MANKIND QUARTERLY 2015 55:3 268-277

A Study of Means and Sex Differences on Raven's Standard Progressive Matrices Plus in Yemen

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Yemen is one of the economically least developed countries in the Middle East, but information about intelligence in this country has been conflicting. In a recent study, the Standard Progressive Matrices-Plus was administered to a sample of 2012 6-13 year olds in a province of Yemen. The sample obtained a British IQ of 68.5. Girls obtained significantly higher average scores than boys at the ages of 7 and 10, and boys obtained a significantly higher average score than girls at age 13.

Key Words: Yemen, Standard Progressive Matrices Plus, Sex Differences, Intelligence

A research program to collect IQs for all nations in the world was initiated by Lynn (1978) and has been extended in a number of subsequent publications summarized by Lynn and Vanhanen (2012). In these studies national IQs are scaled as "Greenwich IQs," with a contemporaneous British mean of 100 and standard deviation of 15 as the reference.

In their most recent compilation of national IQs Lynn and Vanhanen (2012) give three IQs for Yemen. Two of these were based on studies of 6-11 years olds tested with the Colored Progressive Matrices, which gave British IQs of 85 and 81 (Al-Heeti et al, 1997; Khaleefa and Lynn, 2008a). The third study was based on the assessment of 4th grade school students in math and science in TIMSS in 2007, where the Yemen sample obtained a British IQ of 64.7 (Meisenberg and Lynn, 2011). It is evident that these studies have produced inconsistent results.

One of the objectives of this paper is to report new normative data on intelligence in Yemen.

The second objective of this paper is to report normative data on sex differences in intelligence in Yemen. From the early twentieth century up to the present it has been almost invariably asserted that there is no sex difference in general intelligence defined as the IQ obtained from tests like the Progressive Matrices, the Stanford-Binet, the Wechsler, the Cattell Culture Fair and numerous others. In the second decade of the twentieth century this conclusion was advanced by Burt and Moore (1912) and by Terman (1916), who wrote: "the superiority of girls over boys is so slight (on the American standardization sample of the Stanford-Binet test on 4-16 year olds) … that for practical purposes it would seem negligible." In the second half of the century this conclusion was reaffirmed by Cattell (1971, p. 131), Hutt (1972, p. 88), Maccoby and Jacklin (1974, p. 65), Jensen (1980, p. 360), Eysenck (1981, p. 40), Brody (1992, p.323), Herrnstein and Murray (1994, p. 275), Seligman (1998, p. 72), Geary (1998, p. 310), Butterworth (1999, p. 293), Lubinski (2000, p. 416), Halpern (2000, p. 218), Bartholomew (2004, p. 91), Anderson (2004, p. 829), Dolan et al (2006, p. 194), Hines (2004, p. 103), and finally, in a recent textbook, "females and males score identically on IQ tests" Halpern (2012, p. 233).

This consensus that there is no sex difference in intelligence was broken by Lynn (1994, 1998, 1999), who advanced a developmental theory of sex differences in intelligence that stated that boys and girls mature at different rates both physically and mentally during childhood and adolescence. The theory states that boys and girls mature at about the same rate up to the age of around 7 years; that from the age of 8 years, girls begin a growth spurt in which there is an acceleration of their physical growth in respect of height, weight, brain size and intelligence; the growth rate of girls slows at the ages of 14 and 15, while the growth of boys continues. Lynn's (1994) original formulation of the theory stated that for abstract (nonverbal) reasoning ability, there is no sex difference up to the age of around 8 years; between the age range of around 9 through 12 years, girls have an advantage of approximately 1 IQ point; there is no sex difference at ages of around 13 to 15 years; and at the age of 16 years, boys have a small advantage that increases with age reaching an advantage among adults of around 4 IQ points. These estimates were not derived from data on the Progressive Matrices but from other data and, in the case of adults, from the American standardization samples of the Differential Aptitude Test. In a subsequent compilation of studies, Lynn (1999) proposed that among adults the male advantage on abstract reasoning is approximately 5 IQ points. Lynn's thesis was derived from the findings by Ankney (1992) and Rushton (1992) that men have a larger average

brain size than women, even when controlled for body size. The correlation between brain size and intelligence is approximately .40, calculated in a meta-analysis by Vernon et al (2000, p. 248), so it was argued that it follows that men should have greater average intelligence than women.

Lynn's thesis was criticized by Mackintosh (1996, p.567), who argued that Raven's Progressive Matrices is among the best measures of intelligence and that on this test "there is no sex difference in general intelligence worth speaking of …large scale studies of Raven's tests have yielded all possible outcomes, male superiority, female superiority and no difference… there appears to be no difference in general intelligence." He reiterated this conclusion in a subsequent paper contending that there is at most only a very small difference consisting of no more than 1–2 IQ points among adults either way (Mackintosh, 1998).

In response to this criticism, Lynn presented further data on sex differences on the Progressive Matrices that confirmed his thesis that there is a male advantage from the age of 16 years into adulthood (Lynn, Allik and Must, 2000; Lynn et al, 2002; Lynn, Allik and Irwing, 2004; Colom and Lynn, 2004; Pullmann, Allik and Lynn, 2004). He also published a meta-analysis of sex differences on the Progressive Matrices among general population samples that confirmed his thesis of a male advantage from the age of 16 years reaching 5 IQ points among adults (Lynn and Irwing, 2004), and a meta-analysis of sex differences on the Progressive Matrices among college student samples that concluded that males have an advantage of 4.6 IQ points (Irwing and Lynn, 2005).

Despite these results, Mackintosh has continued to assert that "males are not superior to females in reasoning ability" (Mackintosh, 2011, p. 366). This conclusion represents the consensus among many scholars who have continued to contend that there is no sex difference in intelligence measured by the Progressive Matrices. For instance, "it is an important finding of intelligence testing that there is no difference between the sexes in average intellectual ability; this is true whether general ability is defined as an IQ score calculated from an omnibus test of intellectual abilities such as the various Wechsler tests, or whether it is defined as a score on a single test of general intelligence, such as Raven's Matrices" (Anderson, 2004, p. 829) and "sex differences are absent on Raven Progressive Matrices" (Dolan et al, 2006, p. 194).

Method

This study consisted of an administration in 2014 of the Standard Progressive Matrices-Plus (SPM+) to a sample of 2012 6-13 year olds in Yemen. The SPM+ is a more difficult version of the Standard Progressive Matrices (SPM) that was standardized in Great Britain in 2007 (Raven, 2008).

The sample came from public primary schools in the city of Dhamar (also spelt Thamar), the capital of the province of Dhamar. The city has a university established in 1996 and is located about 100 km to the south and southeast of Sana'a, the capital city of Yemen. The sample was selected by dividing the city into north, south, east and west zones, and selecting public schools representative of these for socio-economic status. Schools are coeducational in Yemen and the boys and girls in the sample attended the same schools.

Results

The results are given in Table 1. This shows the numbers of males and females for each age group from 6 to 13 years, their mean scores and standard deviations on the SPM+, differences between males and females expressed as *d*s (standard deviation units), the two-tailed t values for the statistical significance of the sex differences, British percentiles in the 2007 standardization (Raven, 2008), and the British IQs. There are no British norms for 6 year olds.

Table 1. *Data for the Standard Progressive Matrices Plus in Yemen: sample size, raw score mean, sex difference d (negative signs denote higher female scores), t values for 2-tailed t tests, British percentile, and IQ score. * p<.05; ** p<.01.*

Age	Gender	N	Mean (SD)	*d*	t	British PC	British IQ
6	Males	40	12.7 (8.2)	.13	.44	-	-
6	Females	56	11.8 (3.6)			-	-
7	Males	146	11.5 (3.5)	-.40	3.18**	5	75.0
7	Females	104	13.0 (3.9)			8	78.5
8	Males	122	13.5 (4.7)	-.10	.87	4	72.5
8	Females	139	14.0 (4.9)			5	73.5
9	Males	148	14.8 (5.1)	-.12	1.11	1.6	68.0
9	Females	198	15.4 (5.6)			2.3	70.0
10	Males	185	15.9 (6.2)	-.26	2.27*	0.3	60.0
10	Females	173	17.5 (6.2)			1	65.0
11	Males	202	18.3 (6.7)	-.07	.69	1.5	67.0
11	Females	127	18.8 (7.3)			1.8	68.0
12	Males	159	19.6 (6.8)	.00	.00	1.6	67.5
12	Females	104	19.6 (7.2)			1.6	67.5
13	Males	74	20.3 (6.4)	.41	2.03*	1	65.0
13	Females	37	17.8 (5.8)			0.4	60.0

Discussion

There are four points of interest in the results.

First, the average of the British IQs for the eight age groups is 68.5. This is quite close to the IQ of 64.7 calculated from the TIMSS data cited in the introduction. It is substantially lower than the IQs of 81 and 85 for Yemen obtained in the two previous studies cited in the introduction. It should be noted that floor effects are evident because the SPM+ consists of 60 items with 8 answer choices, and even the oldest age group barely reached an average score of 20. This indicates that a large fraction of the subjects scored at chance level. A possible explanation for the inconsistent results is that the two previous studies used the Colored Progressive Matrices (CPM) while the present result is based on the Standard Progressive Matrices-Plus (SPM+). The CPM and the initial and easier items in the SPM and SPM+ are largely measures of visualization ability, while the later items in the SPM and SPM+ are measures of abstract reasoning ability (Lynn, Allik and Irwing, 2004). These abstract reasoning items can be considered as assessing Piaget's stage of formal operations. Earlier investigations have shown that without exposure to formal education of sufficient quality, many individuals in less developed coutries fail to reach this most advanced stage of cognitive development (Dasen, 1977; Oesterdiekhoff, 2013). Younger samples in North African and Middle Eastern countries typically perform better on the largely visualization ability items of the CPM and the initial and easier items in the SPM, than older samples do on the later abstract reasoning items in the SPM . This age trend has been reported for Syria and the United Arab Emirates (Khaleefa and Lynn, 2008b,c).

Second, this age trend is also apparent in the present sample in which the British IQs of the Yemeni sample declined with age. Thus, the 7 year olds obtained the highest average British IQ of 76.75; the 8 year-olds obtained an average British IQ of 73.0; the 9 year-olds obtained an average British IQ of 69.0; the 10 year-olds obtained an average British IQ of 68.5; the 11 and 12 year-olds obtained an average British IQ of 67.5; and the 13 year-olds obtained an average British IQ of 62.5. One possible explanation for this age trend is that schools in Britain and other economically developed nations provide a more cognitively stimulating education. This is expected – and intended – to have a cumulative effect in stimulating the development of abstract reasoning ability as children grow older. The low scores of 4th-grade children in Yemen on the 2007 and 2011 TIMSS assessments in science and mathematics suggest that school quality is indeed low in Yemen (Martin et al, 2012; Mullis et al, 2012).

Third, turning now to the results on the sex differences at different ages in the present sample, at age 6 years the sex difference was negligible at 0.13*d*; at ages 7 through 11 years girls obtained higher means than boys and this advantage was statistically significant at ages 7 and 10 years; there was no sex

difference at age 12 years; and boys obtained a significantly higher average score at the age of 13 years. These age trends are broadly consistent with Lynn's (1994) thesis that there is no sex difference in intelligence among young children, that from the ages of around 8 through 12 years, girls develop an advantage of approximately 1 IQ point; there is no sex difference between the ages of around 13 to 15 years, and that at the age of 16 years, boys begin to develop a small advantage.

The only anomaly with Lynn's thesis is that in the present sample a significant male advantage of .41*d* appears at the age of 13 years while Lynn's thesis posits that the male advantage does not appear until the age of 16 years. Although it may be due to sampling error, this result suggests that the male advantage may appear at a younger age in Yemen than in the western samples summarized in the meta-analysis of sex difference in the Progressive Matrices by Lynn and Irwing (2004). Despite these anomalies, the statistically significant sex differences at different ages in the present sample provide further evidence that generalized assertions that "there appears to be no sex difference in general intelligence" (Hines, 2004, p. 103) and "females and males score identically on IQ tests" (Halpern, 2012, p. 233) cannot be justified.

Fourth, it has frequently been asserted that males have greater variability of intelligence than females. For instance, Jensen (1998, p. 536) wrote of "the typically greater variance of males in test scores" and Deary, Penke and Johnson (2010) concluded that "males have a slightly but consistently wider distribution than females at both ends of the range." This contention is not supported in the present data where the standard deviations as measures of the sex difference in variability were higher in males among 6 and 13 year olds, and higher in females among 7, 8, 9, 11 and 12 year olds, while there was no difference among 10 year olds. .

Acknowledgement

The authors are thankful to the Deanship of Scientific Research, College of Education Research Center at King Saud University for funding this research.

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