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Is the prevalence and level of astigmatism different in indigenous Bangladeshi children compared with first-generation children of Bangladeshi origin born in the United Kingdom?

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Abstract

Aim: **To compare the prevalence and level of astigmatism in indigenous Bangladeshi, first-generation British-Bangladeshi and indigenous white British children.**
Method: **Indigenous Bangladeshi, first-generation British-Bangladeshi and indigenous white British children, aged 6–10 years, were recruited from within six London primary schools in the borough of Tower Hamlets. Each child's refractive error was measured using the Plusoptix autorefractor without cycloplegia. Three readings were taken for each child and averaged to give the mean value for astigmatism.**
Results: **One hundred and thirty-eight (12.8%) positive responses were received in total. Of these, 80 (57%) children fulfilled the inclusion criteria. Fifty-eight (42%) children were rejected because full parental consent was not given for 15 children, 32 children did not fulfil the strict ethnic criteria of the study and 11 children were not within the age range of the study. Eighteen children who fulfilled the criteria were absent from school on the day of testing. In total 62 (45%) children were tested. Analysis showed there was no significant difference in the amount of astigmatism for the right eye ($\chi^2 = 2.306$, d.f. = 2, $p = 0.316$) or left eye ($\chi^2 = 2.935$, d.f. = 2, $p = 0.231$) across the three groups.**
Conclusion: **There was no significant difference in the amount of astigmatism for the right and left eye between indigenous Bangladeshi, first-generation British-Bangladeshi and white-British children aged 6–10 years old. However, due to the small number of children recruited there was limited power to detect any significant differences in the findings.**

Key words: Astigmatism, Bangladeshi, Indigenous

Introduction

Astigmatism is a defect of vision in which the image of an object is distorted, usually in either the vertical or the horizontal axis, because not all the light rays come to a focus on the retina. This is usually due to abnormal curvature of the lens (lenticular astigmatism) and/or the cornea (corneal astigmatism).

Infants show astigmatism which decreases as the emmetropisation process occurs, and the incidence declines during the third year of life.[1–4] By 3 years of age astigmatism has reduced significantly.[2,5,6] Studies suggest that infantile astigmatism is eliminated by the age of 6 years[2] and that the process of emmetropisation is largely complete before this age.[2,7]

The prevalence of astigmatism in subjects aged less than 1 year to 19 years of age in different countries has been studied (Table 1).[8–17] The data show a variation in prevalence according to continent and the ethnicity of the population studied. Comparison of prevalence rates of astigmatism between studies is difficult because different definitions have been used. Many previous studies have used 1 DC as their defined limit (Table 1).[8–17]

The Bangladesh national blindness and low vision survey[18] looked at the prevalence of refractive errors in a national representative sample of 11 624 adults aged 30 years and older (mean age 44 years) living in Bangladesh. Astigmatism (>0.5 DC) was present in 3625 (32.4%) subjects. Fuller *et al.*[12] compared the prevalence of astigmatism in 31 white and 31 Bangladeshi children aged 5–6 years who attended a primary school in East London. They defined astigmatism as >1 DC and reported a greater prevalence of astigmatism in the Bangladeshi children compared with the white British children (Table 1).[8–17]

There are no studies that have focused on differences in astigmatism (or any other refractive error) within a certain ethnic group living in different environments. The aim of this study was to compare the prevalence and level of astigmatism in three populations of children aged 6–10 years: those born in Bangladesh who emigrated to the United Kingdom after their third birthday, first-generation British-Bangladeshi children and indigenous white British children who have lived in the United Kingdom all their lives.

Methods

Ethics approval from the Hammersmith, Queen Charlotte's and Chelsea Research Ethics Committee was

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Table 1. Reported prevalence of astigmatism in other countries

Study	Country	Study population	Age (years)	*n*	Refraction method	Astigmatism definition (DC)	Prevalence (%)
Huynh *et al*. (2006)[8]	Australia	Urban, population-based	6–7	1765	C, A	≥0.75	10.3
Murthy *et al*. (2002)[9]	India	Rural, population-based	5–15	6447	C, A	≥0.75	4.8
Kalikivayi *et al*. (1997)[10]	South India	Urban, population-based	3–18	4029	C, SR	≥ 0.5	10.3
Garner *et al*. (1988)[11]	Vanuatu	Malanesian children from 4 schools	6–19	788	NC, R	≥1.0	0.3
Fuller *et al*. (1995)[12]	United Kingdom	Bangladeshi children from 1 school	5.7[a]	31	NC, R	>1.0	22.6
		White children from 1 school	6[a]	31	NC, R	>1.0	3.2
Pensyl *et al*. (1997)[13]	United States	Sioux Indian clinic subjects	0–6	174	C, A	>1.0	44.2
Fan *et al*. (2004)[14]	Hong Kong	Children from 2 nurseries	2–6.4	522	C, A	>1.0	21.1
Shih *et al*. (2004)[15]	Taiwan	Urban, population-based	7–18	11 175	C, A	>1.0	18.4
Tong *et al*. (2002)[16]	Singapore	Children from 2 schools	7–9	1028	C, A	>1.0	19.2
Kawuma and Mayeku (2002)[17]	Uganda	Population-based	6–9	623	C, R	NR	52

A, autorefraction; C, cycloplegic; NC, non-cycloplegic; R, retinoscopy; SR, subjective refraction; NR, not reported.
[a]Mean age.

obtained for this study, which was conducted in accordance with the principles of the Declaration of Helsinki in 1995.

Subjects were recruited from primary schools within the borough of Tower Hamlets in London. A formal letter that explained the purpose and methodology of the study was sent to the head teachers of the 61 primary schools in the area (special schools were excluded). The letter requested the head teacher's signed consent to recruit children in the school to the study. Subject to the head teacher's consent, the parents/guardians of all Bangladeshi and white British children aged 6–10 years who attended the school were sent 'packs' containing an information sheet explaining the study, a consent form and a questionnaire. Contact details of the researcher were also given if any parent/guardian wished to ask any further questions regarding the study. The 'packs' that were sent to the Bangladeshi families were also translated into Bengali.

The inclusion criteria were that the child was aged 6–10 years old with no previous history of eye problems and belonged to one of the following ethnic groups: indigenous Bangladeshi (group A), first-generation British-Bangladeshi (group B) or indigenous white British (group C). Eligibility was based on parental consent and the responses to the questionnaire (Fig. 1).

The inclusion criteria required children in the indigenous Bangladeshi group (group A) to have emigrated from Bangladesh to the United Kingdom after the age of 3 years and for the parents and grandparents of these children to be indigenous Bangladeshi. The children in the first-generation British-Bangladeshi group (group B) had to be born and resident in the United Kingdom; however, the child's parents and grandparents had to be indigenous Bangladeshi. For the white-British group (group C) the child, parents and grandparents must have been born and resident in the United Kingdom.

Informed written consent was obtained from at least one parent/guardian of all participating children. A simplified children's information sheet/consent form was given to every child to read, and to print their name at the bottom indicating consent.

Testing procedure

One researcher tested all the children recruited to the study. As all measurements were automated, observer bias was negligible. The test procedure was explained verbally prior to testing. Each child's refractive error was measured using the Plusoptix autorefractor without cycloplegia. Three readings were taken for each child and averaged to give the mean value for astigmatism.

The right and left eye of all subjects were analysed separately to avoid inter-ocular bias. Astigmatism of ≥1 DC was defined as a clinically significant amount,[19] in accordance with the majority of previous studies (Table 1).

Results

Six primary schools within the borough of Tower Hamlets agreed to participate in this study. Research packs containing a research information sheet, questionnaire, consent form and a Freepost reply envelope were sent to a total of 1020 Bangladeshi parents and 60 white-British parents.

One hundred and thirty-eight (12.8%) positive responses were received. Of these, 80 (57%) children fulfilled the inclusion criteria. Fifty-eight (42%) children were rejected because full parental consent was not given for 15 children; 32 children did not fulfil the strict ethnic criteria of the study and 11 children were not within the age range of the study. Unfortunately, 18 children who fulfilled the inclusion criteria were absent from school on the day of testing and due to time and practical constraints it was not possible to return to the schools to test them. In total 62 (45%) children were tested.

Group A consisted of 10 children (8 female, 2 male) with a mean age of 9.3 years (range 8–10 years). Group B consisted of 40 children (13 female, 27 male) with a mean age of 7.8 years (range 6–10 years.). Group C consisted of 12 children (5 female, 7 male) with a mean age of 8.8 years (range 7–10 years).

Fig. 2 shows the amount of astigmatism measured for the right and left eye for each child in group A (top), group B (middle) and group C (bottom). In group A, all 10 children had astigmatism of <1 DC in the right and left eye. The interocular difference in astigmatism was <0.5 DC for all the children.

In group B, 13 of the 40 children had astigmatism of ≥1 DC in one or both eyes (child: 1, 6, 7, 8, 12, 20, 22, 26, 27, 30, 34, 36, 40). Of these, 3 children had

Name of child:
Date of birth:

Home address:

Q.1) Please tick the country in which the following people were born:

Child

United Kingdom ☐ Bangladesh ☐ Other ☐

Mother

United Kingdom ☐ Bangladesh ☐ Other ☐

Father

United Kingdom ☐ Bangladesh ☐ Other ☐

Maternal grandfather

United Kingdom ☐ Bangladesh ☐ Other ☐

Maternal grandmother

United Kingdom ☐ Bangladesh ☐ Other ☐

Paternal grandfather

United Kingdom ☐ Bangladesh ☐ Other ☐

Paternal grandmother

United Kingdom ☐ Bangladesh ☐ Other ☐

Q.2) How long has your child lived in the UK?

All his/her life ☐

1 year ☐ 2 years ☐ 3 years ☐
4 years ☐ 5 years ☐ 6 years ☐
7 years ☐ 8 years ☐ 9 years ☐
10 years ☐

Q.3) Has your child ever visited Bangladesh?

Yes ☐ (please go to Q.4)

No ☐ (End of questionnaire)

Q.4) How many times has your child visited Bangladesh, and for how long?

Once ☐ Date_____ Duration _____

Twice ☐ Visit 1 Date_____ Duration _____
Visit 2 Date_____ Duration _____

3 or more times ☐ Visit 1 Date_____ Duration _____
Visit 2 Date_____ Duration _____
Visit 3 Date_____ Duration _____
Visit 4 Date_____ Duration _____

Fig. 1. Parent questionnaire used to determine eligibility for the study.

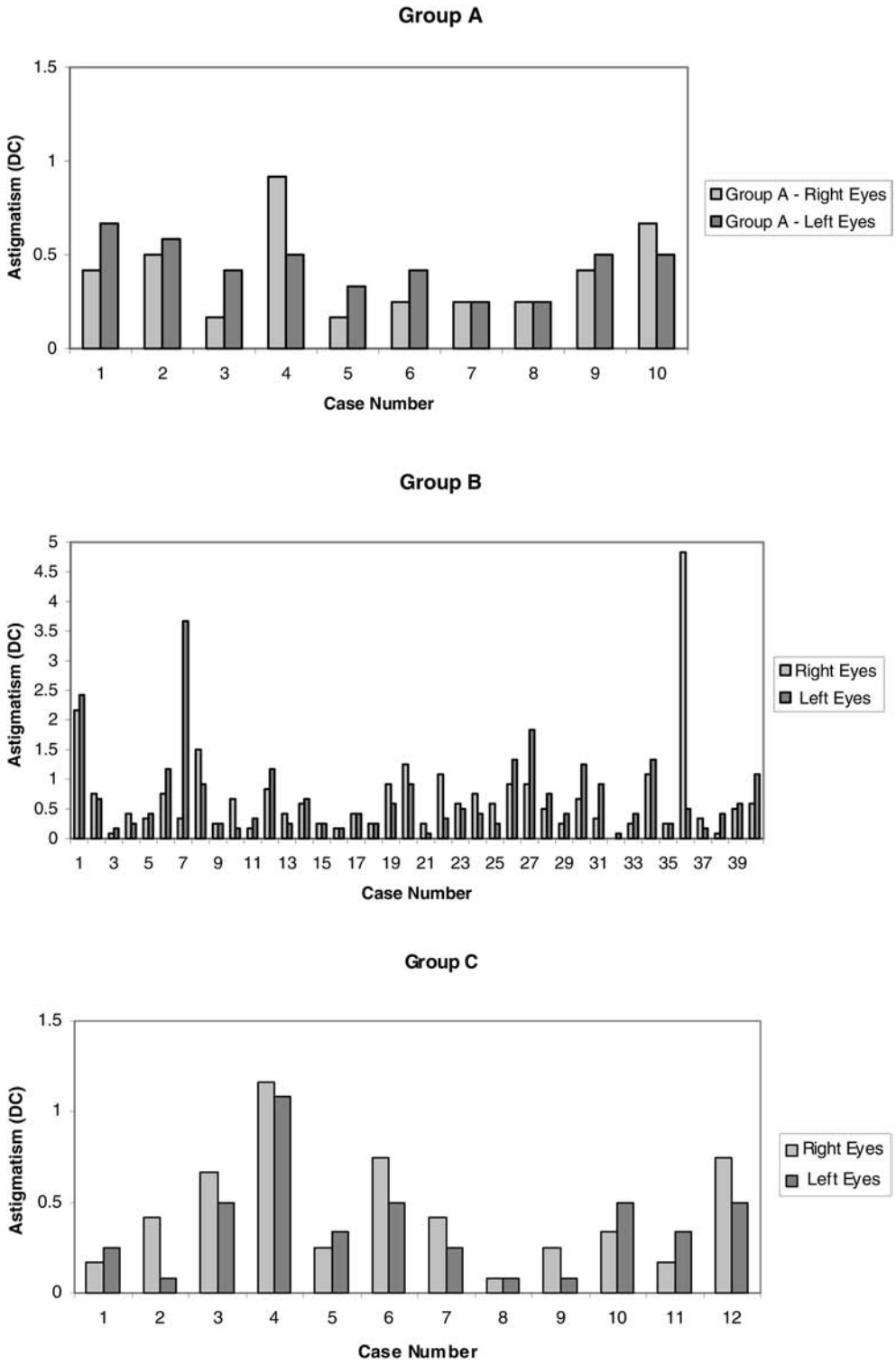

Fig. 2. Distribution of the amount of astigmatism for all children in group A (top), group B (middle) and group C (bottom) for the right and left eyes.

astigmatism >2 DC (child: 1, 7, 36). Two children (child: 7, 36) had a high interocular difference in the amount of astigmatism (3.3 DC and 4.3 DC respectively). For all other children the interocular difference was <1 DC.

In group C, 11 of the 12 children had astigmatism of <1 DC in the right and left eye; one child had astigmatism >1 DC in each eye. The interocular difference in astigmatism was <0.5 DC for all the children.

In general, for all groups, a higher amount of astigmatism was associated with a higher spherical

Table 2. Median and range of astigmatism measured for the children in group A, B and C for the right and left eye

	Group A		Group B		Group C	
	Right eye	Left eye	Right eye	Left eye	Right eye	Left eye
Median	0.33	0.46	0.5	0.42	0.38	0.33
Range	0.75	0.42	4.83	3.58	1.08	1.00
Minimum	0.17	0.25	0.0	0.08	0.08	0.08
Maximum	0.9	0.67	4.83	3.67	1.17	1.08

value. Across the three groups, 19 (31%) children were found to have significant refractive errors (>3 DS hypermetropia, ≥1 DS myopia and/or ≥1 DC astigmatism). The parents/guardians were advised to take these children to their optometrist within 6 weeks for a formal refraction. Two (3%) children were referred to their general practitioner because strabismus was seen on observation (children were not being formally tested for strabismus).

Table 2 shows the median value and range of astigmatism for the right and left eyes for the three groups. Fig. 3 shows the data as box-and-whisker plots. The median amount of astigmatism was similar across the three groups for the right and left eyes and the 'outliers' in the group B data are evident in Fig. 2.

As the data were not normally distributed, non-parametric analysis was performed across the three groups. A Kruskal-Wallis test showed there was no significant difference in the amount of astigmatism for the right eye ($\chi^2 = 2.306$, d.f. = 2, $p = 0.316$) or left eye ($\chi^2 = 2.935$, d.f. = 2, $p = 0.231$) data across the three groups.

Discussion

The results show there was no significant difference in the amount of astigmatism for the right or left eye between indigenous Bangladeshi, first-generation British-Bangladeshi and white-British children aged 6–10 years old.

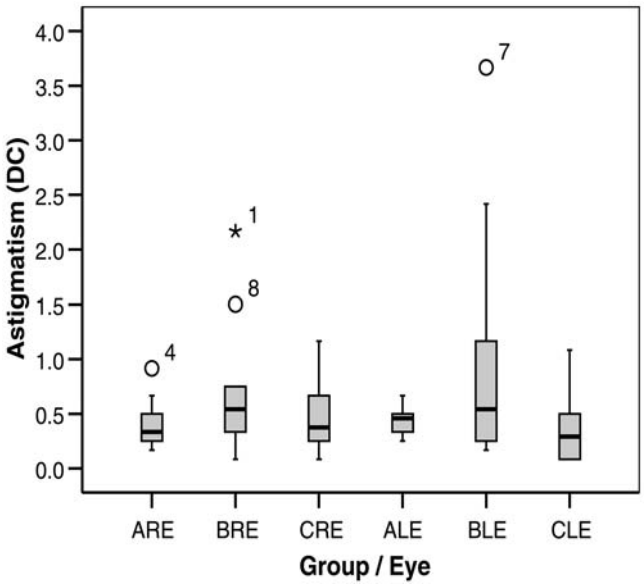

Fig. 3. Box-and-whisker plots to show the median and interquartile ranges with outliers for groups A, B and C for the right and left eyes. ARE, group A right eye; BRE, group B right eye; CRE, group C right eye; ALE, group A left eye; BLE, group B left eye; CLE, group C left eye.

One of the main limitations of this study is the small number of children recruited into groups A and C. The study consequently lacks statistical power to detect significant differences. The recruitment of children into this study was lower than anticipated. The borough of Tower Hamlets is one of the most deprived areas in England, with high levels of unemployment, poor levels of education and poor housing being just some of the social problems encountered. The recruitment of indigenous white-British children into this study was surprisingly poor. This was probably because recruitment was restricted to schools within Tower Hamlets, in which the majority of children are non-white. To avoid any confounding variables, such as socio-economic status, additional recruitment outside Tower Hamlets was not attempted.

It is acknowledged that there was a disproportionate male-to-female ratio in groups A and B. However, studies have found no gender differences for astigmatism.[8]

An objective measure of the refractive status of each child was taken using the Plusoptix. This is the first commercially available instrument that uses the technique of photoretinoscopy at a 1 metre distance. In a study of 15 student subjects, Choi *et al.*[19] found the Plusoptix to be superior with regard to the measurement of the magnitude and axis of astigmatism compared with a modern autorefractor, and indicated that the use of the Plusoptix at a 1 metre distance was not a significant stimulus to accommodation.

Greater levels of astigmatism in Bangladeshi children have been found in other studies with larger cohorts.[8–17] Fuller *et al.*[12] recruited 31 white and 31 Bangladeshi 5- to 6-year-olds from the same area of East London as this study and found astigmatism to be more prevalent in the Bangladeshi population compared with a white-British population, using non-mydriatic refraction. They also had 1 DC as their defined limit for astigmatism. However, in comparison with other prevalence studies their sample sizes were also very small and may not be truly representative of the 5- to 6-year-old ethnic population considered.

The inclusion criteria for the Bangladeshi group A required the child to have spent the first 3 years of his or her life in Bangladesh in order to be considered 'indigenous Bangladeshi'. The age of 3 years was chosen because the majority of the emmetropisation process should have occurred within the environment of Bangladesh.

The Bangladesh national blindness and low vision

survey[18] looked at the prevalence of refractive errors in a nationally representative sample of 11 624 adults aged 30 years and older (mean age 44 years). Automated refraction was carried out on all subjects. Astigmatism (>0.5 DC) was present in 3625 (32.4%) subjects. This is the only study to provide population-based refractive error data for Bangladesh.

It is thought that heredity determines the tendency of certain globe proportions (passive emmetropisation) and that environment plays a part in influencing the action of active emmetropisation.[20] There are no studies that have focused on differences in astigmatism (or any other refractive error) within a certain ethnic group living in different environments. Whilst no differences in the amount of astigmatism were detected in the two Bangladeshi groups evaluated in this study, the study is limited because it lacks statistical power to detect significant differences in the data. It is therefore difficult to draw any definitive conclusions and further study is required with a larger number of subjects.

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The author has no competing interests.

Investigation of patients was according to the guidelines of the Declaration of Helsinki.

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