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GENERATIONAL CHANGES IN HEIGHT AND BODY MASS DIFFERENCES BETWEEN BRITISH ASIANS AND THE GENERAL POPULATION IN GLASGOW

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Summary. A weighted total of 630 pupils aged 14–15 in Glasgow schools, about evenly divided between pupils of South Asian and non-Asian (overwhelmingly British) background, were measured for height and weight and compared with previous results for a similar Glasgow sample aged 30–40. Among 14–15-year-olds, British Asians were not so short compared with non-Asians as among 30–40-year-olds, especially females. Among 30–40-year-old Glasgow Asians only 7% were born in the UK, while among 14–15-year-old Glasgow Asians 86% were so born, indicating that they are the children of migrants. Generational differences in these comparisons cannot be due to positive selection of the migrant generation for height, and are attributed to improved environment, including nutrition and public health measures. This suggests the possibility of corresponding improvements in coronary and diabetic risk.

Introduction

The National Study of Health and Growth (Rona & Chinn, 1986, 1987; Chinn *et al.*, 1992) and other studies (Peters & Jones, 1989; Peters & Ulijaszek, 1992; Ulijaszek, Evans & Mumford, 1979) have shown consistent findings for South Asian children in Britain (i.e. those with ancestry in the Indian subcontinent—henceforth British Asians) within the age range 4–12. They are shorter and lighter for height than white children in Britain, while at the same time they are taller and heavier than children in India. The question has been raised whether these lower values compared with white children are partly due to vegetarian diet, but data on this have been inconclusive (Rona *et al.*, 1987). Nor could these data determine whether the higher values compared with children in India are due to selection for height of migrants from the Indian subcontinent, or to improved nutrition in Britain (Rona & Chinn, 1986). If it is improved nutrition, longer exposure to these better conditions could eventually be

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evidenced in the disappearance of the differences between Britons of South Asian origin and other British children in height and weight.

Similar findings and ambiguities have been noted in studies of other migrations. In a study of Japanese men in Japan, Hawaii and California (the NI-HON-SAN Study), the migrants and their descendants were taller and heavier than Japanese in Japan, and the more so the younger the age group compared. The authors had expected height to be genetically determined, but felt that these results were more likely, along with the weight results, to reflect nutrition. They did not discuss the possibility that the results were due to selection of migrants for height, and did not compare first and second generation migrants (Kagan *et al.*, 1974).

One way of resolving the question of selection is to compare second-generation British Asians with migrants of their parents' generation in the same British community. If it is merely that migrants were selected for height, the next generation should either show the same distribution of heights, in so far as enduring influences on height were initially selected, or regress towards the values of the population of origin in the subcontinent, in so far as ephemeral influences were initially selected. In neither case should the second generation be taller than the migrants' generation, and, if they have not yet reached their full adult height, they should either be no less short, or else be shorter against the general population of the same age than are the migrants. Evidence to the contrary, suggesting that the second generation were actually closing the gap, would point to influences other than selection.

The present study presents such a comparison, using data on 14–15-year-olds of South Asian background, overwhelmingly born in the UK. Where relevant, figures are given for the UK-born alone. Differences in height and weight are compared with the same age group of other backgrounds (predominantly of British background, for brevity 'Non-Asian'), both samples living in Glasgow; and these data are also compared with data for an overwhelmingly first-generation British Asian sample aged 30–40 and its general population counterpart, also in Glasgow.

Sample and methods

In the Glasgow District of Strathclyde Region's Education Department in the West of Scotland, eleven secondary schools covered 94·3% of all Muslim, Sikh and Hindu pupils recorded by the Education Department in 1991 (Strathclyde Region, 1991). A total of 824 respondents were drawn from nine of these schools, the two remaining schools having been used for piloting. A total sample was sought of pupils with South Asian names in S3 and S4 (14–15-years-old on 1st March), yielding an achieved sample of 334. Non-Asian pupils in the same age sets, 98% of British descent, were randomly sampled proportionally to their numbers in each school, or, where the school preferred not to take individuals out of classes, by taking random classes, yielding an achieved sample of 490. Taking random classes yielded numbers in excess of the target sampling proportion for non-Asians, and statistical re-weighting was used to correct this after data collection, resulting in a re-weighted sample of 677. The non-Asian sample compared closely in social class distribution with a large random sample of 15-year-olds in Clydeside in 1987 (Green, Macintyre & West, 1989). The overall response rate before weighting was 71%, and variations in response by school and

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ethnicity were also corrected when re-weighting. In addition, the re-weighted sample used here excludes pupils who were not exactly aged 14 or 15, resulting in a current re-weighted total of 630. Height and weight were not measured, or the question on puberty was not completed, in under 1% of cases. Of the British Asian sample, 86% were born in the UK.

The sample size was sufficient to detect differences of about 0·45 of a standard deviation in continuous variables with 80% confidence at the 5% level of significance for each ethnic comparison by gender within single years of age. Previous work has shown adult height differences between these groups to be of a similar or substantially higher order (Williams, Bhopal & Hunt, 1993). Fuller details of the sample are available elsewhere (Shams & Williams, 1993). The fieldwork, including determination and recruitment of the sample, and the overall supervision of the study, was carried out by the first author.

For comparison, a largely first-generation British Asian random sample aged 30–40 years ($N = 159$, mean age 35) and a general population counterpart aged 35 ($N = 319$) are also available from Glasgow. This sample has been fully described elsewhere (Williams *et al.*, 1993). Of the British Asian sample of this age, only 7% were born in the UK, and 86% spoke Punjabi, thus indicating the main originating source of both samples in the East and West Punjab.

Height was measured in centimetres to the nearest single decimal place. Respondents removed shoes and were measured using Nivotoise portable stadiometers. This has a footplate at the bottom and a head bar with spirit level at the top of a non-stretch metal tape measure. Supervisors were instructed to check each time that the tape was not twisted and that the respondent was not leaning against it. Respondents were instructed to stand with backs against a wall and heels against the back of the foot plate, to take a deep breath with head held in the Frankfurt plane, and to remain standing in that position while the head bar was lowered slowly to press the hair flat. The spirit level was used to check that the bar was horizontal. Training was given using measurement of fixed heights and of successive individuals by systematically varied pairs of supervisors until disagreement between supervisors averaged less than 0·3 cm.

Weight was measured with light indoor clothing only and without shoes using Soehnle portable digital electronic scales calibrated at the local trading standards office. Respondents were instructed to stand with feet together in the centre of the platform with an equal margin in front of and behind the feet. The supervisor took the reading in kilograms to the nearest single decimal place. Training was given in pairs as with height until disagreement on weight averaged less than 0·3 kg.

Pubertal status of pupils was elicited in a self-completion questionnaire filled in under supervision of the first author in the classroom while height and weight measurements were being taken. The question used derives from the National Child Development Study (Stark, Peckham & Moynihan, 1989), where recall of age at menarche at 16 was validated against a study which collected data at half-yearly intervals. For girls the question read ‘Have your periods started?’, and for boys ‘Has your voice broken?’, with response options ‘not yet started’, ‘before 11th birthday’, or ‘when aged 11/12/13/14/15’. Results for this question were analysed by ethnicity in each age/sex group separately, first comparing the proportion of each total ‘not yet started’,

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Table 1. Glasgow 14–15-year-olds 1992: ethnic differences in height, weight and body mass index

		Males		Females	
		Non-Asian origin	S. Asian origin	Non-Asian origin	S. Asian origin
Height (cm)					
Age 14	Mean	164·6	162·5	159·8	158·0*
	SD	8·1	9·5	5·6	6·0
Age 15	Mean	169·7	168·5	161·2	158·9*
	SD	8·5	7·4	6·3	5·3
Weight (kg)					
Age 14	Mean	54·9	54·1	53·8	53·4
	SD	10·5	13·3	8·9	11·0
Age 15	Mean	60·8	60·0	56·9	53·4*
	SD	12·1	11·8	10·1	8·4
BMI (kg/m^2)					
Age 14	Mean	20·2	20·3	21·0	21·3
	SD	2·9	4·0	2·9	3·7
Age 15	Mean	21·0	21·1	21·8	21·1
	SD	3·3	3·5	3·5	3·2
Weighted *N*					
Age 14		73	82	86	80
Age 15		64	77	89	75

*$p < 0{\cdot}05$.

and second, proportions of those already started by age at occurrence. Since both the dichotomised proportion and the proportions by age conform to requirements for rank order measures, Kendall's tau b was used in both cases.

Body mass index (BMI) was calculated as weight (kg) over height (in metres) squared, and the weight-for-height index of Chinn *et al.* (1992) was also calculated as a cross-check, though its use has been for slightly younger pupils.

Results

Height and body mass among the largely second-generation British Asians aged 14–15 are shown in Table 1. British Asian females were significantly shorter than their non-Asian counterparts, by a mean of 1·8 cm at age 14 and of 2·3 cm at age 15. British Asian males were not significantly shorter than non-Asian males, but tended in that direction, the mean difference of 2·1 cm at age 14 being of a similar order to the females although that of 1·2 cm at age 15 is less marked. The wider standard deviation of males at this age helps to explain the difference in significance. British Asian males born in the UK were 0·01–0·02 cm taller than all British Asian males, the significance of the comparison with non-Asians being unaffected; UK-born British Asian females were

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Table 2. Glasgow 14–15 year olds 1992: ethnic differences in onset of puberty

	Males		Females	
Onset of puberty†	Non-Asian origin %	S. Asian origin %	Non-Asian origin %	S. Asian origin %
Age 14				
Before 11	2	0	4	5
Age 11	2	5	14	21
Age 12	8	15	35	36
Age 13	31	20	29	27
Age 14	29	16	13	9
Not yet started	28	44	5	2
Mean age of group (years, months)	14, 6·3	14, 5·3	14, 5·3	14, 5·1
Age 15				
Before 11	3	3	3	5
Age 11	10	6	16	9
Age 12	10	13	27	29
Age 13	25	25	38	41
Age 14	31	20	8	15
Age 15	8	17	5	0
Not yet started	13	16	3	1
Mean age of group (years, months)	15, 5·1	15, 5·2	15, 5·8	15, 5·6
Weighted *N*				
Age 14	71	86	85	80
Age 15	63	74	89	75
Significance				
Voice has broken/periods started: age of occurrence by ethnicity in all four age/sex groups			ns	
Proportion with voice not broken/ periods not started by ethnicity:		Males age 14	$p < 0{\cdot}05$	
		Males age 15	ns	
		Females age 14	ns	
		Females age 15	ns	
Mean age of group by ethnicity:		Males age 14	$p < 0{\cdot}05$	
		Males age 15	ns	
		Females age 14	ns	
		Females age 15	ns	

†Males: age voice broke; females: age periods started.

0·03 cm taller at age 14, and 0·04 cm taller at age 15, than all British Asian females, and among 14-year-olds the comparison with non-Asians became just non-significant.

Ethnic differences in weight occur only among 15-year-old females who also show

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Table 3. Glasgow 1987 and 1992: ethnic differences between British Asians and comparison group at age 30–40 and at age 14–15

Difference of means (British Asians minus comparison group)	Males		Females	
	30–40 (mean 35)	14 15	30–40 (mean 35)	14 15
Height (cm)	−3·0**	−2·1	−4·5***	−1·8*
		−1·2		−2·3*
BMI (kg/m^2)	+0·1	+0·1	+2·2*	+0·3
		−1·2		−0·7

*$p < 0{\cdot}05$; **$p < 0{\cdot}01$; ***$p < 0{\cdot}001$.

the greatest height difference, and there are no significant ethnic differences in BMI, nor in the weight-for-height index of Chinn *et al.* (1992) (not tabulated).

Table 2 shows that for boys whose voice had broken or girls who had started their periods, the age of occurrence showed no significant differences by ethnicity in any of the four age/sex groups. When the proportion who had not yet started puberty is considered, among males aged 14, 44% of British Asians reported that their voices had not broken compared with 28% of non-Asians, this finding being just significant; and correspondingly in the same age/sex group British Asians were on average 1 month younger than non-Asians. Other age/sex groups showed no significant ethnic differences in age or proportion starting puberty.

Among males aged 14, height was re-calculated separately for those whose voice had and had not broken. Among those whose voice had broken, mean height for non-Asians was 165·3 cm (SD 7·4) and for British Asians the same (SD 8·5). Among the rest, mean height for non-Asians was 163·0 cm (SD 9·8) and for British Asians 158·8 (SD 9·7). With smaller totals (55 whose voice had not broken) neither of these differences was significant.

Table 3 compares the equivalent ethnic differences recorded at age 30–40. Among females, the gap in height was at that age particularly marked with a mean difference of 4·5 cm, which is reduced by 2·2–2·7 cm in the 14–15-year-olds. The mean height recorded for British Asian females aged 14 years (158·0 cm) is already 3·3 cm taller than the mean recorded for those aged 30–40 in 1987 (154·7 cm; Williams *et al.*, 1993). Among males the gap in height among 30–40-year-olds was smaller (3 cm) and the corresponding reduction of the gap among 14–15-year-olds (by 0·9–1·8 cm) is less impressive, though still striking. Neither 14- nor 15-year-old British Asian males have yet caught up with the height of those aged 30–40, those aged 15 being still on average 1·4 cm shorter.

In BMI the ethnic differences at age 30–40 were again sharp among females, with British Asian females being conspicuously heavier for height. The absence of this difference among 14–15-year-olds is noteworthy by contrast. Among males, no ethnic differences in BMI are discernible at either age.

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Discussion

These results for British Asian 14–15-year-olds, predominantly of Punjabi origin, are coherent with previous results for 4–12-year-olds, although male height differences are non-significant, partly because of wider variance at this age. Among male 14-year-olds this is in spite of the fact that the British Asian sample turned out to be 1 month younger on average than the non-Asians, with a corresponding just significant excess in the proportion whose voice had not broken. In this age/sex group mean height by ethnicity was identical for those whose voices had broken, and the (non-significant) height differences were confined to the remainder. Otherwise there were no significant ethnic differences in the proportion experiencing onset of puberty, and none in the age at which puberty had occurred; accordingly no other correction for maturation has been made for height.

The chief interest of the present findings is the change between first and second generation British Asians, broadly represented by the two age groups chosen, one almost entirely born abroad before migrating to the UK, and the other almost entirely born in the UK, the two groups having on average 20 years between them. By the second generation there is a clear reduction of the gap in height between the British Asian and comparison groups. The reduction is most striking among British Asian females, who at 14 are already considerably taller on average than those aged 30–40; but there is also a reduction in ethnic differences among males, and while British Asian males are still 1·5 cm shorter at 15 than those aged 30–40, they do not have far to go; the Twenty-07 Study in Glasgow showed a greater gap for general population males of 2·5 cm at age 15 vs age 35, but recorded an increase of 4·4 cm in height of males between ages 15 and 18 (West *et al.*, 1994). Similarly in the Twenty-07 Study general population females were also taller at age 15 than at age 35, but only by 1·1 cm (vs 3·3 cm for British Asians in the present study).

The 14–15-year-old sample was born almost entirely in the UK. Restriction of this sample to those actually born in the UK makes virtually no difference to the results. The UK-born British Asians are fractionally taller than the whole group taken together, indicating that the small number not born in the UK are relatively short. Among UK-born 14-year-old females the gap in height between British Asians and non-Asians becomes marginally non-significant instead of marginally significant.

The reasons for this change between British Asian generations are suggested by the design of the study. While the samples are not genetically linked to any degree at an individual level, it is reasonable to infer that the British Asian second-generation group in Glasgow shares a common genetic pool with the migrant generation in Glasgow, so that either selection for height is held constant between generations, or else height may regress in the second generation towards the mean in the population of origin in the subcontinent at the time of migration. In fact, there has been a rapid shift upwards in this second generation towards British general population norms of height. This shift is therefore likely to represent the influence of social and environmental factors, notably the change in nutrition from birth onwards, but also possibly the influence of immunisation and public health measures. Although greater height is not always necessarily beneficial, such a change is in this case likely to reflect positive developments.

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Furthermore in so far as increased height reflects better nutrition, this should also affect pregnant mothers and infants, suggesting other grounds for optimism. The importance of maternal and infant nutrition for later coronary and diabetic risk, amongst other things, is strongly suggested by the work of Barker (1992). To the extent that it is this nutritional element, rather than a genetic predisposition selected by experience of food scarcity (McKeigue, 1992), that contributes to such risks, there should be an improvement in second-generation British Asians.

The intergenerational findings on body mass give rise to no immediate inferences, because body mass varies so much with age, but the results are of descriptive interest, and will permit inferences as data accumulate on the British Asian second generation over time. In the Twenty-07 Study general population females were heavier by 3·0 kg/m^2 at age 35 compared with age 15 (West *et al.*, 1994), while British Asians in the present study were heavier by 5·9 kg/m^2. It will be interesting to see whether in the course of the next 15–25 years the present 14–15-year-old females will develop ethnic differences in BMI similar to those of the 30–40-year-olds of 1987. For this, longitudinal study will be required which will also seek to elucidate the reasons for differential development between the ethnic groups if it occurs. The result will also be significant for coronary heart disease. Body mass index is not so directly relevant to coronary and diabetic risk as central fat distribution (McKeigue, 1992), but it is correlated with fat distribution, and a tendency to central fat distribution is more likely to be found in children of British Asian background (Peters & Ulijaszek, 1992; Ulijaszek *et al.*, 1979) even when their BMI is below that of white children in Britain (Rona & Chinn, 1987). Further research on these issues among the younger generation of British Asians would be of great interest.

Conclusion

The findings provide early evidence of rapid convergence to general population norms of height in second-generation British Asians, suggesting the possibility of corresponding improvements in coronary and diabetic risk.

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