NORMATIVE DATA FOR IQ, HEIGHT AND HEAD CIRCUMFERENCE FOR CHILDREN IN SAUDI ARABIA

ADEL A. BATTERJEE, OMAR KHALEEFA, KHALIL ASHAER and RICHARD LYNN

Journal of Biosocial Science / Volume 45 / Issue 04 / July 2013, pp 451 - 459
DOI: 10.1017/S0021932013000102, Published online: 21 February 2013

J. Biosoc. Sci., (2013) **45**, 451–459, © Cambridge University Press, 2013
doi:10.1017/S0021932013000102 First published online 21 Feb 2013

NORMATIVE DATA FOR IQ, HEIGHT AND HEAD CIRCUMFERENCE FOR CHILDREN IN SAUDI ARABIA

ADEL A. BATTERJEE*[1], OMAR KHALEEFA†, KHALIL ASHAER‡ AND RICHARD LYNN§

**Dar al Thikr Schools for Boys, Jeddah, Saudi Arabia, †University of Khartoum, Sudan, ‡Sudan Academy of Science, Khartoum, Sudan and §University of Ulster, Coleraine, Northern Ireland, UK*

Summary. Normative data are reported for intelligence, height and head circumference for a sample of 1553 6- to 15-year-olds in Saudi Arabia, and for the correlations between these variables. Intelligence was tested with the Standard Progressive Matrices, on which the Saudi sample obtained a British IQ of 76.2. There were no significant differences in means between boys and girls and differences in variability were inconsistent. The heights of the Saudi sample were generally lower than those of the American norms. The differences in head circumferences between the Saudi children and the American norms were inconsistent. Correlations between IQ and height were weaker than those found in other studies but correlations between IQ and head circumference were positive.

Introduction

The objectives of this paper are to report normative data for intelligence, height and head circumference for 6- to 15-year-olds in Saudi Arabia, and the correlations between these variables. There have been two previous studies of intelligence in Saudi Arabia in which the Standard Progressive Matrices were administered. These obtained British IQs of 78 and 82 (Abdel-Khalek & Lynn, 2009; Batterjee, 2011).

It has long been known that intelligence is positively related to height and head circumference. In the late nineteenth century, the relation between educational attainment (an approximate proxy for intelligence) and height was reported in a study of 33,500 school students by Porter (1892). Since this early report, many studies have found that children who are shorter tend to obtain lower scores in IQ tests (e.g. Wilson *et al.*, 1986; Walker *et al.*, 2000; Gale, 2005). These studies have typically shown correlations between height and IQ of around 0.25. For example, in a large sample of 11-year-olds in Scotland the correlations were 0.24 for boys and 0.25 for girls (Deary *et al.*, 2009, p. 24).

[1] Corresponding author. Email: a-batterjee@althike.edu.sa

There does not appear to be a causal relationship between height and IQ. There is no evidence that an increase in height will cause a rise in intelligence. Thus, Wilson *et al.* (1986) reported that among 2177 children studied longitudinally in the National Health Examination Survey of the 1960s, changes in relative height between the ages of 8 and 13 years were not related to changes in scores on tests of intelligence or academic achievement. Furthermore, in a randomized controlled study into the effects of long-term growth hormone therapy in children born small for gestational age, most of the treated children showed a gain in height of 1 SD or more, paralleled by increases in IQ, but the increase in height did not explain the improvement in IQ (Van Pareren *et al.*, 2004).

A number of theories have been advanced to explain the association between intelligence and height. Diet, disease, psychosocial stress and inadequate cognitive stimulation in childhood have all been suggested as factors that might underlie the positive relation between height and IQ. Evidence that nutrition and cognitive stimulation are at least partially responsible comes from a study of growth-retarded children aged 9–24 months in Jamaica. Improvements in both growth and cognitive function were produced after two years of nutritional supplements and cognitive stimulation. Only those children who received both interventions caught up with the non-growth-retarded control group. Cognitive stimulation, but not nutritional supplements, had a long-lasting effect on intelligence, as shown by test results at age 11 years (Walker *et al.*, 2000). The absence of a causal relation between height and intelligence is indicated by the results of a study of 9-year-olds born in Britain in 1992 in which height was not significantly related to intelligence, even though height was related to the IQs of their mothers (Gale *et al.*, 2004). This suggests that the association between height and IQ has weakened in more recent birth cohorts in economically developed countries, possibly because as standards of living have increased variations in height between social groups has declined.

An association between intelligence and head circumference has also been reported in numerous studies. This association appears to have been first observed in the nineteenth century by the French physician and neurologist Paul Broca (1873), who measured external and internal skull dimensions and weighed wet brains at autopsy and observed that skilled workers had a larger average brain circumference than the unskilled, and eminent individuals averaged a larger brain than the less eminent. Numerous studies reviewed by Rushton & Ankney (2009) have confirmed this relationship. They summarized the results of 59 studies that reported the relation between external head measures and IQ (total $N = 63{,}405$), for which the average correlation was 0.20. They also summarized the results of 28 studies that reported the relation between brain circumference measured by brain imaging and IQ (total $N = 1389$), for which the average correlation was 0.40. The reason that the correlation is higher when brain imaging is used to measure brain circumference is that it is more accurate than external head measures.

These studies of the association between intelligence with head circumference and height have nearly all been made on samples in Europe and North America. As far as the authors are aware, there have only been two studies that have examined these associations elsewhere in the world. The first is a study in India of 200 9-year-olds which reported a correlation of 0.15 between intelligence measured by the Standard Progressive Matrices (SPM) and head circumference, and a correlation of 0.16 between intelligence and height (Lynn & Jindal, 1993). The second is a study in Sudan, in which a correlation of 0.21 was reported between intelligence measured by the SPM and head circumference in a sample of 240 adults (Khaleefa *et al.*, 2012).

Methods

The sample consisted of 636 boys and 917 girls ($N = 1553$) aged between 6.0 and 15.5 years. The sample was drawn from school students at schools in Mecca Province, Saudi Arabia. The province was divided into four quarters, and representative schools were selected in each of the quarters. Participants were randomly selected from both public and private schools. Public schools in Saudi Arabia only teach the curriculum assigned by the Ministry of Education while private schools are allowed to add supplementary material to the mainstream proscribed curriculum. The sample does not include elite private schools. The parents of the sample were given consent forms for the testing and for the collection of demographic information. The forms were collected prior to the day of testing, and were checked for any missing information.

Intelligence was measured by the Standard Progressive Matrices (SPM) (Raven *et al.*, 2000) without a time limit. Head circumference was measured as head circumference at its maximum, just above the ears. Head circumference has been used as an approximate measure of brain size in numerous studies (reviewed by Rushton & Ankney, 2009).

To carry out the testing, teams of female researchers were recruited to test female participants while male researchers were recruited to test male participants. Each team had four members and a co-ordinator. Both teams were trained on the procedure for applying the SPM, measuring head circumference and height, selection of the sample and the collection of the demographic data. All team members had a college education.

On the days scheduled for testing, each team conducted the test in the selected schools. The students were tested in groups in a classroom environment. The testing team explained and demonstrated the procedure to the students using the examples in the test manual. At the conclusion of each test session, more information, including participants' head circumference and height, was collected. The data for height and head circumference were recorded on the participants' test answer sheet. The testing began on 24 April 2010 and ended on 23 June of the same year. The data collection teams used computer software to input, correct and tabulate the results for intelligence, head circumference and height.

Results

Table 1 gives the mean scores and standard deviations of the sample on the SPM for boys and girls, Saudi mean IQs and British IQ equivalents of the Saudi scores given in the 1979 standardization sample given by Raven (1981) and the *t*-values for the statistical significance of the differences. It will be noted that boys obtained a higher mean than girls among the 6- to 7-year-olds but this is not statistically significant. Girls obtained higher means than boys in the age groups 8–15 years and in the 10- and 13-year-olds, and these differences are statistically significant when tested by *t*-test but not after Bonferroni corrections.

Table 1. Mean scores and standard deviations on the Standard Progressive Matrices, variance ratios (VR), British IQ equivalents, *t*-values for the differences between 6- to 15-year-old boys and girls, Saudi Arabia, 2010

			SPM			IQ				
			Saudi			Saudi				
Age (years)	Sex	*n*	Mean	SD	VR	Mean	SD	British	*t*	Sig. (2-tailed)
6–7	Male	24	17.6	8.5	1.63	88.3	14.9	101	−4.163	<0.001*
	Female	40	16.4	6.9		88.1	12.7	98	−4.945	<0.001*
8	Male	36	17.2	5.8	0.65	81.4	10.2	80	0.853	ns
	Female	76	19.2	7.2		85.8	10.9	83	2.301	0.024
9	Male	45	24.1	8.0	0.75	85.8	11.5	86	−0.129	ns
	Female	90	26.0	8.3		88.2	10.8	89	−0.690	ns
10	Male	62	27.5	7.7	0.09	86.5	11.2	80	1.584	ns
	Female	114	30.1	7.8		82.4	11.8	84	2.428	0.017
11	Male	103	29.7	7.0	1.14	81.5	9.8	80	1.524	ns
	Female	105	31.7	7.3		84.8	10.7	84	0.810	ns
12	Male	110	31.9	7.3	1.09	83.0	10.0	83	0.076	ns
	Female	118	32.2	7.0		83.6	9.4	82	1.835	ns
13	Male	91	32.3	7.2	1.03	79.4	8.5	78	1.521	ns
	Female	129	34.8	7.1		83.3	9.6	80	3.942	<0.001*
14	Male	77	36.1	6.1	0.94	81.8	9.2	81	0.763	ns
	Female	113	36.5	6.3		82.5	9.3	81	1.675	ns
15	Male	88	35.6	6.6	1.21	80.7	9.7	79	1.624	ns
	Female	132	36.9	6.0		82.3	9.3	82	0.327	ns
Total	Male	636	30.3	8.8		82.0	10.3		−4.767	<0.001*
	Female	917	31.1	9.2		84.6	10.4			

*Significant after Bonferroni correction.

For the total sample, the mean SPM score of the boys was 30.2 (SD 8.7), and that of the girls was 31.0 (SD 9.1). This is a difference of 0.09 standard deviation units and is equivalent to 1.35 IQ points. Column 6 gives the variance ratios (VR) for the differences in variance of the scores of the boys and of the girls calculated as the square of the standard deviation of the boys divided by the square of the standard deviation of the girls.

Table 2 gives the means and standard deviations for height and head circumference of the Saudi sample and, for comparison, American norms for height for 2000, as given by the National Center for Health Statistics (2000) and American norms for 2000 given by Nellhaus (2010). The statistical significance of the differences between the heights of the Saudi sample and the American norms is given in the right-hand column. It will be noted that among the 6- to 7-year-olds the Saudi sample had higher average heights than the American norms, but this is not statistical significant. In the age groups 8–15 years the Saudi sample had lower average heights than the American norms, and these differences are statistically significant after Bonferroni corrections for boys aged 10, and for boys and girls aged 11, 12 and 13.

Table 2. Means and standard deviations of Saudi height and Saudi head circumference, the *t*-values for US height and head circumference, 6- to 15-year-olds, Saudi Arabia, 2010

			Height (cm)					Head circumference (cm)				
			Saudi					Saudi				
Age (years)	Sex	*N*	Mean	SD	US 2000 mean	*t*	Sig. (2-tailed)	Mean	SD	US mean	*t*	Sig. (2-tailed)
6–7	Male	24	122.3	9.0	121	0.690	ns	52.1	1.3	52.0	0.241	ns
	Female	40	121.6	6.5	121	0.574	ns	51.0	1.7	51.0	0.231	ns
8	Male	36	126.2	8.1	130	−2.815*	0.008	52.2	1.4	52.3	−0.508	ns
	Female	76	128.3	10.7	130	−1.354	ns	52.3	1.4	51.3	6.703	<0.001*
9	Male	45	132.5	6.1	135	−2.711*	0.010	52.3	1.6	52.7	−1.696	ns
	Female	90	134.6	8.2	135	−0.408	ns	52.5	1.8	51.8	3.990	<0.001*
10	Male	62	136.4	8.1	140	−3.435*	0.001*	52.8	1.7	53.0	−0.988	ns
	Female	114	138.9	7.3	140	−1.478	ns	52.9	1.7	52.0	5.796	<0.001*
11	Male	103	140.8	8.6	144	−3.826*	<0.001*	53.0	1.6	53.3	−2.020	0.046
	Female	105	143.5	8.8	148	−5.237*	<0.001*	53.4	1.9	52.4	5.394	<0.001*
12	Male	110	148.3	7.6	150	−2.333*	0.021	53.4	1.6	53.5	−0.428	ns
	Female	118	148.4	8.9	157	−10.492*	<0.001*	53.7	1.8	52.9	5.079	<0.001*
13	Male	91	151.1	9.0	157	−6.231*	<0.001*	53.6	1.7	54.0	12.123	0.036
	Female	129	151.7	8.0	161	−13.047*	<0.001*	53.7	1.8	53.3	2.896	0.004
14	Male	77	159.4	9.2	165	−5.321*	<0.001*	54.3	1.7	55.0	−3.450	<0.001*
	Female	113	154.9	7.6	164	−12.751*	<0.001*	54.2	1.7	54.0	1.233	ns
15	Male	88	161.0	9.0	172	−11.410*	<0.001*	54.1	1.9	55.3	−5.843	<0.001*
	Female	132	156.8	7.6	165	−12.257*	<0.001*	54.4	1.9	54.7	2.606	0.010
Total	Male	636	146.08	14.048		1.608	ns	53.324	1.78716		−1.294	ns
	Female	917	144.968	13.043				53.449	1.90755			

*Significant after Bonferroni correction.

Table 3. Pearson correlations (*r*) IQ scores x height and head circumference, Saudi Arabian 6- to 15-year-olds, 2010

			Height		Head circumference	
Age (years)	Sex	*n*	*r*	Sig. (2-tailed)	*r*	Sig. (2-tailed)
6–7	Male	24	0.186	0.383	0.389	ns
	Female	40	0.484**	0.002	0.139	ns
8	Male	36	−0.018	0.916	0.013	ns
	Female	76	0.108	0.352	0.014	ns
9	Male	45	0.025	0.869	0.161	ns
	Female	90	0.104	0.328	0.144	ns
10	Male	62	0.179	0.164	0.101	ns
	Female	114	0.183	0.052	0.201*	0.032
11	Male	103	−0.107	0.283	0.072	ns
	Female	105	0.171	0.082	0.034	ns
12	Male	110	−0.036	0.710	0.138	ns
	Female	118	0.145	0.117	0.008	ns
13	Male	91	−0.162	0.125	0.145	ns
	Female	129	−0.008	0.925	0.098	ns
14	Male	77	0.126	0.273	0.221	ns
	Female	113	0.134	0.159	0.410	ns
15	Male	88	0.155	0.150	0.388**	<0.001*
	Female	132	0.107	0.224	0.090	ns

$^{*}p<0.05$; $^{**}p<0.01$.

Table 3 gives the correlations for SPM scores by height and head circumference for each age group. For height, fifteen of the eighteen correlations are positive and two are statistically significant. The average of the correlations is 0.126. For head circumference, sixteen of the eighteen correlations are positive and three are statistically significant. The average of the correlations is 0.138.

Discussion

The results for the SPM set out in Table 1 show that the Saudi sample obtained a mean British IQ of 82.4 in relation to the 1979 British standardization sample. However, the British IQ for 11-year-olds (the average age of the Saudi sample) on the SPM increased by 6.2 IQ points over the years 1979–2008 (Lynn, 2009). Hence the Saudi IQ in relation to the British IQ of approximately the same year should be reduced by 6.2 IQ points to 76.2. This is close to the British IQ of 78 obtained by the Saudi sample of 4659 8- to 24-year-olds reported by Abdel-Khalek & Lynn (2009) and a little lower than the Saudi IQ of 82 reported by Batterjee (2011).

The girls obtained a 0.4 IQ point higher IQ than the boys. This should be regarded as negligible and is consistent with the results in the meta-analysis reported by Lynn & Irwing (2004) in which there was no sex difference in the SPM in this age range. The differences between the boys and girls in variability on the SPM are inconsistent. In five of the age groups, the boys had greater variability than the girls, but in the other four age groups, the girls had greater variability than the boys. These inconsistent results are contrary to the frequent assertion that males have greater variability than females. This contention has been advanced since the early years of the twentieth century, e.g. by Ellis (1904), Thorndike (1910) and Terman (1916), and reaffirmed by Eysenck (1981, p. 42) and recently by Deary *et al.* (2007). However, not all studies have found greater variability in males, including a meta-analysis of the performance of college students on the Progressive Matrices by Irwing & Lynn (2005). There have also been a number of recently published studies that have not found greater variability in boys in several countries in the Middle East and North Africa, including Pakistan (Ahmad *et al.*, 2008), Sudan (Khaleefa *et al.*, 2008), the United Arab Emirates (Khaleefa & Lynn, 2008), Saudi Arabia (Abdel-Khalek & Lynn, 2009) and Libya (Lynn *et al.*, 2009). Thus, the present results confirm those of a number of previous studies in finding that greater variability of intelligence in males is not a universal phenomenon.

The results in Table 2 show that boys had significantly greater height than girls at ages 11, 13, 14 and 15 years, and that the heights of the Saudi sample are significantly lower than those of the American norms at the ages of 11–15 years. The existence of a positive correlation between height and intelligence has been found in other countries, e.g. of 0.16 between intelligence and height reported for 9-year-olds in India by Lynn & Jindal (1993) and of 0.24 for boys and 0.25 for girls reported by Deary *et al.* (2009) for 11-year-olds in Scotland, is not confirmed in this sample. Only one of the eighteen correlations shown in Table 3 is statistically significant and five of the correlations are negative.

All of the eighteen correlations between head circumference and intelligence shown in Table 3 are positive, although only two are statistically significant. These results are consistent with the positive correlations found in other countries, e.g. of 0.15 between intelligence and head circumference reported for 9-year-olds in India by Lynn & Jindal (1993) and 0.20 obtained by Rushton & Ankney (2009) in their review as the average of 59 studies, is confirmed in this sample.

The explanation of the positive correlation between height and intelligence is probably that the quality of nutrition obtained by the fetus and by babies affects the development of both height and the brain, bringing the two into positive correlation. The same explanation may be valid for the positive correlation between head circumference and intelligence, but it has also been proposed that head circumference is an approximate measure of brain size, and a larger brain confers greater intelligence because it contains more neurons and therefore more processing power (Vernon *et al.*, 2000).

A multiple regression analysis of the data was carried out entering age, height and head circumference as predictors of IQ giving a multiple correlation of 0.21.

References

Abdel-Khalek, A. M. & Lynn, R. (2009) Norms for intelligence in Saudi Arabia assessed by the Standard Progressive Matrices. *Mankind Quarterly* **50**, 106–113.

Ahmad, R., Khanum, S. J., Riaz, Z. & Lynn, R. (2008) Gender differences in means and variance on the Standard Progressive Matrices in Pakistan. *Mankind Quarterly* **49**, 50–57.

Batterjee, A. (2011) Intelligence and education: the Saudi case. *Mankind Quarterly* **LII**(2), 133–190.

Broca, P. (1873) Sur les cranes de la caverne de l'Homme Mort (Loere). *Revue d'Anthropologie* **2**, 1–53.

Deary, I. J., Irwing, P., Der, G. & Bates, T. C. (2007) Brother–sister differences in the *g* factor in intelligence: analysis of full, opposite-sex siblings from the NLSY 1970. *Intelligence* **35**, 451–456.

Deary, I. J., Whalley, L. J. & Starr, J. M. (2009). *A Lifetime of Intelligence*. American Psychological Association, Washington, DC.

Ellis, H. (1904). *Man and Woman: A Study of Human Secondary Sexual Characteristics.* Walter Scott, London.

Eysenck, H. J. (1981). *Intelligence: Battle for the Mind.* Pan, London.

Gale, C. (2005) Commentary: height and intelligence. *International Journal of Epidemiology* **34**, 678–679.

Gale, C. R., O'Callaghan, F. J., Godfrey, K. M., Law, C. M. & Martyn, C. N. (2004) Critical periods of brain growth and cognitive function in children. *Brain* **127**, 321–329.

Irwing, P. & Lynn, R. (2005) Sex differences in means and variability on the Progressive Matrices in university students: a meta-analysis. *British Journal of Psychology* **96**, 505–524.

Khaleefa, O., Ali, K. & Lynn, R. (2012) IQ and head circumference in a sample in Sudan. *Mankind Quarterly* (in press).

Khaleefa, O., Khatib, M. A., Mutwakkil, M. M. & Lynn, R. (2008) Norms and gender differences on the Progressive Matrices in Sudan. *Mankind Quarterly* **49**, 177–183.

Khaleefa, O. & Lynn, R. (2008) A study of intelligence in the United Arab Emirates. *Mankind Quarterly* **49**, 58–64.

Lynn, R. (2009) Fluid intelligence but not vocabulary has increased in Britain. *Intelligence* **37**, 249–255.

Lynn, R., El-Ghmary Abdalla, S. & Al-Shahomee, A. A. (2009) Intelligence in Libya: norms for the Verbal WISC-R. *Mankind Quarterly* **49**, 292–300.

Lynn, R. & Irwing, P. (2004) Sex differences on the Progressive Matrices: a meta-analysis. *Intelligence* **32**, 481–498.

Lynn, R. & Jindal, S. (1993) Positive correlations between brain size and intelligence: further evidence from India. *Mankind Quarterly* **34**, 109–115.

National Center for Health Statistics (2000) *Height Reference Charts*. National Center for Health Statistics, Hyattsville, MD.

Nellhaus, A. (2010) *Head Circumference Reference Charts up to age 18*. URL: www.docstoc.com/docs/22379331/Nellhaus-Head-Circumference (accessed 20th June 2011).

Porter W. T. (1892) The physical basis of precocity and dullness. *Transactions of the Academy of Science of St. Louis* **6**, 161–181.

Raven, J. (1981) *Irish and British Standardisations*. Oxford Psychologists Press, Oxford.

Raven, J., Raven, J. C. & Court, J. H. (2000) *Standard Progressive Matrices.* Oxford Psychologists Press, Oxford.

Rushton, J. P. & Ankney, C. D. (2009) Whole brain circumference and general mental ability: a review. *International Journal of Neuroscience* **119**, 691–731.

Terman, L. M. (1916) *The Measurement of Intelligence.* Houghton Mifflin, New York.

Thorndike, E. L. (1910) *Educational Psychology.* Houghton Mifflin, New York.

Van Pareren, V. K., Duivenvoorden, H. J., Slijper, F. S., Koot, H. M. & Hokken-Koelega, A. C. (2004) Intelligence and psychosocial functioning during long-term growth hormone therapy in children born small for gestational age. *Journal of Clinical & Endocrinological Metabolism* **89**, 295–302.

Vernon, P. A., Wickett, J. C., Bazana, P. G. & Stelmack, R. M. (2000) The neuropsychology and neurophysiology of human intelligence. In R. J. Sternberg (ed.) *Handbook of Intelligence*. Cambridge University Press, Cambridge, UK.

Walker, S. P., Grantham-McGregor, S. M., Powell, C. A. & Chang, S. M. (2000). Effects of growth restriction in early childhood on growth, IQ, and cognition at age 11 to 12 years and the benefits of nutritional supplementation and psychosocial stimulation. *Journal of Pediatr*ics **137**, 36–41.

Wilson, D. M., Hammer, L. D. & Duncan P. M. (1986) Growth and intellectual development. *Pediatrics* **78**, 646–650.