Ethnic and socio-economic differences in the prevalence of wheeze, severe wheeze, asthma, eczema and medication usage at 4 years of age: findings from the Born in Bradford birth cohort.

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Background

Asthma, wheeze and eczema are common in early childhood and cause considerable morbidity. Globally wheeze and asthma prevalence in children aged 6-7 is generally highest in high income countries, with the prevalence~~rates~~ of current wheeze being lowest in the Indian subcontinent and highest in English-speaking countries such as the United Kingdom and New Zealand ~~Oceania, whilst asthma ever was lowest in Africa and again highest in the Oceania region~~[1]. Within Western countries ~~however~~, ~~further differences in prevalence between native born populations and non-Western migrants, with~~ migrants generally~~on average~~ have~~ing~~ lower prevalence rates than~~relative to~~ native born populations ~~in Western countries~~[2]. H~~Evidence does suggest h~~owever, ~~that~~ the prevalence of wheeze and asthma symptoms may be higher in migrants compared to their peers in their countries of origin, and prevalence and severity ~~the risk of development and symptoms increase in~~ increase~~severity~~ with each additional year of residence in high-prevalence countires [2-4]. The~~e evidence of~~ ethnic ~~related~~ differences in ~~the prevalence of~~ eczema prevalence are~~is~~ not ~~however~~ as consistent, with high prevalence ~~rates~~ observed in Western countries, such as the UK and NZ, but also high prevalence in some low and middle income countries ~~with~~in Africa and Latin America[5]. Similar to the situation with asthma, r~~Results for eczema also showed a similar relationship with, with r~~ecent migrants to affluent and Western countries experienc~~ing~~ lower eczema prevalence than populations already resident in host countries[6].

The prevalence of physician--diagnosed asthma in childhood has been reported to differ by ethnicity~~c background~~ in UK and other western populations. In the UK, the highest rates have been reported in children of Black ethnicity followed by those of White and South Asian ethnicity~~background~~ [7]. P~~In addition to the differences in prevalence by ethnicity there is further evidence that p~~henotypes of asthma, wheeze and atopy may also differ by ethnicity [8]. Atopy has also been shown to vary by ethnicity, with South Asian children ~~shown to~~ having~~e~~ higher rates than their White British peers[9], although it is being

increasingly recognised that not all persons who experience asthma, wheeze and/or eczema are also atopic[10, 11]. Despite persons of South Asian origin resident in the UK being less likely to experience symptoms of wheeze and asthma, there are reports of poorer outcomes in asthma, with ~~potentially linked to lower rates of adequate diagnosis and being more likely to have both a~~ higher risks of asthma exacerbations and hospitalisations ~~for their asthma~~ [7, 12]. However, South Asian populations resident in the United Kingdom (UK) are ~~however~~ heterogeneous, originating from different countries including India, Pakistan and Bangladesh, experiencing differing cultural and socio-economic profiles ~~and~~. ~~As previous research has not always examined the relationship between wheeze asthma and eczema in different South Asian groups it remains unclear how applicable these findings are to different South Asian populations and what impact migration status may make to the observed results.~~

Few studies of e~~E~~thnic differences in childhood eczema have been ~~not been consistently~~ reported. Lower eczema prevalence in children of Indian, Pakistani and Bangladeshi origin compared to children of White British origin has been reported in a London based study[3], whilst another prevalence study conducted in Leicester found no differences between White and Asian children[13].

The current study ~~will~~ therefore examines the risks of wheeze, severe wheeze, doctor diagnosed asthma and eczema, and treatment provision for breathing problems, in an early childhood population that is UK born and predominantly of White British and Pakistani ethnic origin. We also~~This study will~~ examine the comparability of these results to studies that have included heterogeneous South Asian populations with differing migration profiles[14].

Methods

A sub-cohort of children from the Born in Bradford cohort study were recruited to participate in this study of ~~the assessment of~~ asthma and allergy; this work was conducted as part of a larger EU FP7 project entitled~~called~~ Mechanisms of the Development of ALLergy (MeDALL) [15]. This subcohort consisted of a convenience sample of 1648 children aged between 4 and 5 years recruited between 22nd October 2012 and 24th April 2014. Full details

of the main Born in Bradford study and recruitment processes have been reported~~can be found~~ elsewhere [16].

Children's parents or guardians were asked to report on a range of ~~of factors related to symptoms, diagnoses and~~ potential risk factors and their associations with~~related to~~ wheeze, asthma and atopy. Children's ethnicity was assigned based on mother's self-reported ethnicity. We excluded responses from cases where maternal ethnicity was missing (excluded n=2), resulting in an eligible study population of 1646 children and their carers; ~~who~~ in the majority of cases the carers were their mother (n=1621) or father (n=22).

Clinical outcomes

Wheeze: defined as self-reported wheeze in the past 12 months.

Severe wheeze: defined as reported wheeze on four or more occasions in the past year

Asthma: defined as a positive report of doctor diagnosis of asthma ever

Eczema: defined as a positive report of ever been diagnosed by a physician with having eczema/atopic dermatitis.

Medication use: defined as a positive response to question asking if child had received medication for asthma or other breathing problems during the previous 12 months.

Atopy: Sensitivity to five common aeroallergens (dog and cat dander, mixed grasses, *Mite D Pteronyssinus* and *Mite D Farinae*) was assessed using skin prick testing in a subgroup~~cohort~~ of 167 children. A child was considered sensitized if a weal reaction of >3 mm was present to a specific allergen after subtraction of the negative control. A child was considered atopic if a positive weal reaction to at least one of the six allergens tested was present.

Data analysis~~Covariable adjustment~~

The variables included in the analysis were based on previous literature, and in the case of socio-economic variables, were selected to ensure that a wide range were considered as our previous work in the cohort has shown that socio-economic measures may differ between different ethnic groups [17]. In particular, we~~We~~ considered adjusting~~ed~~ for ~~co~~variables that have previously been shown to be associated with wheeze, asthma, eczema or~~and~~ medication usage in childhood. These ~~covariables~~ included age of mother at delivery, maternal history of asthma or atopy (yes *vs* no), paternal history of asthma or atopy (yes *vs*

no), maternal smoking during pregnancy (yes *vs* no), child currently exposed to smoke (yes *vs* no), visible signs of mould or damp in the home (yes *vs* no), gas cooker used in the home (no, yes always use an extractor fan, yes sometimes use a fan, yes never use a fan) mother born abroad (yes *vs* no), father born abroad (yes *vs* no), child seen doctor for chest infection in the past 12 months (yes *vs* no), born at term (yes *vs* no), gender of child (male *vs* female), ever breastfed (yes *vs* no), older sibling(yes *vs* no), birthweight (<2500g, 2500-2999g, 3000-3499g, 3500-3999g, >=4000g), mode of birth (vaginal *vs* caesarean), ever eczema ever (yes *vs* no), ever had a problem with sneezing, or a runny or blocked nose when s/he did not have a cold or the flu (yes *vs* no) and mother's BMI at pregnancy booking.

We included~~further adjusted for~~ three different socio-economic indicators including: highest level of maternal education (categorised as less than 5 GCSEs, >5 GCSEs, A level, Degree Level, Other, Foreign Unknown or Other); current home ownership (yes *vs* no); and subjective poverty (yes *vs* no). Subjective poverty was derived by asking women how they felt they were managing financially and were classified as subjectively poor if they responded that they were "finding it very difficult" or "finding it quite difficult" and not subjectively poor if they responded that they were "living comfortably", "doing alright" or "just getting by".

Univariate associations between each potential confounder~~covariables~~ and each clinical outcome of interest were estimated~~calculated~~ using logistic regression followed by mutually adjusted logistic regression models. ~~Selection of covariables included in the analysis were based on previous literature, and in the case of socio-economic variables, were selected to ensure that a wide range were considered as our previous work in the cohort has shown that socio-economic measures may differ between different ethnic groups [17].~~ Output from these models was expressed as odds ratios and 95% confidence intervals of the effect estimates and corresponding p values are also provided. Estimates were assumed to indicated statistically significant differences if p values were less than 0.05. All analyses were conducted using Stata SE 13.1[18].

Results

The baseline characteristics of the participating mother-child pairs, ~~stratified~~ by ethnicity, are shown ~~below~~ in table 1. ~~Some differences were observed between the baseline characteristics of different ethnic groups. Specifically, both~~ Mmaternal and paternal history of asthma or atopy, were more common in~~higher for~~ children of White British origin compared to Pakistani and Other ethnic groups. Maternal smoking during pregnancy was highest in the White British group compared to the Other ethnic group and lowest in the Pakistani group. Current exposure to smoke in the home was highest in the Pakistani group compared to White British and lowest in the other group. Women of Pakistani ethnicity were most likely to be within the normal weight category at pregnancy booking.

Socio-demographic characteristics differed between the different ethnic groups. Mother's age at delivery was youngest for mothers of Pakistani origin followed by mothers of Other ethnicity and of White British origin. Women in the Other ethnic group were more likely to have a degree or an A level ~~equivalent~~ education (or equivalent) followed by White British and Pakistani women. Mothers of Other ethnic origin were most likely to report that they were managing financially whilst White British mothers were least likely to report this. Mothers of Other ethnic origin were most likely to be born abroad compared to mothers of White British and Pakistani ethnic groups, whereas fathers of Pakistani children were most likely to born abroad compared to children of White British and Other ethnic origin. Rates of home ownership were greatest amongst Pakistani respondents.

There were also ethnic differences ~~observed~~ in specific household environmental risk factors; White British families were most likely to have gas cookers and use them without an extractor fan or only sometimes use an extractor fan, whilst children of Other ethnicities were slightly more likely to have visible damp in their homes.

Children of Pakistani origin were more likely to have been born at low or very low birth weight, ~~although they were also more likely~~ to be delivered through vaginal rather than caesarean birth, and to have an older sibling compared to White British and Other ethnic groups. Children of Other ethnic origin were most likely to have ever been breastfed, followed by Pakistani whilst lowest breastfeeding rates were observed in the White British group. Minimal ethnic differences were observed between the prevalence of term birth.

Eczema prevalence was highest in children of White British origin compared to children of other ethnic groups.

Table 1 CBaseline characteristics of study participants

	White British	Pakistani	Other	Total
	495 (30.0)	n=961	n=190	n=1646
Family history				
Maternal history of asthma or atopy	287 (58.0)	277 (28.8)	69 (36.3)	633 (38.5)
Paternal history of asthma or atopy	204 (41.2)	264 (27.5)	61 (32.1)	529 (32.1)
Socio-demographic factors				
Maternal age at child's birth	29.2 (6.2)	28.6 (5.3)	29.1 (5.2)	28.8 (5.5)
Maternal BMI at booking				
Underweight	3 (0.6)	59 (6.1)	4 (2.1)	66 (4.0)
Normal	210 (42.4)	429 (44.6)	92 (48.4)	731 (44.4)
Overweight	129 (26.1)	271 (28.2)	53 (27.9)	453 (27.5)
Obese	123 (24.9)	150 (15.6)	31 (16.3)	304 (18.5)
Missing	30 (6.1)	52 (5.4)	10 (5.3)	92 (5.6)
Maternal education (baseline)				
<5 GCSEs	84 (17.0)	290 (30.2)	26 (13.7)	400 (24.3)
5+ GCSEs	150 (30.3)	290 (30.2)	44 (23.2)	484 (29.4)
A level	81 (16.4)	101 (10.5)	25 (13.2)	207 (12.6)
Degree level	127 (25.7)	247 (25.7)	65 (34.2)	439 (26.7)
Other	47 (9.5)	17 (1.8)	9 (4.7)	73 (4.4)
Foreign	6 (1.2)	12 (1.3)	20 (10.5)	38 (2.3)
unknown/Don't know				
Married living with a partner	253 (51.1)	900 (93.7)	139 (73.2)	1292 (78.5)
Not married living with a partner	129 (26.1)	4 (0.4)	21 (11.1)	154 (9.4)
Not living with a partner	113 (22.8)	57 (5.9)	30 (15.8)	200 (12.2)
Housing tenure (current)				
Owns house	291 (58.8)	716 (74.5)	110 (57.8)	1117 (67.9)
Subjectively poor (current)	34 (6.87)	49 (5.10)	15 (7.89)	98 (5.95)
Mother born abroad (baseline)				
Yes	9 (1.8)	645 (67.1)	121 (63.7)	775 (47.1)

Father born abroad (baseline) **Yes**	22 (4.4)	572 (59.5)	112 (59.0)	706 (42.9)
Environmental exposures				
Currently exposed to smoke+	50 (10.1)	108 (11.2)	16 (8.4)	174 (10.6)
Maternal smoking during pregnancy	125 (25.3)	33 (3.4)	21 (9.3)	179 (10.9)
Gas cooker in the home, No Yes always use a fan Yes sometimes use a fan Yes never use a fan	 92 (18.6) 138 (27.9) 122 (24.7) 143 (28.9)	 12 (1.3) 498 (51.9) 221 (23.0) 230 (23.9)	 21 (11.1) 70 (36.8) 52 (27.4) 47 (24.7)	 125 (7.6) 706 (42.9) 395 (24.0) 420 (25.5)
Visible signs of dampness or mould	99 (20.0)	206 (21.4)	41 (21.6)	346 (21.0)
Child characteristics				
Female gender	234 (47.2)	497 (51.7)	96 (50.5)	827 (50.2)
Ever breastfed, yes	336 (67.9)	730 (76.0)	162 (85.3)	1228 (74.6)
Seen doctor for chest infection past 12 months	52 (10.9)	155 (16.9)	22 (12.0)	230 (14.5)
Older sibling*	261 (52.7)	627 (65.2)	108 (55.8)	996 (60.5)
Eczema ever	177 (35.8)	227 (23.6)	49 (25.8)	453 (27.5)
Ever sneezing, runny or blocked nose when no cold	106 (21.4)	178 (18.5)	42 (22.1)	326 (19.8)
Birth weight <2500 2500-2999 3000-3499 3500-3999 >4000	 27 (5.5) 74 (15.0.) 170 (34.3) 145 (29.3) 79 (16.0)	 104 (10.8) 277 (28.8) 342 (35.6) 184 (19.2) 54 (5.6)	 17 (9.0) 46 (24.2) 80 (42.1) 35 (18.4) 12 (6.3)	 148 (9.0) 397 (24.1) 592 (36.0) 364 (22.1) 145 (8.8)
Term pregnancy, yes	437 (88.3)	833 (86.7)	166 (87.4)	1436 (87.2)
Mode of birth Vaginal Caesarean	 379 (76.6) 110 (22.2)	 755 (78.6) 193 (20.1)	 141 (74.2) 47 (24.7)	 1275 (77.5) 350 (21.3)
Childs BMI, mean (SD)	16.1 (1.43)	15.7 (11.4)	15.8 (1.7)	15.9 (1.7)

+ Includes smoke exposure from mother, father or others in the home.

Table 2 presents the patterns, by ethnivity, of~~differences in~~ wheeze in the last 12 months, severe wheeze, doctor diagnosis of asthma or medication usage for asthma or other breathing problems between the children of different ethnicities. W~~Prevalence of w~~heeze in

the last 12 months was highest in children of Pakistani ethnicity, followed by children of White British and Other ethnic groups. In contrast, severe wheeze and eczema was highest in the White British group followed by those of Pakistani and Other ethnic background. Doctor diagnosis of asthma and medication usage for asthma or breathing problems was consistently highest in children of Pakistani origin followed by children of White British and then children of Other ethnic background.

Table 2 Summary of asthma, wheeze, eczema and medication usage by ethnic group

	White British	Pakistani	Other	Total
	n=495	n=961	n=190	n=1646
Wheeze				
Wheeze in the last 12 months	98 (19.8)	217 (22.6)	29 (15.3)	344 (20.9)
Severe wheeze (>4 times in a year)*	31 (6.3)	39 (4.1)	4 (2.1)	74 (4.5)
Asthma diagnosis and management				
Ever diagnosed by doctor as having asthma	42 (8.9)	129 (13.4)	6 (3.2)	179 (10.9)
Ever diagnosed by doctor as having eczema or atopic dermatitis	161 (32.5)	200 (20.8)	42 (22.1)	403 (24.5)
Taken medicines for asthma or breathing difficulties in past 12 months	94 (19.0)	185 (19.3)	23 (12.1)	302 (18.3)
Positive skin prick test+	2 (3.4)	23 (26.4)	2 (11.1)	28 (17.0)

*Denominator participants that reported wheezing or whistling in the last 12 months.

+Denominator 164 participants with valid atopy and ethnicity data

All potential confounders~~covariables~~ were explored in a series of two different models for each outcome of interest wheeze in the last 12 months, severe wheeze, doctor diagnosis of asthma/eczema and taken medications for asthma or breathing problems. The first model (~~shown below in~~ table 3) examined the ~~univariate relationship between~~ univariate associations between the various measures of socioeconomic position~~ socio-economic variables~~ and all four health outcomes;~~. univariate between covariables and the outcomes and~~ the second model ~~conducted was multivariate analysis~~ mutually adjusted~~ing~~ for all variables (table 4)~~covariates. The results of these models are shown below in table 3~~.

Commented [EP1]: Should we model skin prick tests or wait til the All in analyses where we will have greater power. Very interesting that ever eczema is lower in the Pakistani group but positive skin prick tests much higher in the Pakistani group!

Table 3 ~~F~~Associations of~~indings by~~ socio-economic measures with asthma

	Wheeze in the last 12 months	Severe Wheeze	Doctor diagnosed asthma	Doctor diagnosed eczema	Medications for asthma or breathing problems
Maternal Education					
<5 GCSEs	0.90 (0.65-1.24)	1.09 (0.57-2.10)	1.13 (0.77-1.67)	0.76 (0.55-1.04)	0.91 (0.65-1.27)
5+ GCSEs	1	1	1	1	1
A level	0.86 (0.58-1.28)	1.05 (0.47-2.36)	0.53 (0.29-0.96)*	1.15 (0.80-1.67)	0.89 (0.58-1.34)
Degree level	0.70 (0.51-0.97)	1.05 (0.55-1.99)	0.52 (0.32-0.81)*	1.08 (0.80-1.45)	0.71 (0.51-1.01)
Other	1.07 (0.61-1.90)	1.70 (0.62-4.70)	0.96 (0.45-2.02)	1.14 (0.66-1.99)	1.20 (0.67-2.15)
Foreign	0.62 (0.25-1.51)	1.29 (0.29-5.73)	1.03 (0.39-2.74)	0.94 (0.43-2.04)	0.89 (0.38-2.08)
unknown/Don't know					
Subjectively poor, yes (current)	2.21 (1.44-3.41)*	1.15 (0.45-2.91)	1.79 (1.03-3.09)*	1.25 (0.79-1.96)	1.56 (0.97-2.50)
Housing tenure (current)	0.65 (0.51-0.83)**	0.45 (0.29-0.72)**	0.66 (0.48-0.90)**	0.94 (0.74-1.19)	0.69 (0.53-0.89)**
Owns house, yes					

Table 4 ~~Univariate~~Unadjusted and ~~Multivariate~~Adjusted associations ~~relationship~~ with asthma ~~outcome+~~

	Wheeze in the last 12 months		Severe Wheeze		Doctor diagnosed asthma		Doctor diagnosed eczema		Medications for asthma or breathing problems	
	~~Univariate~~Unadjusted	~~Multivariate~~ Adjusted	~~Univariate~~Unadjusted	~~Multivariate~~ Adjusted	~~Univariate~~Unadjusted	~~Multivariate~~ Adjusted	~~Univariate~~Unadjusted	~~Multivariate~~ Adjusted	~~Univariate~~Unadjusted	~~Multivariate~~ Adjusted
Ethnicity White British Pakistani Other	1 1.18 (0.90-1.54) 0.73 (0.47-1.16)	1 1.02 (0.63-1.66) 0.56 (0.30-1.05)	1 0.63 (0.39-1.03) 0.32 (0.11-0.92)	1 0.97 (0.42-2.26) 0.45 (0.13-1.55)	1 1.59 (1.11-2.28)* 0.33 (0.14-0.80)*	1 1.88 (1.00-3.52)* 0.33 (0.12-0.93)*	1 0.55(0.43-0.70)*** 0.59 (0.40-0.87)**	1 0.79 (0.52-1.21) 0.67 (0.39-1.13)	1 1.02 (0.77-1.34) 0.59 (0.36-0.97)*	1 1.32 (0.80-2.17) 0.72 (0.38-1.38)
Female compared to male gender	0.77 (0.60-0.96)*	0.72 (0.54-0.96)*	0.88 (0.55-1.41)	0.90 (0.53-1.53)	0.64 (0.46-0.87)**	0.53 (0.37-0.75)***	0.97 (0.77-1.21)	1.01 (0.78-1.29)	0.67 (0.52-0.86)**	0.61 (0.45-0.82)***
Eczema ever	1.96 (1.53-2.52)*	1.77 (1.30-2.40)***	1.85 (1.49-2.98)*	1.28 (0.73-2.24)	2.43 (1.77-3.34)***	2.21 (1.53-3.19) ***	-	-	2.26 (1.75-2.94)***	1.96 (1.44-2.67)***
Ever sneezing, runny or blocked nose when no cold	2.76 (2.11-3.60)*	2.53 (1.84-3.48) ***	3.51 (2.18-5.64)***	4.01 (2.29-7.02)***	2.42 (1.73-3.39)***	1.93 (1.31-2.85) ***	2.06 (1.59-2.67)***	1.80*** (1.34-2.40)	2.89 (2.19-3.81)***	2.44 (1.76-3.37)***
Older sibling, yes	0.80 (0.62-1.02)	0.72 (0.52-1.01)	0.56 (0.35-0.89)*	0.70 (0.38-1.30)	0.87 (0.63-1.20)	0.85 (0.56-1.31)	0.61 (0.49-0.77)***	0.60*** (0.45-0.80)	0.72 (0.56-0.93)*	0.66 (0.47-0.93)*

compared to no										
Maternal age at child's birth **15-19** **20-24** **25-29** **30-34** **35+**	 1.07 (0.57-2.01) 1.13 (0.82-1.56) 1 1.01 (0.73-1.39) 0.97 (0.67-1.41)	 0.90 (0.41-1.95) 1.09 (0.73-1.63) 1 1.23 (0.83-1.83) 1.36 (0.87-2.12)	2.51 (1.09-5.77) 0.88 (0.48-1.62) 1 0.54 (0.27-1.07) 0.57 (0.26-1.26)	1.27 (0.42-3.80) 0.65 (0.32-1.34) 1 0.56 (0.25-1.23) 0.56 (0.22-1.43)	1.72 (0.85-3.48) 1.21 (0.81-1.83) 1 0.77 (0.49-1.20) 1.10 (0.69-1.76)	1.44 (0.60-3.48) 1.05 (0.64-1.71) 1 0.86 (0.52-1.43) 1.25 (0.72-2.17)	1.05 (0.59-1.90) 0.99 (0.73-1.34) 1 0.88 (0.64-1.18) 0.99 (0.70-1.40)	0.76 (0.38-1.52) 0.90 (0.63-1.29) 1 1.02 (0.72-1.43) 0.99 (0.67-1.47)	1.19 (0.63-2.24) 1.04 (0.75-1.46) 1 0.84 (0.59-1.18) 1.00 (0.69-1.47)	0.80 (0.36-1.76) 0.86 (0.57-1.30) 1 0.90 (0.60-1.35) 1.11 (0.70-1.74)
Family history										
Maternal history of asthma or atopy	1.43 (1.13-1.82)*	1.08 (0.80-1.47)	1.94 (1.22-3.10)*	1.09 (0.62-1.90)	1.72 (1.26-2.35)**	1.70 (1.17-2.47)**	2.48 (1.97-3.12)***	2.08*** (1.60-2.70)	1.82 (1.41-2.34)***	1.45 (1.06-1.98)*
Paternal history of asthma or atopy	1.09 (0.85-1.41)	1.16 (0.85-1.57)	1.08 (0.66-1.77)	0.92 (0.51-1.67)	1.34 (0.97-1.84)	1.45 (1.00-2.10)	1.52 (1.20-1.92)***	1.24 (0.95-1.62)	1.18 (0.90-1.53)	1.12 (0.82-1.53)
Maternal	1.23 (0.85-1.77)	1.06 (0.64-1.74)	1.29 (0.65-2.57)	0.49 (0.21-1.15)	0.90 (0.54-1.51)	0.82 (0.42-1.59)	1.08 (0.76-1.54)	0.78 (0.50-1.22)	1.05 (0.70-1.55)	0.79 (0.47-1.34)

smoking during pregnancy										
Currently exposed to smoke	1.19 (0.82-1.72)	1.09 (0.70-1.69)	1.87 (1.00-3.47)*	2.00 (0.95-4.22)	1.21 (0.75-1.95)	1.03 (0.60-1.76)	1.09 (0.76-1.56)	1.14 (0.77-1.70)	1.00 (0.67-1.50)	0.87 (0.54-1.40)
Mother born abroad (baseline) Yes	0.98 (0.78-1.25)	0.85 (0.60-1.22)	0.32 (0.18-0.56)***	0.21 (0.097-0.44)***	1.25 (0.91-1.70)	1.16 (0.73-1.83)	0.65 (0.51-0.81)***	0.90 (0.64-1.25)	0.88 (0.68-1.13)	0.83 (0.57-1.22)
Father born abroad vs UK born (baseline)	1.19 (0.94-1.51)	1.29 (0.92-1.82)	0.85 (0.52-1.37)	1.06 (0.53-2.13)	1.33 (0.97-1.81)	1.35 (0.89-2.06)	0.71 (0.56-0.90)**	0.96 (0.71-1.31)	1.13 (0.88-1.45)	1.21 (0.85-1.72)
Seen doctor for chest infection past 12 months	7.77 (5.77-10.45)***	7.19 (5.17-10.0)***	4.22 (2.59-6.89)***	4.67 (2.64-8.27)***	4.03 (2.89-5.70)***	3.03 (2.05-4.48)***	1.56 (1.16-2.11)**	1.41* (1.01-1.98)	5.74 (4.27-7.73)***	5.19 (3.72-7.25)***

Gas cooker in the home No Yes always use a fan Yes sometimes use a fan Yes never use a fan	1 1.98 (1.14-3.44)* 1.70 (0.95-3.04) 1.86 (1.05-3.31)*	1 3.25 (1.54-6.86)** 3.09 (1.44-6.65)** 2.46 (1.16-5.22)*	1 1.21 (0.47-3.17) 1.28 (0.47-3.48) 0.89 (0.31-2.50)	1 2.33 (0.70-7.81) 3.27 (0.94-11.4) 1.17 (0.33-4.11)	1 1.58 (0.77-3.24) 1.37 (0.64-2.92) 1.95 (0.93-4.06)	1 2.20 (0.83-5.85) 2.40 (0.88-6.54) 2.55 (0.96-6.76)	1 0.66 (0.44-1.00) 0.67 (0.43-1.04) 0.77 (0.50-1.20)	1 0.86 (0.53-1.41) 0.74 (0.44-1.23) 0.90 (0.54-1.48)	1 1.58 (0.91-2.76) 1.52 (0.85-2.72) 1.63 (0.92-2.91)	1 2.48 (1.19-5.18) * 2.77 (1.31-5.89) ** 2.26 (1.08-4.74)*
Visible signs of dampness or mould	1.18 (0.89-1.57)	1.08 (0.77-1.53)	1.13 (0.65-1.96)	1.42 (0.76-2.66)	0.98 (0.67-1.44)	0.93 (0.62-1.41)	1.34 (1.03-1.74)*	1.33 (0.99-1.79)	1.23 (0.91-1.65)	0.85 (0.61-1.20)

Table 4 ~~Univariate~~Unadjusted and ~~Multivariate~~Adjusted relationship with asthma outcome+ (continued)

Child characteristics										
Birth weight										
<2500	1.63 (1.09-2.44)*	1.79* (1.03-3.11)	2.18 (1.09-4.38)	1.98 (0.76-5.14)	1.39 (0.81-2.38)	1.58 (0.79-3.16)	0.79 (0.51-1.23)	0.44** (0.25-0.77)	1.58 (1.03-2.43)*	1.28 (0.72-2.27)
2500-2999	1.02 (0.75-1.40)	1.06 (0.73-1.54)	0.77 (0.39-1.52)	0.92 (0.43-1.99)	1.05 (0.69-1.60)	1.03 (0.64-1.65)	0.87 (0.64-1.17)	0.86 (0.62-1.20)	0.93 (0.66-1.31)	0.88 (0.59-1.30)
3000-3499	1	1	1	1	1	1	1	1	1	1
3500-3999	0.90 (0.65-1.25)	0.83 (0.56-1.23)	1.18 (0.63-2.19)	1.29 (0.63-2.66)	1.19 (0.78-1.80)	1.17 (0.73-1.87)	1.03 (0.76-1.39)	0.91 (0.65-1.28)	1.05 (0.75-1.48)	1.04 (0.70-1.55)
>4000	0.84 (0.53-1.35)	0.73 (0.39-1.36)	0.81 (0.30-2.15)	0.97 (0.32-2.93)	0.95 (0.51-1.75)	0.88 (0.39-1.97)	1.22 (0.82-1.83)	1.09 (0.67-1.77)	1.29 (0.82-2.03)	1.40 (0.79-2.48)
Term pregnancy (yes compared to no)	0.56 (0.40-0.79)**	0.80 (0.51-1.27)	0.45 (0.26-0.81)*	0.60 (0.27-1.34)	0.81 (0.51-1.28)	1.14 (0.63-2.05)	0.81 (0.58-1.14)	0.60* (0.39-0.93)	0.54 (0.38-0.77)**	0.68 (0.42-1.08)
Ever breastfed, yes	0.93 (0.71-1.22)	0.98 (0.70-1.37)	0.74 (0.45-1.23)	0.82 (0.45-1.48)	0.86 (0.61-1.22)	0.93 (0.62-1.41)	1.18 (0.91-1.54)	1.14 (0.84-1.54)	0.90 (0.68-1.19)	0.85 (0.61-1.20)
Mode of birth										
Vaginal	1	1	1	1	1	1	1	1	1	1
Caesarean	1.11(0.83-1.47)	0.96 (0.68-1.36)	1.37 (0.81-2.32)	1.14 (0.60-2.14)	1.05 (0.72-1.54)	1.00 (0.65-1.54)	1.54 (1.19-2.00)	1.52** (1.13-2.04)	1.21 (0.90-1.63)	1.14 (0.80-1.61)
Maternal BMI at booking		1.18 (0.57-2.42)	1.73 (0.65-4.60)	2.25 (0.72-7.02)	0.96 (0.43-2.18)	0.66 (0.27-1.64)	0.93 (0.52-1.67)	1.15 (0.61-2.18)	1.20 (0.63-2.27)	1.05 (0.50-2.21)
Underweight	1.31 (0.71-2.40)	1	1	1	1	1	1	1	1	1
Normal	1	1.37 (0.98-1.93)	0.98 (0.55-1.72)	1.01 (0.53-1.94)	0.99 (0.68-1.44)	0.95 (0.62-1.46)	0.89 (0.68-1.17)	0.88 (0.65-1.19)	1.13 (0.83-1.53)	1.16 (0.81-1.64)
Overweight	1.34 (1.01-1.79)*	1.39 (0.94-2.06)	1.02 (0.54-1.94)	0.93 (0.45-1.92)	0.99 (0.64-1.52)	0.95 (0.58-1.55)	0.90 (0.66-1.23)	0.80 (0.56-1.14)	1.23 (0.87-1.72)	1.13 (0.76-1.69)
Obese	1.33 (0.96-1.84)									

+Adjusted for ethnicity and socio-economic measures

Wheeze in the past 12 months

Mutual adjustment of ~~covariable~~variables showed that the odds of wheeze in the preceding 12 months was higher if the child had eczema ever OR 1.85 (1.39-2.46), had a history of sneezing, runny or blocked nose when no cold 2.66 (1.98-3.58) or used a gas cooker either if always used a fan OR 3.25 (1.54-6.86), sometimes used a fan OR 3.09 (1.44-6.65) or never used a fan OR 2.46 (1.16-5.22). Gender was the only ~~covariable~~variable associated with a lower odds of wheeze, with girls having a lower odds then boys OR 0.69 (0.53-0.90).

Severe Wheeze

T~~Next t~~he mutually adjusted ~~relationships~~associations with severe wheeze were examined with only a few variables found to contribute to the odds of severe wheeze. The odds were higher in children who reported sneezing, runny or blocked nose when no cold OR 4.81 (1.49-2.98) and report of a doctor visit for chest infection OR 4.67 (2.64-8.27). Only term birth was associate with lower odds of severe wheeze OR 0.32 (0.18-0.56).

Doctor diagnosed asthma

In adjusted analyses eczema OR 2.21 (1.53-3.19), ever sneezing, runny or blocked nose when not had a cold OR 1.93 (1.31-2.85), maternal history of asthma or atopy OR 1.70 (1.17-2.47) and seen a doctor for a chest infection in the past 12 months OR 3.03 (2.05-4.48) and Pakistani compared to white British children OR1.88 (1.00-3.52) were all associated with an increased odds of doctor diagnosed asthma. Reduced odds of asthma were only observed in girls compared to boys OR 0.53 (0.37-0.75) and children of Other ethnic group compared to White British OR 0.33 (0.12-0.93). Paternal history of asthma or atopy was not statistically significantly associated with increased odds although results were marginal OR 1.45 (1.00-2.10).

Doctor diagnosed eczema

Odds of eczema were higher in children who had problems with sneezing when didn't have a cold OR 1.80 (1.34-2.40), had a maternal history of asthma or atopy OR 2.08 (1.60-2.70), had seen a doctor for a chest infection OR 1.41 (1.01-1.98) or had been born via caesarean section OR 1.52 (1.13-2.04).Lower odds were associated with having older siblings OR 0.60 (0.45-0.80) and being born <2500g compared to 3000-3500g OR 0.44 (0.25-0.77).

Medications for asthma or breathing problems

In the mutually adjusted analyses having eczema ever OR 1.96 (1.44-2.67), ever sneezing or having a runny nose ever when not having a cold OR 2.44 (1.76-3.37), maternal history of asthma or atopy OR 1.45 (1.06-1.98), having seen a doctor a chest infection in the previous 12 months OR 5.19 (3.72-7.25) and use of a gas cooker in the home whether always using an extractor fan OR 2.48 (1.19-5.18), sometimes uses a fan OR 2.77 (1.31-5.89) or never uses a fan OR 2.26 (1.08-4.74) were all positively associated with medications for asthma or breathing problems. Female gender OR 0.61 (0.45-0.82) and having an older sibling OR 0.66 (0.47-0.93) were all associated with a lower odds of receiving medications in line with the reduced risk of respiratory problems in these participants.

Discussion

This study has ~~We~~ found ~~that there were~~ ethnic differences in the prevalence of doctor diagnosed asthma, with Pakistani children more likely to receive a diagnosis than White British or Other ethnicity children. However, no major ethnic differences were observed for wheeze in the last 12 months, severe wheeze, doctor diagnosed eczema or taking medications for breathing problems or asthma, even after adjustment for other risk factors. For all five outcomes evaluated, two ~~covariable~~variables had consistent positive ~~relationships~~associations with outcomes~~;~~ sneezing or having a runny nose ever when not having a cold and having seen a doctor for a chest infection in the previous 12 months, the latter variable having the strongest ~~largest~~ positive association~~effect size~~. For all respiratory and respiratory medication usage outcomes, eczema was shown to confer an extra risk of having these outcomes.

W~~Our results demonstrate that w~~ell established factors such as gender, family history, socio-economic status and child's medical history and chest infection were stronger risk factors than ethnicity for the outcomes examined ~~in a UK born child cohort~~.

Strengths and weaknesses

The strengths of our studies include the large sample size, a homogenous UK born Pakistani comparator group with a rich collection of socio-demographic and clinical data which has

allowed for adjustment for a wide range of potential confounding factors. We were able to adjust ~~our results~~ for a wide range of factors including multiple measures of socio-economic status at different periods of the life course, an approach that has been recommended when examining health inequalities within and between ethnic groups [19-21]. We also adjusted for a wide range of factors relating to ~~the~~ maternal and paternal migration in addition to ethnic background as well as other established risk factors for asthma and wheeze, although we were unable to adjust for pet ownership or day care attendance as this information was not collected.

Strengths and weakness compared to other studies

Our findings are consistent with results from the Millennium cohort study in finding no difference in wheeze between children of White British and Pakistani or Indian ethnic origin children [22] in the early years. Our findings of higher rates of doctor diagnosed asthma in Pakistani compared to White British children are similar to those of ~~was not replicated by~~ Panico et al[22] who had used a definition of asthma ever ~~and found no ethnic differences between~~. Irrespective of the definition used, results for asthma both from ours and earlier studies should be interpreted with caution given the diagnostic uncertainty of asthma in the age groups under study. Our results are also based on a UK born Pakistani population which may also explain the similarity of some of our findings to those of Panico et al[22].

With the exception of the current study and that of ~~e results published by~~ Panico et al [22], previous studies of ~~examining~~ ethnic differences in wheeze, asthma and asthma treatment in the UK that have included Pakistani participants, have analysed their data ~~results~~ as part of a homogenous grouping of South Asian participants. A previous systematic review and meta-analysis of ethnic variations in asthma frequency and morbidity concluded that the prevalence of asthma and wheeze was lower in South Asian populations than observed for White children; ~~,~~ however these studies were limited by the heterogeneity of ethnic groups included, ~~with the South Asian population groupings included~~ and the lack of adjustment for migration status [12]. The other variable that is perhaps ~~far~~ more likely to have influenced the lower prevalence results observed for South Asian children in the systematic review is the socio-economic profile of the included participants. There is evidence ~~indicating~~ that different South Asian groups resident in the UK have different socio-economic profiles.

South Asian women of Indian ethnic origin are more likely to be economically active compared to women of Pakistani and Bangladeshi ethnic backgrounds [23] and children of Bangladeshi and Pakistani origin are more likely to be economically deprived than Indian children[24].

Our findings for eczema are consistent with earlier findings in showing lower rates of eczema in children of Pakistani origin compared to White British children. Lower rates of eczema in Pakistani children are likely related to the lower rates of familial history and higher likelihood of being in a low socio-economic group, given previous consistent findings showing higher rates of eczema in offspring born to parents with asthma and/or eczema and those of higher socio-economic status (refs to be added).

We selected children for inclusion in this study based on their age based on those already participating in the overall Born in Bradford study. Compared to the main Born in Bradford study population[16] we have oversampled children of Pakistani ethnicity in this current subgroup. Whilst our results are likely representative of the Bradford district they may not be representative childhood populations in other UK cities.

~~Further research~~

The finding of a higher prevalence of doctor diagnosed asthma for Pakistani children in this young age group, in contrast with the lack of ethnic difference in asthma symptoms, may suggest greater medicalization of wheeze and respiratory symptomology for children of this ethnic group.

The findings of the current study confirm the conclusions of~~from~~ the Millenium Cohort study [22], that suggest that ~~relationships~~associations between wheeze, asthma, eczema and medication usage for South Asian children is not homogenous. Authors of future studies should seek to stratify results by different South Asian origin and seek to report the migration status. By adhering to these recommendations future systematic reviews in this area will be able to produce evidence that has greater applicability to the diverse South Asian diaspora and their offspring resident in the UK.

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