-2.88***	(0.54)	-2.50***	(0.53)
SGA						
Not SGA					0.00	(0.00)
SGA					-2.94***	(0.62)
Smoking History at Booking						
Never					0.00	(0.00)
Current					-1.99***	(0.43)
Former					-1.20*	(0.58)
Not known					2.28*	(0.98)
Mode of Delivery						
Normal					0.00	(0.00)
Other					0.04	(0.38)
Maternal Age						
Below 24					-1.72***	(0.48)
25-30					0.00	(0.00)
Above 30+					1.61***	(0.41)
Parity						
Nulliparous					0.00	(0.00)
Multiparous					-3.01***	(0.38)
Maternal Height						
Below 155cm					-0.40	(0.57)
156-169cm					0.00	(0.00)
Above 170cm					0.25	(0.49)
Constant	43.26***	(0.70)	43.35***	(0.70)	44.30***	(0.78)
n records	14313		14313		14313	
R^2	0.17		0.17		0.20	
n	5201		5201		5201	

Standard errors in parentheses $^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$
Source: Scottish Longitudinal Study

Table 5 Logistic Regression Models for Gaining 5 or more Standard Grade Credit Passes

	Model 4		Model 5		Model 6	
	B	*SE*	*B*	*SE*	*B*	*SE*
Sex (2001)						
Female	0.00	(0.00)	0.00	(0.00)	0.00	(0.00)
Male	-0.45***	(0.07)	-0.43***	(0.07)	-0.45***	(0.07)
Parental RGSC (2001)						
I	0.00	(0.00)	0.00	(0.00)	0.00	(0.00)
II	-0.44**	(0.14)	-0.44**	(0.14)	-0.39**	(0.15)
IIIN	-0.80***	(0.16)	-0.80***	(0.16)	-0.70***	(0.16)
IIIM	-1.26***	(0.18)	-1.26***	(0.18)	-1.08***	(0.18)
IV	-0.95***	(0.20)	-0.95***	(0.20)	-0.75***	(0.20)
V	-1.17***	(0.31)	-1.16***	(0.31)	-0.97**	(0.31)
No Job	-1.42***	(0.40)	-1.40***	(0.41)	-1.13**	(0.41)
Parental Highest Qualification (2001)						
Degree	0.00	(0.00)	0.00	(0.00)	0.00	(0.00)
HNC/HND	-0.56***	(0.11)	-0.56***	(0.11)	-0.52***	(0.12)
Highers/CSYS	-0.62***	(0.10)	-0.62***	(0.10)	-0.55***	(0.11)
O Grade/S Grade	-1.05***	(0.10)	-1.05***	(0.10)	-0.91***	(0.10)
No Qualifications	-1.58***	(0.16)	-1.58***	(0.16)	-1.41***	(0.16)
Maternal Marital Status (at birth)						
Married	0.00	(0.00)	0.00	(0.00)	0.00	(0.00)
Other	-0.32***	(0.09)	-0.32***	(0.09)	-0.20*	(0.10)
Household Type (2001)						
Lives with Both Parents	0.00	(0.00)	0.00	(0.00)	0.00	(0.00)
Lives with Mother Only	-0.45***	(0.09)	-0.46***	(0.09)	-0.42***	(0.10)
Lives with Father Only	0.01	(0.16)	0.01	(0.16)	0.04	(0.16)
Gross Motor Skills						
Normal or Incomplete			0.00	(0.00)	0.00	(0.00)
Abnormal or Doubtful			-0.35	(0.26)	-0.43	(0.28)
Vision & Fine Motor Skills						
Normal or Incomplete			0.00	(0.00)	0.00	(0.00)
Abnormal or Doubtful			-0.24	(0.19)	-0.20	(0.19)
Social						
Normal or Incomplete			0.00	(0.00)	0.00	(0.00)
Abnormal or Doubtful			-0.42	(0.22)	-0.41	(0.23)
Hearing & Language						
Normal or Incomplete			0.00	(0.00)	0.00	(0.00)
Abnormal or Doubtful			-0.42***	(0.11)	-0.39***	(0.11)
SGA						
Not SGA					0.00	(0.00)
SGA					-0.50***	(0.12)
Smoking History at Booking						
Never					0.00	(0.00)
Current					-0.41***	(0.09)
Former					-0.42***	(0.12)
Not known					0.38	(0.20)
Mode of Delivery						
Normal					0.00	(0.00)
Other					-0.16*	(0.08)
Maternal Age						
Below 24					-0.31**	(0.10)
25-30					0.00	(0.00)
Above 30+					0.32***	(0.08)
Parity						
Nulliparous					0.00	(0.00)
Multiparous					-0.53***	(0.08)
Maternal Height						
Below 155cm					-0.14	(0.12)
156-169cm					0.00	(0.00)
Above 170cm					0.12	(0.10)
Constant	1.13***	(0.14)	1.15***	(0.14)	1.38***	(0.16)
n records	14313		14313		14313	
McFadden's Adjusted R-squared	0.13		0.13		0.15	
n	5201		5201		5201	

Standard errors in parentheses $p < 0.05$, $^{**} p < 0.01$, $^{***} p < 0.001$
Source: Scottish Longitudinal Study

3. Discussion

There are marked inequalities in educational attainment in Scotland by social background and these are confirmed in this study (Croxford 2009, 2015). The association between parental occupation and educational attainment is consistent with studies of attainment in England and Wales (Drew, Gray, and Sime 1992, Demack, Drew, and Grimsley 2000, Gillborn and Mirza 2000, Gayle, Berridge, and Davies 2003, Connolly 2006, Gayle, Lambert, and Murray 2009, Phillips 2009, Sullivan, Heath, and Rothon 2011, Connelly, Murray, and Gayle 2013, Gayle, Murray, and Connelly 2016). Whether measured by parental occupation or parental education, these inequalities persist at the end of compulsory schooling (Jackson 2013). It is plausible that this inequality by social background may be manifested through differences in birthweight and other birth outcomes, many of which are strongly associated with socioeconomic position. Bartley et al. (1994) observed that low birthweight was associated with childhood socioeconomic disadvantage. Our study suggests that controlling for being born SGA partially reduces the inequality in educational attainment by socioeconomic position. This is similar to findings by Conley and Bennett (2000) who observed that low birthweight results in lower educational attainment net of other socioeconomic factors.

A number of Scandinavian studies have investigated educational outcomes by birth outcomes and socioeconomic background. Kirkegaard et al. (2006) separately examined the relationship between: a) gestational age and bi) birthweight and subsequent educational attainment at age 10. Difficulties with reading, spelling and arithmetic were observed for babies born with birthweights between 2500–2999g compared to those with birthweights between 3500–3999g and for those with gestational age between 37–38 weeks compared to 39-40 weeks. In both sets of models, adjustments were made for other variables with parental education the only measure of socioeconomic position. The lack of association between birthweights of less than 2500g and gestational ages of less than 37 weeks was attributed to small sample size. In a study of 51 infants born Very Low Birthweight (VLBW, less than 1500g), Leijon et al. (2015) observed that these children demonstrated deficits in all reading domains, had poorer cognition and more behavioural problems aged 7. These results corrected for maternal education and maternal smoking among other variables. Brekke (2015) studied the odds of enrolment in higher education for infants born with low birthweight. The unadjusted association observed did not persist once control for parental education and parental income was included in the models. The studies noted above focused largely on the effect that birthweight had on subsequent educational outcomes net of parental socioeconomic position. We focused instead on moderation of the impact on socioeconomic position on education through birth variables. We also

demonstrate improved control through more detailed measures of parental occupation and parental education.

In a broadly comparable study, Härkönen et al. (2012) fitted models of educational attainment (based on an ordinal measure) controlling for parental class, mother's education, mother's marital status, mother's age at birth, whether the pregnancy was wanted, attitudes toward self-provision, and birth order. The inclusion of prenatal health and birth outcome variables had a modest moderating effect on the socioeconomic variables of at most 6 percent of the original coefficient size (for class background). Being born prematurely or small for gestational age did not have effects on educational attainment in this study. In contrast, Heinonen et al. (2013) identified that being born late preterm (34 to 36 weeks) were more likely to have a basic or upper secondary level than to have a tertiary level of education. This model was adjusted for gender, year of birth, father's occupational category in childhood, birth order, mother's age, mother's BMI at delivery, and birth weight relative to length of gestation (standardised).

3.1. Possible explanations and implications

There are a number of potential reasons for the association between educational attainment and birth outcomes once socioeconomic position has been controlled for. The first of these is that the birth outcomes are socioeconomically patterned, and whilst parental socioeconomic position has been controlled for using the measures described, there may remain omitted variable(s) bias. If this variable (or variables) were identified and controlled for, educational outcomes would not differ by birth outcomes. However, we argue that parental RGSC, parental highest qualification, maternal marital status and household type are good indicators of socioeconomic position and it is unlikely that an omitted variable would be found that captures an unmeasured dimension of socioeconomic position.

The models instead suggest that there is an additional attainment penalty for infants born SGA. It is plausible that lack of foetal nutrition and results in impaired cognitive development among those born SGA. Many studies observe an association between low birthweight and childhood intelligence (see Lawlor et al. 2005, Shenkin et al. 2001, Shenkin, Starr, and Deary 2004, Huang et al. 2013). Bukodi, Erikson, and Goldthorpe (2014) observe that early-life cognitive ability, parental class, parental status and parental education all have an independent effect on educational attainment. Feinstein (2003) also observes stratification in pre-school educational ability by parental occupation (at age 22 and 42 months) and pre-school ability is strongly correlated with schooling outcomes by age 26. Connelly (2012) identifies that paternal occupation has a direct effect on educational attainment but also an effect on childhood ability test score (which is strongly associated with educational attainment). Childhood cognitive ability test scores are highly correlated with educational attainment at

school (Deary et al. 2007, Calvin et al. 2010, Strenze 2007). We did not have access to childhood cognitive measures but future work might consider including these in addition to socioeconomic position and birth outcomes to examine whether the effect of being born SGA persists once this is controlled for.

3.2. Challenges in the measurement of fetal growth

SGA was selected as the measure of growth because of a number of features. Whilst the mean birthweight in Scotland has increased (Bonellie and Raab 1997, Bonellie 2005, Bonellie et al. 2008), the proportion of infants born LBW (<2500g) has remained broadly consistent between 1980 and 2003 (Bonellie 2005). This is a similar time range to the infants born within this study. SGA is a relative measure, so the increase in weights across the upper tail of the distribution should not have a marked influence on the prevalence of babies born SGA.

Birthweight and estimated gestation were available but were not included as separate measures in the models because of the inclusion of child development measures. Reichman (2005, 99) suggests why inclusion of birthweight, estimated gestation and child development indicators would be problematic: *"Clearly, individual children born low birth weight can be seriously disadvantaged with respect to schooling. But because most serious birth weight–related disabilities tend to occur at the lowest weight ranges and therefore affect a very small proportion of children, low birth weight may not explain much of the observed variation in educational attainment at the aggregate level."* This was confirmed when models were fitted including birthweight, estimated gestation and child development measures separately. It is also noted that the addition of the child development measures within the models explains little additional variation to socioeconomic position.

There are variations in the prevalence of SGA by ethnicity and other factors such as maternal smoking (for example, see Norris et al. 2015). This is potentially influential on findings due to the birthweight paradox (see Wilcox 2001, Wilcox 2006). This paradox is that for babies with lower birthweights, those with a maternal risk factor (such as smoking) may have better outcomes than those without the risk factor. The reason for this is the different distribution of birthweights for those with and without the risk factor. Schisterman et al. (2009) suggest creating standardised Z-scores to overcome this problem, by stratifying on the risk factors. The most likely variables upon which to stratify are ethnicity and mother's smoking status. However, in the sample there are too few ethnic minority individuals to make this practicable.

3.3. Limitations

A limitation of this study is that the sample size is quite small once linkage has occurred (n=5201). Ideally a larger sample could be analysed using

complete census linkage but this is not currently available. Future work at the Administrative Data Research Centre – Scotland may make this possible. Only those children who gained standard grades were included in the models which may underestimate the relationship between socioeconomic position, birth variables and educational outcomes because the most disadvantaged children may not have been entered. This would suggest that the findings are a conservative estimate of the underlying relationship. The child development measures that had the clearest association with educational attainment were vision & fine motor skills and hearing & language skills. It is plausible that these directly affect communication and learning but also that this may also indicate variability in the numbers of children being entered for standard grades, depending on their development.

Further to this, the statistical methods employed can indicate association but not causation. Corsi, Davey Smith, and Subramanian (2013) claim that there is a need for more creative analytical strategies to ascertain the relative importance of intra-uterine versus extra-uterine influences on childhood cognitive outcomes. We believe this study assists in improving this understanding but it is recognised that the process is complex. We would advise that future work includes cognitive measures recorded during childhood.

4. Conclusions

Social inequalities in educational attainment are a persistent feature of these analyses. The addition of child development and birth outcomes has offered further insights into the processes of differentiation of educational attainment. As Hack, Klein, and Taylor (1995) observed, for most low birthweight children, social factors have a far greater effect on long-term cognitive outcomes than biological factors, unless the biological factor is severe. Disadvantage by socioeconomic position can persist from generation to generation, in terms of environment when a young person is growing up and through the differences in birth outcomes by socioeconomic position. Children with abnormal development exhibit a serious disadvantage in educational attainment but represent a small proportion of the sample. Infants born SGA continue to experience disadvantage in educational attainment measures, net of socioeconomic position. Gluckman, Hanson, and Beedle (2007) argue that it is important to focus on maternal health and nutrition during pregnancy as a potential means to alleviate this disadvantage.

The linked longitudinal dataset constructed uses a range of administrative datasets containing information on child birth outcomes, child development measures, parental socioeconomic position and educational attainment which enable analysis of intergenerational processes. The advantage of using the SLS over other cohort or longitudinal survey datasets is that there is very little loss to follow up (Hattersley and Boyle 2009). There

is an established history of linking Scottish Morbidity Record (SMR) health data to the SLS (Boyle et al. 2009). There are very few comparable datasets which could currently answer the questions posed. One possible study, Growing Up in Scotland (GUS), does not have a cohort who are sufficiently old to evaluate educational attainment using measures of Standard Grade performance[5]. Similarly the Millennium Cohort Study have yet to sit General Certificate of Secondary Education (GCSE) qualifications with the most recent sweep being recorded at age 11 (see Connelly and Platt 2014).

These findings suggest that whilst there is variation in birthweight and child development by family socioeconomic position, these factors only partially explain differences in educational outcomes. This complements social science research (which has traditionally focused largely on family background measures) by seeking to further explore the mechanisms by which this variation occurs. We would suggest that future research explores in greater depth the role of child development in relation to educational outcomes and the reproduction of social inequalities.

[5] See http://growingupinscotland.org.uk/about-gus/study-design-and-methodology/ (accessed 5th January 2016).

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