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**Article:**

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<https://doi.org/10.1111/ppe.12310>

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## **Incidence and burden of wheezing disorders, eczema and rhinitis in children: findings from the Born in Bradford Cohort**

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### **Abstract**

**Background:** Bradford city has high infant mortality and there is a major health concern in the community due to environmental pollution. The aim of the study was to investigate the incidence and burden of wheezing disorders, eczema and rhinitis in children aged 3-7 years.

**Methods:** it is a prospective cohort study; the participants were 13,734 children from the Born in Bradford cohort.

**Results:** There were a total of 22.1% (95% CI: 21.4 to 22.8%), 52.4% (95% CI: 51.5 % to 53.2%) and 19.3% (95% CI: 18.6 to 19.9%) incidence cases of wheezing disorders, eczema and rhinitis, respectively. A total of 37% (95% CI: 36.2% to 37.8%), 19.5% (95% CI: 18.9% to 20.2%) and 5.9% (95% CI: 5.5% to 6.3%) of the children were affected by only-one, two and three diseases, respectively. Boys to girls incidence rate ratios for wheezing disorders, eczema and rhinitis was 1.41 (95% CI: 1.31 to 1.51), 1.02 (95% CI: 0.97 to 1.07) and 1.18 (95% CI: 1.09 to 1.28) respectively. The respective incidence rate ratios of Pakistani to white British were 0.94 (95% CI: 0.87 to 1.02), 1.31 (95% CI: 1.24 to 1.39) and 2.03 (95% CI: 1.83 to 2.25) respectively.

**Conclusion:** our study shows that the impact of wheezing disorders, eczema and rhinitis is substantial in this cohort and higher than previously reported in earlier studies. In addition, it indicates that whilst boys are more likely to suffer from wheezing disorders, rhinitis and multiple diseases than girls, Pakistani children are more likely to suffer from eczema, rhinitis and multiple diseases than white British children.

## **INTRODUCTION**

Wheezing disorders, eczema and rhinitis are global health problems and their prevalence was observed to rise in the last decades (1-3). Based on self-reported symptoms, the International Study of Asthma and Allergies in Childhood (ISAAC) reported that the global prevalence of asthma, rhinitis and eczema for 6-7 age group during 2002-2003 was 12.6% (range =2.8–37.6%), 8.5% (range = 2.2–24.2%) and 8.9% (range =2–22.3%), respectively (1). The respective prevalence for the 13-14 age groups was 14.1% (range = 3.4–31.2%), 14.8% (range = 4.5–45.1%) and 8.1% (range = 1.4–21.8%). The UK was among the highest affected countries in the world with 12-months period prevalence of 20.9%, 10.1% and 16% for asthma, rhinitis and eczema symptoms in the 6-7 age group. The respective prevalence for the 13-14 age group was 24.7% 15.3% and 14.7% (1).

In the United Kingdom (UK), it is estimated that 1 in 5 and 1 in 11 children suffer from eczema (4) and asthma (5), respectively. Although figures for eczema and rhinitis are not available, there were 1.1 million childhood asthma cases with around 25,000 emergency hospital admissions in 2012 (5). It is also estimated that the National Health Service (NHS) spends £1 billion a year treating and caring for childhood and adult asthma cases (5).

Bradford district, populated by around half a million residents mainly white British and Pakistani (mostly from the Mirpuri region of Pakistan), is one of the most deprived areas in the UK (6, 7). The district's population is younger than the national average (6); and, while only around 18% of the residents are Pakistani origin (7), around 44% babies born in the district are from Pakistani origin mothers (6). Bradford has twice the national average infant mortality and relatively high childhood morbidity (8, 9), with childhood asthma presenting a major health concern in the community due to environmental pollution (7). In response to these health concerns in the district, Born in Bradford (BiB) cohort project was established in 2007 (7). The aim of the project was to examine the impact of genetic, nutritional, environmental, behavioural and social factors on child health and development, and adult life (7).

The aim of the study was to investigate the burden of wheezing disorders, eczema, and rhinitis in the Born in Bradford (BiB) cohort. The study will also compare the burden of the three diseases among the two ethnicities (i.e. white British and Pakistani) as well as boys and girls.

## **METHODS:**

### **Study participants**

The Born in Bradford study is a prospective cohort, mainly bi-ethnic, that examines the impact of environmental, genetic and social factors on health of the population of Bradford (7). The methods of recruitment are explained in detail elsewhere Kingdom (6, 7). In brief: all women booked for delivery at the Bradford Royal Infirmary were offered an oral glucose tolerance test (OGTT) at 26–28 weeks gestation. Eighty percent of them agreed to do OGTT. Between March 2007 and December 2010, 80% of those who attended for OGTT also agreed to participate in the BiB cohort. A total of 12,453 mothers were recruited which resulted in 13,776 pregnancies. Out of the total births, 123 died before the age of 1 week and a total of 13 734 children were included in this analysis.

### **Ethics statement**

Ethics approval was granted to the Born in Bradford project by Bradford Research Ethics Committee (Ref 07/H1302/112.).

### **Data collection**

Three data sources were used. (a) Baseline questionnaire for information on ethnicity of the mother (i.e., proxy for child's ethnicity); (b) the hospital maternity records for sex and birth year of a child and (c) information on wheezing disorders, eczema, and rhinitis drug prescription were collected from the systemOne primary care data.

SystemOne is an integrated system with four modules: primary care, secondary care, mental health and social care (10). The systemOne primary care module allows clinicians to record and access patient data during consultation. It is currently used by more than 2500 General Practices (GPs) in England and all 84 GPs in Bradford district areas (10).

Baseline questionnaire and hospital maternity data were directly available from the data and research team of the BiB project (<http://www.borninbradford.nhs.uk/our-team/>) upon request. However, collection of drug prescription data was conducted in two steps. First, a list of drug family names and chapters were extracted from the British National Formulary (BNF) for Children Handbook version 2015 and were given to the data manager of BiB project. Based on the list of drug names and chapters the BiB data manager then conducted a SystemOne query and extracted the data. The baseline questionnaire, maternity and drug prescription data were then merged using 'child ID' as an identifier variable.

### **Case definition and ascertainment**

Incidence of wheezing disorders, eczema and rhinitis was confirmed through questionnaires or clinician-diagnosis data in the past. However, these types of data are prone to recall and reporting bias

respectively which are very likely to underestimate the true impact level of a disease in very young children. In order to overcome the potential for the misdiagnoses, a treatment based algorithm was used to allocate a diagnosis of disease conditions where wheezing disorder, eczema and rhinitis cases were ascertained by the existence of at least two respective drug prescriptions a minimum of one week and maximum of 12 months apart. A child can only be counted once as an incident case for each condition. Drug prescription primary care data was available up to November 2014. Supplementary Table 1 lists the drugs used to confirm the diagnosis of eczema, rhinitis and wheezing disorders.

### **Statistical analysis and software**

Life-time prevalence was defined as the proportion of the cohort of children with diseases (i.e. wheezing disorders, eczema and rhinitis) during the follow up period which was calculated by dividing the total incident cases by the total number of the cohort of children at risk during the follow-up. Incidence rates were defined as the number of new cases of diseases per the cohort population at risk in a given time period calculated as the ratio of number of children diagnosed with the condition to the total person-years at risk. Ethnicity, sex and birth year specific incidence rates were calculated as the ratio of number of children diagnosed with diseases for the particular birth year, ethnicity and sex to the respective total person-years at risk.

Analyses of overall prevalence, incidence rates and incidence ratios were carried out on the 13,734 BiB cohort children. As a sensitivity analyses, “five-year period” prevalence were then calculated for those children with complete 5 year data.

## **RESULTS**

The cohort consisted of 13,734 children born between April 2007 and June 2011. A total of 37.3% and 32.8% were Pakistani and white British, respectively; and 17.4% of the cohort had their information on ethnicity missing and 12.6% of the cohort was from other ethnicities. The other ethnicities (12.6%) of the cohort was made up of 19 ethnicities all representing <2% of the total BiB cohort. A total of 50.4% and 47.3% were boys and girls, respectively, (Table 1). The cohort yielded a total follow up period of 74,940 person years. The median follow up period was 5.55 years, ranging from 7 days to 7.6 years. Of the 13,734 cohort children, 140 had missing information on date of censoring, 225 withdrew from the study and 59 died during follow-up period.

**Table 1** Cumulative number of incident cases and percentages for 13,734 BiB cohort children

	Number of children (%)	Allergic conditions (%)		
		Wheezing disorders	Eczema	Rhinitis
<b>Overall</b>	13,734 (100)	3,035 (22.1)	7,192 (52.4)	2,646 (19.3)
<b>Ethnicity</b>				
Pakistani	5,117 (37.2)	1,150 (22.5)	2,995 (58.5)	1,255 (24.5)
White British	4,501 (32.8)	1,074 (23.9)	2,010 (44.7)	543 (12.1)
Other	1,733 (12.6)	308 (17.8)	948 (54.7)	352 (20.4)
Missing	2,383 (17.4)	503 (21.1)	1,239 (52.0)	495 (20.8)
<b>Sex</b>				
Boys	6,917 (50.4)	1,775 (25.7)	3,662 (52.9)	1,445 (20.9)
Girls	6,490 (47.3)	1,190 (18.3)	3,382 (52.1)	1,150 (17.7)
Missing	327 (2.3)	70 (21.4)	148 (45.3)	51 (15.6)
<b>Birth year</b>				
2007	2,082 (15.2)	507 (24.4)	1,085 (52.7)	490 (23.5)
2008	3,669 (26.7)	836 (22.8)	1,935 (53.0)	779 (21.2)
2009	3,817 (27.8)	872 (22.8)	2,021 (51.8)	725 (19.0)
2010	3,432 (25.0)	693 (20.2)	1,779 (50.7)	551 (16.1)
2011	734 (5.3)	127 (17.3)	372 (50.7)	101 (13.8)

### Wheezing disorders

There were 3,035 incident cases (cumulative incidence = 22.1%, 95% CI: 21.4 to 22.8%) of wheezing disorder during the follow up period (Table 1). There was no significant difference in the cumulative incidence between white British (23.9%; 95% CI: 22.6% to 25%) and Pakistani (22.5%; 95% CI: 21.3% to 23.6%) children. However, boys (25.7%; 95% CI: 24.6% to 26.7%) were more likely to have been diagnosed with wheezing disorders than girls (18.3%; 95% CI: 17.4% to 19.3%) during the follow up period (Table 1).

The overall incidence rate of wheezing disorders was 40.3 (95% CI: 38.9 to 41.8) per 1000 person years (Table 2). There was no significant difference between Pakistani and white British children (Incidence rate ratio = 0.94; 95% CI: 0.87 to 1.02). However, the rate was significantly higher for boys than girls (incidence rate ratio=1.41; 95% CI: 1.31 to 1.51), see Table 2. Although the cumulative incidence showed substantial decrease between 2007 and 2011 birth years (Table 1), there was a considerable increase in the incidence rate during the same period (Table 2).

## Eczema

There were a total of 7,192 (cumulative incidence: 52.4%, 95% CI: 51.5 % to 53.2%) childhood eczema incident cases during the follow up period (Table 1). There were more incident cases of Pakistani (58.5%; 95% CI: 57.2% to 59.9%) than the white British children (44.6%; 95% CI: 43.2% to 46.1%). However, there was no significant difference between boys (52.9%; 95% CI: 51.8% to 54.1%) and girls (52.1%; 95% CI: 50.9% to 53.3%), see Table 1.

The overall incidence rate of eczema was 95.6 (95% CI: 93.4 to 97.9) per 1000 person years. The rate was significantly higher in Pakistani than the white British (1.31; 95% CI: 1.24 to 1.39), but no significant difference between boys and girls (Table 2). The incidence rate of eczema showed a consistent and substantial increase between 2007 and 2011 birth years (Table 2).

**Table 2** Age, birth year, ethnicity and sex specific person years and incidence rates of allergic conditions for 13,734 BiB cohort children

	Incidence rate per 1000 person years (95% CI)		
	Wheezing disorders	Eczema	Rhinitis
<b>Overall</b>	40.3 (38.9 to 41.8)	95.6 (93.4 to 97.9)	35.3 (34.0 to 36.7)
<b>Ethnicity</b>			
White British	43.7 (41.2 to 46.4)	81.9 (78.4 to 85.6)	22.2 (20.4 to 24.2)
Pakistani	41.2(39.0 to 43.7)	107.4 (103.6 to 111.3)	45.0 (42.6 to 47.6)
Pakistani: white British	0.94 (0.87 to 1.03)	1.31 (1.24 to 1.39)	2.03 (1.83 to 2.25)
<b>Sex</b>			
Boys	46.8 (44.7 to 49)	96.5 (93.4 to 99.7)	38.2 (36.3 to 40.2)
Girls	33.3 (31.5 to 35.3)	94.8 (91.7 to 98)	32.3 (30.5 to 34.3)
Boys: girls	1.41 (1.31 to 1.51)	1.02 (0.97 to 1.07)	1.18 (1.09 to 1.28)
<b>Birth Year</b>			
2007	34.6 (31.7 to 37.7)	74.0 (69.7 to 78.6)	33.5 (30.7 to 36.6)
2008	36.3 (34.0 to 38.9)	84.1 (80.5 to 88.0)	33.9 (31.6 to 36.4)
2009	43.8 (41.0 to 46.8)	101.7 (97.3 to 106.2)	36.5 (34.0 to 39.3)
2010	46.4 (43.0 to 50.0)	119.2 (113.8 to 124.9)	37.1 (34.2 to 40.2)
2011	46.4 (39.0 to 55.3)	135.3 (122.2 to 149.8)	36.9 (30.4 to 44.9)

## Rhinitis

There were 2,646 incident rhinitis cases (cumulative incidence: 19.3%; 95% CI: 18.6 to 19.9%) during the follow period (Table 1). There were more cases of rhinitis of Pakistani and boys than white British and girls, respectively (Table 1).

The overall incidence rate of rhinitis in the cohort was 35.3 (95% CI: 34.0 to 36.7) per 1000 person years. The incidence rate was higher in Pakistani and boys as compared white British and girls, respectively (Table 2). There was a slight but consistent increase in the incidence rates of rhinitis between 2007 and 2011 birth years (Table 2).

### Incidence of multiple diseases

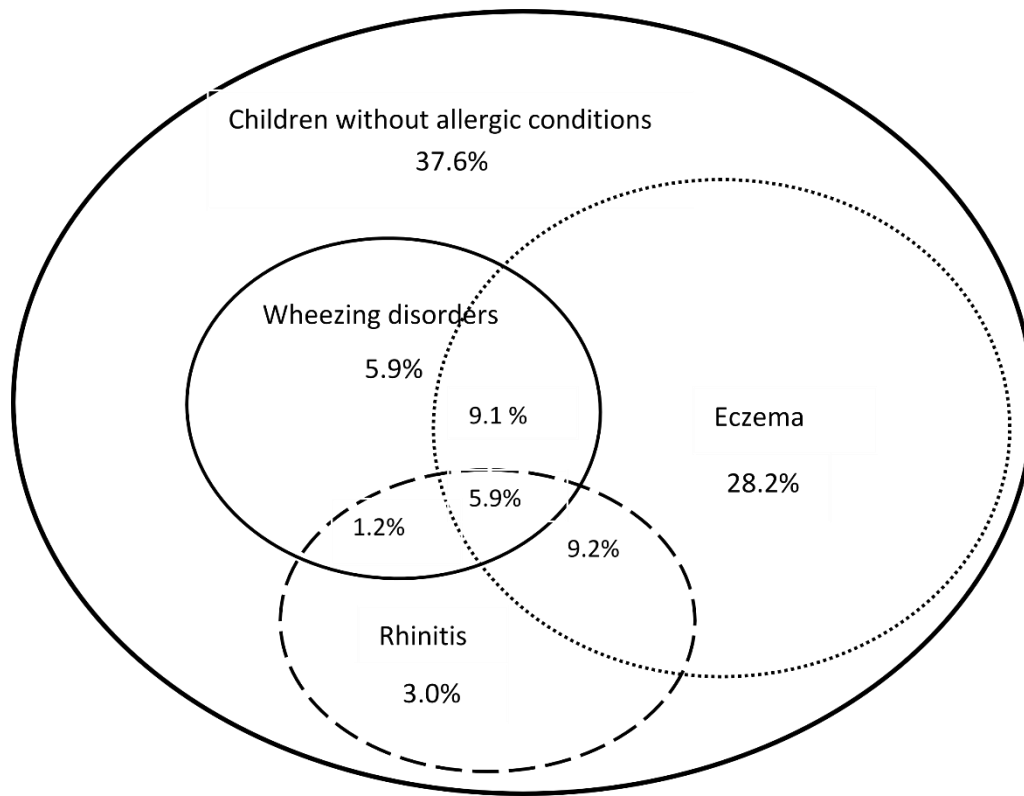
Of the overall cohort of 13,734 children, a total of 5,085 were affected by one of the three diseases; and, a total of 2,682 and 808 children had suffered from two and three diseases at the same time, respectively. The cumulative incidence for only one, two and three diseases was 37% (95% CI: 36.2% to 37.8%), 19.5% (95% CI: 18.9% to 20.2%) and 5.9% (95% CI: 5.5% to 6.3%), respectively (Figure 1 and Table 3).

**Table 3** Cumulative number of multiple incident cases and percentages for 13,734 BiB cohort children during the follow-up period

	Number of children (%)	Allergic conditions (%)		
		One condition	Two conditions	Three conditions
<b>Overall</b>	13,734 (100)	5,085 (37)	2,682 (19.5)	808 (5.9)
<b>Ethnicity</b>				
Pakistani	5,117 (37.3)	1,963 (38.4)	1,144 (22.4)	383 (4.1)
White British	4,501 (32.8)	1,647 (36.6)	711 (15.8)	186 (7.5)
Other	1,733 (12.6)	628 (36.2)	348 (20)	95 (5.5)
Missing	2,383 (17.4)	847 (35.5)	479 (20.1)	144 (6.0)
<b>Sex</b>				
Boys	6,917 (50.4)	2,539 (36.7)	1,456 (21.0)	477 (6.9)
Girls	6,490 (47.3)	2,444 (37.6)	1,174 (18.1)	310 (4.8)
Missing	327 (2.3)	102 (31.2)	52 (15.9)	21 (6.4)
<b>Birth year</b>				
2007	2,082 (15.2)	730 (35.1)	457 (22)	146 (7.0)
2008	3,669 (26.7)	1,340 (36.5)	730 (19.9)	250 (6.8)
2009	3,817 (27.8)	1,438 (37.7)	739 (19.4)	234 (6.1)
2010	3,432 (25.0)	1,294 (37.7)	626 (18.2)	159 (4.6)
2011	734 (5.3)	283 (38.6)	130 (17.7)	19 (2.6)

Although Pakistani children were more likely to be diagnosed with one or two conditions than the white British, they were less likely to have three diseases simultaneously. Boys and girls were equally to have been diagnosed from a single condition, but, boys were more likely to be diagnosed from two and three diseases than girls (Table 3).





The overall incidence rate for at least one, two and three diseases was 67.5 (95% CI: 65.7 to 69.4), 35.7 (95% CI: 34.4 to 37.1) and 10.8 (95% CI 10.1 to 11.5) per 1000 person years respectively. Boys and Pakistanis were more likely to be affected by multiple diseases than girls and white British children, respectively (Table 4). A consistent increase of trend in the incidence rate of single and two diseases between 2007 and 2011 birth years was observed (Table 4).

**Table 4** Age, birth year, ethnic and sex specific person years and incidence rates of at least one and multiple allergic conditions

	Incidence rate per 1000 person years (95% CI)		
	One condition	Two conditions	Three conditions
<b>Overall</b>	67.5 (65.7 to 69.4)	35.7 (34.4 to 37.1)	10.8 (10.1 to 11.5)
<b>Ethnicity</b>			
White British	67.2 ( 64.0 to 70.5)	29.0 (26.9 to 31.2)	7.6 (6.6 to 8.76)
Pakistani	70.3 (67.3 to 73.5)	41.0 (38.7 to 43.5)	13.7 (12.4 to 15.2)
Pakistani: white British	1.05 (0.98 to 1.12)	1.41 (1.29 to 1.56)	1.81 (1.52 to 2.17)
<b>Sex</b>			
Boys	66.8 (64.3 to 69.5)	38.4 (36.5 to 40.5)	12.6 (11.5 to 13.8)
Girls	68.5 (65.8 to 71.3)	32.9 (31.1 to 34.9)	8.7 (7.8 to 9.5)
Boys: Girls	1.02 (0.96 to 1.08)	1.17 (1.08 to 1.26)	1.45 (1.25 to 1.67)
<b>Birth Year</b>			
2007	49.7 (46.2 to 53.5)	31.3 (28.5 to 34.3)	9.9 (8.4 to 11.7)
2008	58.3 (55.2 to 61.5)	31.7 (29.5 to 34.1)	10.9 (9.6 to 12.3)
2009	72.2 (68.6 to 76.1)	37.2 (34.6 to 40.0)	11.8 (10.4 to 13.4)
2010	86.6 (82.0 to 91.5)	42.0 (38.8 to 45.4)	10.7 (9.2 to 12.5)
2011	102.8 (91.4 to 115.5)	47.5 (40.0 to 56.5)	6.9 (4.4 to 10.9)

### Five-year period prevalence

Of the total 13,734 children, 9,079 (66.1%) had a complete follow-up from birth until 5 years. Of these, 3,382 (37.2%) were Pakistani and 2,865 (31.6%) were white British children. 4,590 (50.6%) were boys and 4,298 (47.3%) were girls. Hence, there was no significant difference between the subset and the overall cohort.

Of those 9,079 children, there were a total of 2,135 (23.5%), 4,867 (53.6%) and 1,939 (21.4%) prevalent cases of wheezing disorders, eczema and rhinitis, respectively (Supplementary Table 2). Eczema and rhinitis were more prevalent in Pakistani than the white British children, although there was no significant difference in wheezing disorders. All three diseases were more prevalent in boys than in girls (Supplementary Table 2).

## COMMENTS

In this prospective cohort study, the results indicate that 1 in 2 children have suffered from eczema, and 1 in 5 children have suffered from wheezing disorders and rhinitis sometime between 0 and 7 years of age. A 37%, 19.5% and 5.9% of the children have suffered from only-one, two and three diseases, respectively. While there was no significant difference for eczema by gender, boys were more likely to suffer from wheezing disorders and rhinitis than girls. Furthermore, while no difference was observed for wheezing disorders, Pakistani children were more likely to suffer from eczema and rhinitis than white British children. Boys and Pakistani children were more likely to suffer from multiple diseases than girls and white British children, respectively.

The five-year prevalence estimates suggest that 1 in 5 children will have been diagnosed with a wheezing disorder and rhinitis, when they reach the age of 5 years; and, 1 in 2 of the cohort have had eczema during the same period. Eczema and rhinitis were more prevalent in Pakistani than white British children, whilst all three diseases were more prevalent in boys than girls.

In a meta-analysis and systematic review of studies conducted in the UK by Netuveli, Hurwitz (11) it was reported that 12-months period prevalence of asthma was lower in south Asian children (prevalence: 7.6%; 95% CI: 3.7 to 11.4%) as compared with black (prevalence: 15%; 95% CI: 3.5 to 26.5%) and white (prevalence: 10.6; 95% 4.6 to 16.7%) children. These figures are significantly lower than any of the five-year prevalence (i.e. overall or ethnicity based figures) in this study which could be due to difference in the ethnic composition of the population, diagnosis terms used (i.e. 'asthma' versus 'wheezing disorders') and the prevalence period. It was also reported that in Pakistan, the prevalence of asthma, wheezing, eczema and rhinitis in school children of Karachi was 15.8%, 11.7%, 21.8% and 28.5% respectively (12). The prevalence figures for rhinitis are similar to the BiB Pakistani group results although it must be noted that the authors defined 'wheezing' and 'asthma' as separate terms and used questionnaires to confirm diagnoses of diseases.

Punekar and Sheikh (13) who used the national General Practice Research Database (GPRD) data (14), reported lower incidence rates and lifetime prevalence than the BiB cohort's findings. The incidence rates for eczema, asthma and rhinitis were 22.7, 13.7 and 6.1 per 1000 person years, respectively. The 18-year prevalence figures reported by the authors are also significantly lower for eczema (36.5%, 95% CI: 35.9 to 37.2%) and rhinitis (11.4%, 95% CI: 11.0 to 11.8%) while similar for wheezing disorders (22.9%, 95% 22.3 to 23.4%) when compared with the five-year prevalence of BiB cohort. These could be for two reasons. First, the authors used clinician-diagnosed diseases and 'asthma' instead of 'wheezing disorders'. However, drugs can be prescribed for some period of time as a trial without any formal diagnosis (15). If the condition is transient, the child may not be formally diagnosed so this would underestimate the true burden of allergic diseases. In fact, in our previous work we found that although 22.1% of the children were treated for asthma drugs, only 6.1% of them were formally

diagnosed as asthmatic (16). Second, the GPRD data reflects the UK population and regions, but, the BiB data were composed of mainly Pakistani and white British who live in the district of Bradford. The district of Bradford has higher infant mortality (8), and air pollution has been a major concern in the community (7). Hence, the higher incidence of diseases in the BiB cohort than national level could be due to either difference in ethnic composition or higher environmental pollution.

Although similar in direction, the cumulative incidence of wheezing disorder figures from the BiB cohort are moderately lower and higher than the Health Survey for England (HSE) figures for wheezing occurrence and doctor diagnosed asthma respectively. The HSE reported 30% and 23% cumulative incidence of wheezing occurrences in boys and girls respectively; and, 17% and 12% of cumulative incidence of doctor-diagnosed asthma for boys and girls respectively, in 0-15 year old children (17). The disparities could be due to longer follow up and the use of questionnaires to confirm wheezing occurrences and doctor-diagnosed asthma in HSE's analysis report.

The findings of the BiB cohort are moderately different from the other three UK cohorts (18-20). For example, in a recent study that used data from the Millennium Cohort study (<http://www.cls.ioe.ac.uk/page.aspx?siteid=851>) the lifetime prevalence at age 7 for eczema, wheeze and asthma were 42.9%, 25.8% and 15.1% respectively (21). Another recent study that used data from the Avon Longitudinal Study of Parents and Children (ALSPAC) cohort (<http://www.bristol.ac.uk/alspac/>) and the Manchester Asthma and Allergy Study (MAAS) cohort (<http://www.maas.org.uk/>) also reported that the prevalence of eczema, wheeze and rhinitis at five years of age were 24.4%, 18.4% and 2.3%, respectively, for ALSPAC cohort; and, 32.4%, 22.5% and 28.1%, respectively, for MAAS cohort (22). The 5-years prevalence figures from the BiB cohort were slightly higher than the prevalence reported from the Millennium Cohort; and, moderately higher than the ALSPAC and MAAS cohort results. The variations in prevalence of allergic diseases between the BiB and the other UK cohorts could be due to the difference in ethnic composition and the use of questionnaire based data.

From the cumulative incidence rates analysis of the BiB cohort based on the birth years, it can be noted that there was no significant change in the incidence rate of rhinitis during 2007-2011 (Table 2). However, there were substantial increases in the incidence rates of eczema during every subsequent birth year. The same pattern was also observed in the incidence rate of wheezing disorders although it plateaued between 2009 and 2011 birth years (Table 2). These results may indicate that either the impact of diseases has increased during those birth years (23-25) or there may have been changes in clinicians' prescribing habits.

The results of this study indicate that Pakistani children are more affected by eczema and rhinitis than the white British which may imply that there could be a genetic component in the causation of these diseases. The predominance of wheezing disorders and rhinitis in boys than girls may be difficult to

understand for the BiB cohort's age group although the same pattern was observed until puberty age in previous studies (26).

The study has certain weaknesses and results need to be interpreted cautiously. First, in the analysis of incidence and burden of childhood diseases, there was a moderate proportion of missing information on ethnicity (17.4%) which could possibly have impacted the ethnic-specific incidence rate and ratio results. Second, recruitment was based on a willingness of the mothers to participate and study participants were those who were born at a single centre: the Bradford Royal Infirmary (BRI) maternity hospital. Births in the regional tertiary centre, home births and births in smaller hospitals outside Bradford will have been excluded. Third, the BiB cohort is mainly composed of white British and Pakistani children. While this could be a plus for comparative analyses between the two ethnicities, it was not possible to carry out comparative analyses for the other ethnicities. Fourth, the follow-up period for the cohort was also short (a maximum of 7 years) which could have impacted the incidence rate and ratio results as well as comparability with results from other cohorts that used longer follow-up periods. Fifth, although clinical records are best sources of data the possibility of errors during recording and consequently, disease outcome misclassification errors cannot be ruled out.

Nonetheless, this study has strengths. First, the sample size of the study was sufficiently large. Second, clinical records were used in identifying cases of diseases. Clinical records have minimal misclassification errors in excluding cases as opposed to questionnaires and clinical diagnosis data. The drug and prescription data are entered onto the primary care database by the GPs at the time of consultation which is an incentive for records to be accurate. Third, unlike 12-months period or point prevalence which measure the disease burden during a limited period, lifetime prevalence figures provide a clearer picture about the burden of disease and are therefore more helpful for health policy makers.

In conclusion, our study shows the impact of wheezing disorders, eczema and rhinitis is substantial in the Bradford district. In addition, it indicates that whilst boys are more likely to suffer from wheezing disorders, rhinitis and multiple diseases than girls, Pakistani children are more likely to suffer from eczema, rhinitis and multiple diseases than white British children.

**Acknowledgments:** Born in Bradford is only possible because of the enthusiasm and commitment of the Children and Parents in BiB. We are grateful to all the participants, health professionals and researchers who have made Born in Bradford happen.

**Funding:** Production of the manuscript was funded by Hall Dorman Research Scholarship. Data collection was funded by the National Institute for Health Research (NIHR) under the Collaborations

for Leadership in Applied Health Research and Care (CLAHRC) programme for Leeds, York and Bradford and the Programme Grants for Applied Research funding scheme.

**Contributors:** TFM, RGF and RCP conceived the idea. TFM performed all the statistical analyses, interpretation of results and drafted the manuscript. RGF and RCP revised and commented on the manuscript. All authors approved the final version of the manuscript.

**Competing interests:** none declared.

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