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Immigrant Generation, Ethnicity, and Early-life Education Outcomes: Evidence from the Born in Bradford Family Cohort Study

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Abstract

This paper examines the relationship between ethnicity and immigrant generation in relationship to early educational outcomes and their potential determinants. Using Born in Bradford, a large longitudinal birth cohort, and its linked education and health records, we investigated the associations between ethnicity, immigration generations and education measures (Early Years Foundation Stage Profile and National Curriculum Key Stage One). We looked at the children of both first- and second-generation immigrants and compared them with White British non-immigrant children. Logistic regressions were used to examine the explanatory factors of the differences. On the Early Years Foundation Stage Profile, children of first-generation Pakistani immigrants did less well than White British non-immigrant children. This was largely related to language barriers. There were no significant differences between the children of second-generation Pakistani families and children of White British non-immigrant families. In Key Stage One results, there were no differences in reading and maths between children of first-generation Pakistani immigrants and the White British children, however, children of first-generation Pakistani immigrants had better scores in Key Stage One writing. Children of second-generation Pakistani immigrants had better odds of achieving expected standards in most models for reading and writing (but not maths) than the White British children. This might be attributed to better socioeconomic circumstances. Immigrant generation is an independent predictor for early educational outcomes. There are different patterns associated with different immigrant generations. Early life policy interventions to help children of first-generation immigrant with their English language before school could improve these children's school readiness.

Keywords Children of Immigrants · Ethnicity · Immigrant Generation · Education Attainment · Born in Bradford

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1 Introduction

Research has shown that early childhood development outcomes are related to socioeconomic circumstances, home learning environment, family relationships and attendance at any type of early years education (Green et al., 2021; Hartas, 2011; Pillas et al., 2014; Spencer et al., 2022). Child factors are also important to early years development, including being first born, gestational age, birthweight and school entry age (Boyle et al., 2012; Hansen & Jones, 2010; Pettinger et al., 2020). Poor early life education outcomes are also associated with deprivation, maternal mental health, lone parenthood, language barriers and belonging to an ethnic minority group (Camacho et al., 2019; Sullivan et al., 2021).

International studies have documented that ethnicity/race is an independent predictor for education outcomes, but results have been mixed in relation to different ethnic groups (Nazroo et al., 2018; van de Werfhorst & Heath, 2019; Zilanawala et al., 2015). The role of immigrant generations is even less clear. Different generations of immigrants may have different experiences affecting their education outcomes (Hoffmann, 2018). One study looked at 18 OECD countries and found that children of immigrants had worse educational attainment compared to children of non-immigrants (Shapira, 2012). While some studies found that children of immigrants tend to have better educational attainment compared to non-immigrant children (Dustmann & Theodoropoulos, 2010). In the Netherlands, second generation immigrants from Turkey and Morocco had similar educational attainment after controlling for socioeconomic factors and only the first generation showed a disadvantage compared to a non-immigrant Dutch group (van Ours & Veenman, 2003). In the US, second-generation Asian immigrants have been found to have higher educational attainment and a higher likelihood of getting into elite universities (Tran et al., 2019).

There is a large international literature on immigrant generation from different academic disciplines (Algan et al., 2010; Portes & Rumbaut, 2005). Generally, a first-generation immigrant is defined as a person who was not born in the country, and a second-generation immigrant is defined as a person who was born in the country but one or both parents were not (Portes & Rumbaut, 2005). This definition has been used widely in international studies and is also used by international statistical agencies (Ochmann, 2023; Rumbaut, 2004; van Ours & Veenman, 2003). One study used the UK's Millennium Cohort Study in the UK and found that all children of immigrants had positive trajectories compared to their White British peers with no substantial difference between having one or both immigrant parents (Hoffmann, 2018).

There are important underlying theoretical mechanisms to explain differences in education and health outcomes across immigrant generations that include economic, sociological, psychological, and systemic factors. Country of origin has been shown to account for a large part of differences in educational attainment with immigrants who share a background closer to the host country (for example in language and culture) having the best education outcomes (Gries et al., 2022). Proficiency in the dominant language of instruction is essential for academic success and even when adjusting for family background and resources linguistic ability influences academic performance among immigrant children (Glick & Hohmann-Marriott, 2007).

Favourable selection in education and health of immigrants may also explain differences (Abraído-Lanza et al., 1999; Dustmann & Theodoropoulos, 2010; Hou et al., 2019). For example, a study that examined selectivity of immigrants from origin countries to ten destination countries found that positive selectivity in terms of initial differences between host and origin countries contributed to the educational gap in educational attainment between host and origin children (van de Werfhorst & Heath, 2019). Students of immigrant parents who are less educated than their native counterparts and poorer tend to have worse academic performance (Schleicher, 2006).

Adaptation and acculturation after initial immigration, and assimilation processes are also important mechanisms through which immigration affects the outcomes of immigrants (Gibson, 2001; Portes & Rivas, 2011; Portes & Rumbaut, 2005). The 'immigration paradigm' proposes that immigrants have higher motivation and perseverance to succeed educationally as a means of escaping poverty (Kao & Thompson, 2003). However this is not reflected in the outcomes of all migrant communities. Ogbu and colleague (1998) distinguishes between 'voluntary minorities' who are more recent immigrants and more optimistic about future opportunities, and minority groups who have been longer established and less optimistic. Strand (2021) proposes the relevance of 'selective assimilation theory' whereby Black Caribbean migrants in the 1960's predominantly moved to poor urban and inner city environments with close intersection with White British working class populations and subsequent intersection whereby Black Caribbean and Mixed White students share cultural attitudes that parallel their White British working class neighbours. In contrast Pakistani immigrants in Bradford have also tended to move to poorer, inner city areas, but they tended to have higher levels of segregation and retain cultural homogeneity (Small, 2012). There is evidence that assocations between concentration of people from the same ethnic group in the neighbourhood and health outcomes vary by ethnicity and outocme (Pickett et al., 2009).

Socioeconomic factors play a crucial role. Students from higher socio-economic backgrounds generally achieve higher levels of educational performance (OECD, 2010). Families with higher income can afford better educational resources and, while low-income families may struggle with basic needs, affecting educational support. Stable and high-paying jobs allow parents to invest more in their children's education. Conversely, job instability and low wages can limit educational opportunities.

Neighbourhood and school influences may amplify socio-economic factors as well as wider systemic biases and discrimination within the educational system that can adversely affect ethnic minority students. Schools with a greater proportion of wealthier socio-economic students have better results (Langenkamp & Carbonaro, 2018). An influx of immigrant students into schools can lead to 'native flight' and exacerbate this socio-economic effect. Supportive relationships for students at home and in school are important factors in educational attainment. Schools with inclusive practices and multicultural curricula can positively impact the educational experiences of ethnic minority and immigrant students (Garcia-Reid et al., 2015) whereas lower teacher expectations, biased assessment practices, and limited access to advanced courses can disadvantage students.

Further racism and discrimination are also important systemic factors that can adversely influence economic, sociological, psychological factors in underlying the-

oretical mechanisms. Not only because direct experience of these can have negative impacts on health and education outcomes of vulnerable groups, but at an institutional level, these negatively influence the economic and social opportunities immigrants and ethnical groups have, as well as the quality of health and social services they receive(Nazroo, 2003; Ouillian et al., 2019; Thomas et al., 2009). In addition, public policy on immigration and integration policies in host nations can also influence health and education outcomes and trajectories of immigrants (Small, 2012; Washbrook et al., 2012).

There are several gaps in the existing literature. First, few studies have looked at ethnicity, immigrant generation and education outcomes in pre-school age children. This is likely to be due to limitations of data. For example, in the UK, much contemporary research on child development and education uses the large, population-based Millennium Cohort Study (MCS). However, although the MCS initially over-sampled ethnic minority groups, the sample sizes of these groups are still relatively small when stratified by ethnicity and finer demographic details (Joshi & Fitzsimons, 2016). Second, some studies on immigrant generations at the national level have grouped immigrants from all ethnicities or nationalities together as a group (Ochmann, 2023). This may be problematic as the features of immigration generations are not static – they are influenced and shaped by social, economic and political policies and circumstances (Perlmann & Waldinger, 1997). Third, health is an important aspect of child development and is strongly related to early-life educational attainment (Lodh et al., 2023; Wright et al., 2019), although it has not been considered by the majority of previous studies on the educational attainment of immigrant children (Dustmann et al., 2014). Furthermore, many studies on children of immigrants used cohorts born several decades ago. As demographics of population, education provision, public policies and ethnic inequalities are changing, it is important to examine this relationship with a more recent cohort.

In this paper, we examine immigrant generation, ethnicity and early-life education outcomes using Born in Bradford, a large longitudinal and family birth cohort study. Bradford is one of the largest cities in the North of England with a population of over half a million. According to the 2021 Census of England and Wales, it has a large ethnic minority population (43%), mainly of Pakistani heritage (26%). Thus, the Bradford setting offers an outstanding opportunity to study the relationships between immigrant generation and ethnicity. Previous studies from Bradford have found that British Pakistani children were more likely to be low birthweight and more likely to be obese but the relationships between ethnicity, immigration generation, child and family factors and child health in relationship to educational outcomes have not been explored (Atkinson et al., 2022; Stacey et al., 2016; West et al., 2018). In this paper, we examine whether there are any differences in early education outcomes between children of different generations of Pakistani immigrants - and their White British non-immigrant peers, and go on to examine the influence of potential explanatory factors of differences.

2 Methods

2.1 Setting and Study Design

This is a cross-sectional analysis of data from a prospective longitudinal family cohort. It utilised Born in Bradford (BiB) cohort data and its linked education and health routine records. BiB is a multi-ethnic family birth cohort study that aims to study how environmental, psychological and genetic factors influence maternal and child health and wellbeing (Wright et al., 2013). Almost half of the childbirths are to mothers of South Asian origin. BiB baseline recruitment took place between 2007 and 2010 at the Bradford Royal Infirmary. Women were recruited at 26–28 weeks gestation. For those consenting, baseline data were collected through an interview administered questionnaire. BiB cohort is largely representative of the city's maternal population during this period (Power et al., 2018). Data on birth and clinical outcomes was attained from medical and maternity records (Wright et al., 2013). Ethics approval for the data collection was granted by Bradford Research Ethics Committee (Ref 07/H1302/112).

2.2 Education Outcomes

2.2.1 Early Years Foundation Stage

Linked BiB education data from schools were used to look at education outcomes of BiB children. To measure school readiness, we used the Early Years Foundation Stage (EYFS) profile. This framework sets the statutory standards for the development of children from birth to age five in England. By law, all registered education providers must complete the EYFS profile assessment in the last school term before children reach age five years (the first year of compulsory education in England). EYFS profiles consisted of 17 early learning goals (ELGs) across seven domains, consisting of the following domains: communication and language development (3 ELGs), physical development (2 ELGs), personal, social and emotional development (3 ELGs), literacy (2 ELGs), mathematics (2 ELGs), understanding of the world (3 ELGs), expressive arts and design (2 ELGs). These goals were assessed primarily by the teachers' knowledge of the child from observation, daily activities and events. For each ELG, there were three levels or grades; emerging, expected and exceeding. Only communication and language development and literacy have to be assessed in English. Other dimensions could be assessed using any language. A detailed explanation is provided in the Supplementary Information.

The primary outcome for this study was "not achieving a 'Good level of development (GLD)'", defined as children not having achieved at least the expected level for the ELGs in all of personal, social and emotional development, physical development, communication and language, mathematics and literacy at the end of Reception Year. To operationalise GLD, we first coded each of the five domains from their respective ELGs as 'below expected level' or 'expected level and above'. For each domain to be coded as expected and above level, all ELGs in that domain reached at least the expected level. Then GLD was coded as one if all five domains reached

expected level and above category. EYFS profiles data analysed included assessment results for each academic year from 2012 to 2016.

2.2.2 National Curriculum Key Stage One

Key Stage 1 mathematics, reading and writing results - an assessment of the child's ability completed by seven years of age - were also analysed. For each topic, there were three categories; below expected standard, at expected standard and above expected standard. For Key Stage One, the testing framework changed in the 2015–2016 academic year and, as we had data before and after this change, we standardised a new set of variables accounting for these changes. Details on the methods used can be found here (Norris et al., 2018). In this analysis, for each subject, we modelled the outcome of below expected standard category compared to the rest. Key Stage One results included assessment for each academic year from 2014 to 2018.

2.3 Immigrant Generations and Ethnicity

The focus of this study is on the children of immigrants rather than immigrant themselves, as all BiB children were born in the UK. The BiB baseline questionnaire records the country of birth of both parents and grandparents. The participant was given options including England, Northern Ireland, Scotland, Wales, Chanel Island, Isle of Man, Republic of Ireland, Czech Republic, Poland, Slovakia, Bangladesh, India, Pakistan, Sri Lanka, Philippines, Don't know and Other. Based on these questions, immigrant generation was defined as the following: (1) non-immigrant: parents and all grandparents were born in the UK (England, Northern Ireland, Scotland and Wales); (2) first generation: one or both of the parents were born overseas; (3) second generation: one or more grandparents were born overseas, but parents were born in the UK.

For information on the ethnicity of the children, records from linked education data at Reception Year – age 4 to 5 before first year of primary school in England, were used. In total, ten different ethnic categories were present in the data. However, the White British and Pakistani ethnic groups accounted for over 80% of the records (35% White British and 47% Pakistani in BiB baseline data). The third largest group was the mixed ethnic group which accounted for only 6% of the records. In order to look at ethnicity and immigration generations together, our analytical sample included all participants from White British and Pakistani ethnic groups who had information on family immigration history from the baseline questionnaire. Due to limited number of other ethnic groups in the data and heterogeneity in potential drivers of differences in outcomes in other ethnic categories, we did not include other ethnic groups in this study.

2.4 Covariates

As health outcomes are also related to early-life education outcomes and immigrant generations (Crede et al., 2020; Lodh et al., 2023; Wright et al., 2019) two indicators were included. Low birthweight (<2500 g) was included from linked maternal

records. We also constructed a variable of total number of discharges from hospital admissions prior to age 5 years (so before the EYFS assessment). To obtain this, we used linked Secondary Uses Service data from Bradford Teaching Hospitals Foundation Trust, which is one of two main acute trusts in Bradford District. These data were extracted in May 2023.

To account for family socioeconomic position (SEP), given its multidimensional nature, a SEP variable developed by Fairley and colleagues using Latent Class Analysis (LCA) and BiB cohort data was utilised in our analysis (Fairley et al., 2014). This variable was derived from 19 measures included in the BiB baseline questionnaire, which covered both parents' employment status and education levels, subjective poverty, receipt of means tested benefits, up-to-date with bills, ownerships of material goods and items, and housing tenure. Latent class models with two to ten classes were fitted. Based on criteria related to LCA model fit, five distinct SEP subclasses were identified. These included "Least socioeconomically deprived and most educated"–characterised as both parents are highly educated, mortgaged, not subjectively poor and materially deprived; "Employed and not materially deprived"- featured as medium level of education, employed, mortgaged, not subjectively poor and materially deprived; "Employed and no access to money "– characterised as employed, moderately behind bills, mortgage or private renting, moderate subjective poverty and moderate materially deprived; "Benefits and not materially deprived" – characterised as low current employment, low levels of education, owns house outright, not subjectively poor and materially deprived, and high receipt of means tested benefits; and finally "Most economically deprived"- characterised as low level of current employment, low level of education, behind bills, private renting or social housing, subjectively poor and the highest receipt of means tested benefits. For consistency with the literature, this study used same labels as described in the paper(Fairley et al., 2014). In addition, quintiles of the index of multiple deprivation (IMD), a measure of neighbourhood deprivation for the mother's place of residence, was included in the analysis (Duncan et al., 1994; Roux, 2001).

Finally, we used EYFS profile data to record whether English was an additional language in the home. This was used to indicate language barriers.

2.5 Statistical Analysis

Logistic regressions were used to investigate the associations between education outcomes in early life and immigration generation. In the analysis of the Early Years Foundation Stage Profile, we started with a specification which only adjusted for gender. Model 2 adjusted for sex and the two health indicators, low birthweight and total number of hospital discharges by the assessment of EYFS. Model 3 adjusted for sex and family socioeconomic status. Model 4 adjusted for sex and IMD. Model 5 adjusted for sex and English as an additional language reported at the Reception year-the age between 4 and 5 years. Model 6 was a fully adjusted model. Odds ratios and 95% confidence intervals were reported in all models. To adjust for variations due to school level differences in education outcomes, school fixed effects were included as a categorical variable in all models. Complete case analyses were conducted using Stata 17 (StataCorp).

2.6 Sensitivity Analysis

As the SEP derived from multiple measures using LCA may have complex interactions with indicators included in our model, an alternative socioeconomic status measure was used instead as a sensitivity analysis. This included using two variables - maternal education from the baseline questionnaire and whether the child was in receipt of free school meals during Reception year.

3 Results

3.1 Descriptive Statistics

The analytical sample size for this paper is 6,352. Table 1 describes sample characteristics and also education outcomes by ethnicity and immigration generations. In the analytical sample, there were 2,460 (38.7%) Children of White British non-immigrants, 3,398 (53.5%) children of first-generation Pakistani immigrants and 494 (7.8%) children of second-generation Pakistani immigrants.

Children of Pakistani first-generation immigrants (9.3%) and of second-generation immigrants (11.9%) had the highest percentage of being in the low birthweight

Table 1 Description of variables by ethnicity and immigration status in BiB cohort

	Children of White British Non-immigrant		Children of Pakistani Second GN		Children of Pakistani First GN	
Variables list	Count	%	Count	%	Count	%
Male	1242	50.5%	251	50.8%	1688	49.7%
Low birthweight (<2500 g)	126	5.1%	59	11.9%	317	9.3%
	Mean	SD	Mean	SD	Mean	SD
Number of hospital admissions	0.790	1.497	0.829	2.013	0.911	2.135
SEP: Least deprived and most educated	356	14.5%	147	29.8%	463	13.6%
SEP: Employed and not materially deprived	830	33.7%	75	15.2%	262	7.7%
SEP: Employed and no access to money	401	16.3%	50	10.1%	510	15.0%
SEP: Benefits and not materially deprived	403	16.4%	174	35.2%	1621	47.7%
SEP: Most economically deprived	470	19.1%	48	9.7%	542	16.0%
IMD: Most deprived quintile	1205	49.0%	351	71.1%	2778	81.8%
IMD: Second most deprived quintile	581	23.6%	87	17.6%	451	13.3%
IMD: Not in the top two most quintiles	674	27.4%	56	11.3%	169	5.0%
Whether English is an additional language	1	0.0%	271	54.9%	2755	81.1%
Education outcomes						
Not achieving Good Level of Development	845	34.3%	176	35.6%	1443	42.5%
% of participants in below expected standard - KS1 maths	492	20.0%	77	15.6%	653	19.2%
% of participants in below expected standard - KS1- reading	495	20.1%	78	15.8%	683	20.1%
% of participants in below expected standard - KS1- writing	632	25.7%	100	20.2%	797	23.5%
Observations		2460		494		3398

category compared to the White British non-immigrant children (5.1%). Immigrant groups had slightly higher averages of total number of hospital discharges compared to the White British non-immigrant group (0.790), with the children of first generation (0.911) having the highest average numbers. In terms of individual socioeconomic position, children of Pakistani second-generation immigrants (29.8%) had the largest percentage in the least deprived and most educated category compared to the children of first-generation Pakistani group (13.6%) and of the White British non-immigrant group (14.5%).

On the neighbourhood deprivation measure, 81.8% of children from first-generation Pakistani immigrant families and 71.1% of children of second-generation Pakistani families lived in the most deprived IMD quintile compared to 49% of the White British non-immigrant children. As for language barriers, 81.1% of children of first-generation Pakistani immigrants and 54.9% of the children of second-generation Pakistani immigrants reported English as an additional language in Reception year.

With respect to education outcomes, children of first-generation Pakistani immigrants (42.5%) had higher percentages of not achieving a Good Level of Development (GLD) in Reception year, while children of second-generation Pakistani immigrants (35.6%) had similar percentage in not achieving GLD, compared to children of the White British non-immigrants (34.3%). At Key Stage One, children of second-generation Pakistani immigrants had the lowest percentages of being in the below expected standard in all Key Stage One subjects (15.6% in Math, 15.8% in Reading and 20.2% in Writing). Children of first-generation Pakistani immigrants had similar Key Stage One results (19.2% in Maths, 20.1% in Reading and 23.5% in Writing) compared to the White British non-immigrant children (20.0% in Maths, 20.1% in Reading and 25.7% in Writing).

3.2 Associations Between Immigrant Status and Education Outcomes

Tables 2, 3, 4 and 5 report findings from the multivariate analyses. In Table 2, compared to children of White British non-immigrants' families, only children of first-generation Pakistani immigrants had a higher odds ratio of not achieving a Good Level of Development in model 1. Adjusting for health indicators, socioeconomic factors and neighbourhood deprivation explained little of this disadvantage, as shown in models 2, 3 and 4. However, this difference was fully explained after adjusting for language barriers in model 5. Moreover, there were no statistically significant differences between children of White British non-immigrants and children of second-generation Pakistani immigrants in all models.

Key Stage 1 results for reading are shown in Table 3. After adjusting for sex in model 1, there was an initial advantage for children of second-generation Pakistani immigrants compared to children of White British non-immigrants. This remained after adjusting for explanatory factors, although the difference was not significant in the model that adjusted only for family socioeconomic position (model 3). There were no statistically significant differences in Key Stage One reading results between children of first-generation Pakistani immigrants and children of White British non-immigrants.

Table 2 Not achieving a good level of development at reception year, logistic models

	Model 1 Sex	Model 2 Sex + health indicators	Model 3 Sex + SES	Model 4 Sex + IMD	Model 5 Sex + language	Model 6 Full
Children of White British Non-immigrants	1.00	1.00	1.00	1.00	1.00	1.00
Children of Pakistani Second GN immigrants	1.04	1.02	1.21	1.05	0.89	1.03
	[0.80,1.37]	[0.78,1.34]	[0.92,1.59]	[0.80,1.37]	[0.67,1.18]	[0.77,1.38]
Children of Pakistani First GN immigrants	1.38**	1.37**	1.40**	1.38**	1.09	1.15
	[1.12,1.72]	[1.11,1.70]	[1.12,1.75]	[1.11,1.71]	[0.85,1.41]	[0.89,1.49]
Male, Female as ref	2.17***	2.19***	2.27***	2.17***	2.18***	2.30***
	[1.95,2.42]	[1.96,2.45]	[2.03,2.54]	[1.95,2.42]	[1.96,2.43]	[2.05,2.57]
Low birthweight (<2500 g): Yes		1.53***				1.50***
		[1.25,1.87]				[1.23,1.84]
Total number of hospital discharges		1.04*				1.03
		[1.00,1.07]				[1.00,1.06]
SEP: Least deprived and most educated as reference			1.00			1.00
SEP: Employed and not materially deprived			1.25*			1.24*
			[1.02,1.54]			[1.01,1.53]
SEP: Employed and no access to money			1.51***			1.46***
			[1.22,1.86]			[1.18,1.81]
SEP: Benefits and not materially deprived			2.41***			2.31***
			[2.00,2.91]			[1.91,2.80]
SEP: Most economically deprived			2.84***			2.74***
			[2.30,3.51]			[2.22,3.40]
IMD: Not in the top two most deprived quintiles as ref				1.00		1.00
IMD: Second most deprived quintile				0.97		0.89
				[0.78,1.21]		[0.71,1.11]
IMD: Most deprived quintile				1.20		1.03
				[0.98,1.47]		[0.84,1.27]
English is an additional language					1.41***	1.32**

Table 2 (continued)

	Model 1 Sex	Model 2 Sex + health indicators	Model 3 Sex + SES	Model 4 Sex + IMD	Model 5 Sex + language	Model 6 Full
					[1.17,1.69]	[1.09,1.59]
Constant	0.19***	0.19***	0.08***	0.16***	0.18***	0.08***
	[0.10,0.37]	[0.10,0.36]	[0.04,0.17]	[0.08,0.32]	[0.09,0.34]	[0.04,0.16]
Observations	6304	6304	6304	6304	6304	6304
Pseudo R^2	0.080	0.083	0.098	0.081	0.082	0.102

Odds ratio reported and 95% CI statistics in brackets * $p<0.05$ ** $p<0.01$ *** $p<0.001$

School fixed effects were also adjusted for in all models

Table 4 reports results on Key Stage One writing. Compared with the White British non-immigrants' children, Pakistani second-generation immigrants' children had lower odds of not achieving expected standards in Key Stage One writing after adjusting for sex in model 1. This remained after adjusting for health indicators, neighbourhood deprivation, and language barriers. However, once socioeconomic position was controlled for in model 3, this advantage was reduced and was no longer statistically significant. The advantage associated with second-generation Pakistani immigrants' children was still present in the fully adjusted model. In addition, there was a persistent advantage in Key Stage One writing results associated with children of first-generation Pakistani immigrant families in all models. Adjusting for language barriers slightly attenuated this relationship in model 5, it remained statistically significant in the fully adjusted model.

Table 5 shows the Key Stage One results in maths. There were no differences after adjusting for sex between children of both first- and second-generation Pakistani families and children of the White British non-immigrant families in model 1. For children of the second-generation Pakistani immigrant group, there was a statistically significant advantage after adjusting for health indicators and language barriers in models 2 and 5. But this was not statistically significant in the fully adjusted model 6. For children of first-generation Pakistani immigrants, there were no statistically significant differences compared to children of White British non-immigrant families, except for in model 5 where language barrier was adjusted for. No statistically significant association remained in the fully adjusted model.

In both Early Years Foundation Stage Profiles and Key Stage One results, males consistently did worse compared to females. Health status (proxied using birthweight and total number of hospital discharges by the age of five years) also showed statistically significant and positive associations with all education outcomes. Socioeconomic positions of families showed a statistically significant and positive gradient in these outcomes. Neighbourhood deprivation measured using IMD was not statistically significant in most cases after additionally adjusting for other factors including socioeconomic position at family level. English as an additional language was a highly statistically significant predictor for Early Years Foundations Stage results but this was not the case for Key Stage One results except for maths. The results from sensitivity analyses in the Supplementary Information were similar to the above.

Table 3 Key stage one reading results whether or not in the below expected standard, logistic models

	Model 1 Sex	Model 2 Sex + health indicators	Model 3 Sex + SES	Model 4 Sex + IMD	Model 5 Sex + language	Model 6 Full
Children of White British Non-immigrants	1.00	1.00	1.00	1.00	1.00	1.00
Children of Pakistani Second GN immigrants	0.62**	0.60**	0.73	0.61**	0.59**	0.70
	[0.44,0.87]	[0.43,0.84]	[0.52,1.03]	[0.44,0.86]	[0.41,0.84]	[0.49,1.00]
Children of Pakistani First GN immigrants	0.81	0.80	0.82	0.80	0.76	0.79
	[0.62,1.05]	[0.61,1.03]	[0.63,1.06]	[0.62,1.04]	[0.56,1.03]	[0.59,1.08]
Male, Female as ref	1.73***	1.74***	1.82***	1.73***	1.73***	1.83***
	[1.52,1.98]	[1.53,1.99]	[1.59,2.08]	[1.52,1.97]	[1.52,1.98]	[1.60,2.09]
Low birthweight (<2500 g): Yes		1.48**				1.44**
		[1.17,1.86]				[1.13,1.82]
Total number of hospital discharges		1.12**				1.11**
		[1.04,1.20]				[1.03,1.20]
SEP: Least deprived and most educated as reference			1.00			1.00
SEP: Employed and not materially deprived			1.25			1.24
			[0.95,1.65]			[0.94,1.63]
SEP: Employed and no access to money			1.59***			1.54**
			[1.21,2.11]			[1.16,2.04]
SEP: Benefits and not materially deprived			2.69***			2.58***
			[2.10,3.45]			[2.01,3.31]
SEP: Most economically deprived			3.49***			3.34***
			[2.67,4.55]			[2.55,4.38]
IMD: Not in the top two most deprived quintiles as ref				1.00		1.00
IMD: Second most deprived quintile				1.12		1.01
				[0.85,1.46]		[0.77,1.33]
IMD: Most deprived quintile				1.31*		1.08
				[1.01,1.69]		[0.83,1.40]
English is an additional language					1.10	1.02

Table 3 (continued)

	Model 1 Sex	Model 2 Sex + health indicators	Model 3 Sex + SES	Model 4 Sex + IMD	Model 5 Sex + language	Model 6 Full
					[0.88,1.38]	[0.81,1.28]
Constant	0.34**	0.32**	0.14***	0.26***	0.33**	0.12***
	[0.17,0.67]	[0.16,0.63]	[0.07,0.28]	[0.13,0.54]	[0.16,0.65]	[0.06,0.26]
Observations	6237	6237	6237	6237	6237	6237
Pseudo R2	0.054	0.063	0.077	0.055	0.054	0.085

Odds ratio reported and 95% confidence interval statistics in brackets * $p<0.05$ ** $p<0.01$ *** $p<0.001$

School fixed effects were also adjusted for in all models

4 Discussion

This paper examined the relationship between ethnicity, immigrant generation, and early-life education outcomes in a large birth cohort in the UK. Using linked education and health data, we looked at two ethnic groups, Pakistani and White British, and found that immigrant generation, as well as ethnicity, was associated with early-life education outcomes. For the Early Years Foundation Stage Profile measured between ages four and five years, children of first-generation Pakistani immigrants were disadvantaged relative to their White British (non-immigrant) counterparts. This was largely related to the language barriers. There were no significant differences between children of second-generation Pakistani families and children of White British non-immigrant families in the Early Years Foundation Stage Profile. *At Key Stage One*, *compared to their White British non-immigrant peers*, *children of second-generation Pakistani immigrant families had better odds of achieving expected standards in reading and writing in most models except for fully adjusted models and models that adjusted for family socioeconomic position*, *but not in maths.* Children of first-generation Pakistani immigrant families had no differences compared to children of White British non-immigrant families in Key Stage One reading and maths. Nevertheless, children of first-generation Pakistani immigrants had a persistent advantage in Key Stage One writing and our models explained little of this advantage.

Our finding that children of first-generation Pakistani immigrants had a disadvantage in Early Years Foundation Stage Profile results were largely due to language barriers. A previous study looked at children of immigrant parents in Australia, Canada, the United Kingdom and the United States aged between four and five years and found these children underperformed in vocabulary tests, but were not generally disadvantaged in nonverbal cognitive domains, and they found this was largely due to language barriers (Washbrook et al., 2012). At Key stage One, this disadvantage related to children of firs-generation Pakistani immigrants largely disappeared and there was an unexplained advantaged in Key Stage One writing results associated with this group. *This might be due to unobserved factors in this study such as cultural factors such as valuing education (*Abbas, 2007). Additionally, studies from other countries also documented a rapid catch-up in academic achievement gap during elementary school from early childhood or school entry related to the children of immigrants, especially with those whose first language was different from host countries (Han, 2008; Worswick, 2004). This may partly be attributed to school level

Table 4 Key stage 1 writing results whether or not in the below expected standard, logistic models

	Model 1 Sex	Model 2 Sex + health indicators	Model 3 Sex + SES	Model 4 Sex + IMD	Model 5 Sex + language	Model 6 Full
Children of White British Non-immigrants	1.00	1.00	1.00	1.00	1.00	1.00
Children of Pakistani Second GN immigrants	0.65**	0.63**	0.76	0.65**	0.60**	0.70*
	[0.47,0.89]	[0.46,0.87]	[0.55,1.04]	[0.47,0.89]	[0.43,0.83]	[0.50,0.99]
Children of Pakistani First GN immigrants	0.76*	0.74*	0.76*	0.75*	0.67**	0.70*
	[0.59,0.96]	[0.58,0.95]	[0.60,0.98]	[0.59,0.96]	[0.50,0.89]	[0.52,0.93]
Male, Female as ref	2.01***	2.02***	2.10***	2.01***	2.01***	2.11***
	[1.78,2.27]	[1.78,2.28]	[1.86,2.38]	[1.77,2.27]	[1.78,2.28]	[1.86,2.39]
Low birthweight (<2500 g): Yes		1.32*				1.30*
		[1.05,1.66]				[1.03,1.63]
Total number of hospital discharges		1.12**				1.11**
		[1.04,1.20]				[1.03,1.19]
SEP: Least deprived and most educated as reference			1.00			1.00
SEP: Employed and not materially deprived			1.25			1.24
			[0.98,1.61]			[0.96,1.59]
SEP: Employed and no access to money			1.63***			1.56***
			[1.27,2.09]			[1.21,2.00]
SEP: Benefits and not materially deprived			2.47***			2.34***
			[1.98,3.09]			[1.87,2.93]
SEP: Most economically deprived			3.10***			2.93***
			[2.43,3.96]			[2.29,3.75]
IMD: Not in the top two most deprived quintiles as ref				1.00		1.00
IMD: Second most deprived quintile				1.30*		1.19
				[1.01,1.67]		[0.92,1.53]
IMD: Most deprived quintile				1.45**		1.23
				[1.15,1.84]		[0.97,1.56]
English is an additional language					1.20	1.11

Table 4 (continued)

	Model 1 Sex	Model 2 Sex + health indicators	Model 3 Sex + SES	Model 4 Sex + IMD	Model 5 Sex + language	Model 6 Full
					[0.97,1.48]	[0.90,1.38]
Constant	0.30***	0.28***	0.13***	0.21***	0.28***	0.10***
	[0.15,0.60]	[0.14,0.57]	[0.06,0.27]	[0.10,0.44]	[0.14,0.57]	[0.05,0.22]
Observations	6272	6272	6272	6272	6272	6272
Pseudo R2	0.062	0.069	0.081	0.064	0.063	0.088

Odds ratio reported and 95% confidence interval statistics in brackets * $p<0.05$ ** $p<0.01$ *** $p<0.001$

School fixed effects were also adjusted for in all models

factors, such as school resources including provision of additional languages support, learning and teaching environment(Han, 2008).

The improved academic performance of children of second-generation Pakistani immigrants may reflect a combination of parental, cultural and economic factors. Children of second-generation immigrants often benefit from stronger parental support, which includes emotional encouragement, educational aspirations, and involvement in their children's education (Karakus et al., 2023). *Cultural capital—such as valuing education*, *language proficiency*, *and familiarity with the host country's educational system— may also positively influence academic outcomes(*Jæger, 2011; Sullivan, 2001*). As our results indicate*, *language skills are also important and children of second-generation typically acquire language skills more effectively than their parents. Proficiency in the host country's language enhances their ability to engage in learning and perform well academically. Growing up in a multicultural environment may provide social support and help children of second-generation immigrants develop adaptability and resilience - qualities which contribute to their academic success* (Chen et al., 2023; Karakus et al., 2023; Mishra, 2020). Economic factors are crucial to educational attainment and may explain the improvements seen across generation (Dustmann & Theodoropoulos, 2010; Pivovarova & Powers, 2019). Children of second-generation Pakistani families tend to be substantially better off than their first-generation families and this is reflected in BiB data.

On the contrary to studies found gaps in education attainment between immigrant children of South Asian origin and White British children (Meunier et al., 2013; Shapira, 2012), our results looking at the children of Pakistani second-generation immigrants in the UK here suggested that there were no disadvantages in education outcomes compared to the White British non-immigrant children. This emphasises the importance of studying both immigrant generation and ethnicity together when looking at education and health outcomes.

One novelty of this analysis was that we were able to control for health using objective data from maternity and hospital records as well as control for measures of family socioeconomic position and family information on country of birth. In addition, we not only looked at teacher assessed education outcomes at the Reception year before formal primary education but also we linked to results at Key Stage One. There is evidence that teachers' perceptions of students' characteristics such as gender, ethnicity, family socioeconomic status and learning disabilities may affect assessment of students' academic ability, teacher-student interactions and teachers'

Table 5 Key stage one below expected standard in maths

	Model 1 Sex	Model 2 Sex + health indicators	Model 3 Sex + SES	Model 4 Sex + IMD	Model 5 Sex + language	Model 6 Full
Children of White British Non-immigrants	1.00	1.00	1.00	1.00	1.00	1.00
Children of Pakistani Second GN immigrants	0.72	0.70*	0.86	0.72	0.62**	0.73
	[0.52,1.01]	[0.50,0.98]	[0.61,1.21]	[0.52,1.01]	[0.43,0.89]	[0.51,1.06]
Children of Pakistani First GN immigrants	0.92	0.90	0.94	0.91	0.74*	0.78
	[0.71,1.19]	[0.70,1.17]	[0.73,1.22]	[0.71,1.18]	[0.54,1.00]	[0.57,1.06]
Male, Female as ref	1.24**	1.25**	1.28***	1.24**	1.24**	1.29***
	[1.09,1.42]	[1.09,1.42]	[1.12,1.46]	[1.09,1.41]	[1.09,1.42]	[1.12,1.47]
Low birthweight (<2500 g): Yes		1.57***				1.53***
		[1.24,1.98]				[1.21,1.94]
Total number of hospital discharges		1.11**				1.10**
		[1.04,1.18]				[1.03,1.17]
SEP: Least deprived and most educated as reference			1.00			1.00
SEP: Employed and not materially deprived			1.31			1.29
			[1.00,1.74]			[0.98,1.71]
SEP: Employed and no access to money			1.75***			1.67***
			[1.33,2.30]			[1.26,2.20]
SEP: Benefits and not materially deprived			2.51***			2.36***
			[1.95,3.22]			[1.84,3.04]
SEP: Most economically deprived			3.23***			3.05***
			[2.47,4.21]			[2.33,4.00]
IMD: Not in the top two most deprived quintiles as ref				1.00		1.00
IMD: Second most deprived quintile				1.19		1.09
				[0.91,1.56]		[0.83,1.43]
IMD: Most deprived quintile				1.30*		1.10
				[1.00,1.67]		[0.85,1.42]
English is an additional language					1.38**	1.29*

Table 5 (continued)

	Model 1 Sex	Model 2 Sex + health indicators	Model 3 Sex + SES	Model 4 Sex + IMD	Model 5 Sex + language	Model 6 Full
					[1.09,1.74]	[1.02,1.64]
Constant	0.28***	0.26***	0.12***	0.22***	0.25***	0.10***
	[0.14,0.57]	[0.13,0.54]	[0.05,0.25]	[0.10,0.46]	[0.12,0.52]	[0.04,0.22]
Observations	6244	6244	6244	6244	6244	6244
Pseudo R2	0.052	0.061	0.071	0.053	0.053	0.079

Odds ratio reported and 95% confidence interval statistics in brackets * $p<0.05$ ** $p<0.01$ *** $p<0.001$

School fixed effects were also adjusted for in all models

expectations (Hansen, 2016; Wang et al., 2018). This may also contribute to disadvantages associated with children of first-generation Pakistani immigrant families at Reception year observed in this study.

There are some limitations to this study. We were only able to look at the largest ethnic group by immigration generation because of the limited sample sizes of other ethnic groups. Only examining Pakistani group in the same birth cohort and comparing to White British non-immigrant children may allow us to better investigate immigration generation, ethnicity and its relationship with early-life education outcomes. Because of data limitations, we were unable to include other important confounders to early-life education outcomes, including factors related to parent-child relationship, parenting behaviours, attendance at early-years education settings and detailed school level factors. Also we only had access to hospital data from one of the two hospitals in the district. Further, we relied on self-reported data on immigrant generation and thus might be prone to recalled bias and other information biases.

This is a single urban setting and we recognise that Bradford may not be representative of other UK cities. However it shares the same historical demographic patterns of inward immigration from diverse populations from the industrial revolution to the late 20th Century as other major northern cities in the UK(Small, 2012). British Pakistanis are the second largest ethnic minority in the UK and the most likely to live in income-deprived neighbourhoods so are a particularly important population for inequalities research. A key strength of this cohort is its detailed recording of generation and large, well-classified and homogenous British Pakistani population with linked administrative data.

In conclusion we found that immigrant generation is an independent predictor for early educational outcomes and that there are different patterns associated with different immigrant generations. Our findings suggest that early life policy interventions to help children of first-generation immigrant with their English language before school could improve these children's school readiness.

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Declarations

Ethics This research was approved by the Born in Bradford Ethics Committee, reference number SP386

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