Cognitive ability in male and female medical students

Yatanar Tint Lwin●, Win Naung■, Mya Mya Thwin★, Ohnmar♦

Abstract

In matriculation examinations at age 16, girls achieved greater score than boys. It is still uncertain whether gender gap in examination achievement reflects sex difference in fundamental cognitive domains or not. This cross sectional comparative study was undertaken to determine the cognitive ability in 62 male and 62 female medical students between 16-22 years of age attending in University of Medicine (2) Yangon with body mass index within 18.5-24.9 kg/m^2. Blood haemoglobin concentration was determined by cyamet-haemoglobin method. Serum ferritin concentration was measured by enzyme linked immunoassay method. Cognitive ability, i.e. four main cognitive domains; attention, memory and learning is assessed by using General Memory Scale, and reasoning is assessed by Raven's Standard Progressive Matrices. Blood haemoglobin concentration and serum ferritin concerntration were 14.17 ± 1.04 g/dl, 61.78 ± 35.24 µg/L in male and 12.85 ± 1.09 g/dl, 38.77 ± 25.79 µg/L in female, respectively. They are within normal range. General memory score for male was 60.38 ± 10.02 and for female was 58.30 ± 8.01 (P = 0.206). Raven's progressive matrices score were 41.62 ± 7.35 and 43.62 ± 7.35 in male and female, respectively (P = 0.133). Mental control score for male was 5.09 ± 1.76 and for female was 5.08 ± 1.48 (P = 0.956). Logical memory score for male was 18.56 ± 5.35 and female was 18.19 ± 5.13 (P = 0.694), Digit span score for male was 13.37 ± 1.42 and female was 13.20 ± 1.26 (P = 0.508), Visual memory score for male was 5.62 ± 0.46 and female was 5.58 ± 0.42 (P = 0.619), Paired associative learning score for male was 17.34 ± 6.12 and female was 16.24 ± 5.34 (P = 0.286). There were no significant differences in score of mental control, logical memory, digit span, visual memory and paired associative learning, General Memory Score and Raven's standard progressive matrices. <u>These results showed no significant difference in cognitive ability between male and female medical students.</u>

Key words: Cognitive ability, attention, memory, learning, reasoning, medical students

Introduction

The study of cognitive ability is becoming a topic of global interest because basic cognitive skills such as logic and reasoning, as well as memory and recall, are mandatory for successfully resolving workplace issues. In the last two decades, many interdisciplinary studies have been carried out to determine factors influencing cognition. Many mathem-

● Assistant Lecturer, Department of Physiology, University of Medicine, Magway
■ Associate Professor, Department of Physiology, University of Medicine, Magway
★ Professor & Head, Department of Physiology, University of Medicine (2) Yangon
♦ Professor & Head, Department of Physiology, University of Medicine (1) Yangon

atical concepts, physics problems, computer science tasks, and science problems require strong reasoning skills[1]. Non-verbal intelligence is important because it enables students to analyze and solve complex problems without relying upon or being limited by language abilities.

Cognitive functions in human and animals can be altered by many diseases, nutritional, metabolic and hormonal changes, ageing, sex, drugs etc[2,3,4,5]. Moreover, in human, educational status and some environmental and social factors also influence the cognitive ability[6,7]. Economic prosperity and gender equity affect females and males differently. Controversial societal issues such as single-sex education and the under-representation of women in science and engineering fields have sparked new interest in and debate about sex differences in cognitive abilities. Many small-scaled as well as large-scaled studies including meta-analysis have studied the sex difference on the cognitive ability. Some authors argue that no or only minimal differences in general cognitive performance exists between males and females. However, it was reported that some domains disclose more female superiority and some, male superiority. Hyde and Linn (1988) reported that there was a modest female superiority on tests of general verbal ability and for speech production although, paradoxically, they also concluded that there was a male advantage on spatial ability[8]. Spatial ability refers to a set of separable but related cognitive functions concerned with representing and processing spatial information, including visualization, spatial orientation and speeded mental rotation or spatial relations[9]. Geary and deSoto (2001) reported male superiority in three-dimensional spatial cognition[10]. Hite (2003) found that there is a gender difference on verbal spatial memory for object and location tasks favoring women[11]. Although those studies are large-scale studies, meta-analysis, they did not analyze biochemical test parameters which also influence the cognitive ability. Nutritional deficiencies especially iron, micro and macro nutrients and anaemia are found to affect the cognitive ability. It has been proved that iron deficiency anaemia may cause cognitive impairment[12]. The brain iron deficiency at any age may disturb metabolic processes and subsequently change in cognitive and behavioral functions[13]. In addition, one theory which is partially accepted is that anaemia via cerebral hypoxia and other possible mechanisms has a major influence on cognition[14]. Murray-Kolb and Beard (2004) found that women who had normal iron levels were able to perform cognitive tasks better and more quickly than women with iron deficiency anaemia; women with low iron stores scored somewhere in between[15]. After puberty, the females have greater chance to get anaemia and iron deficiency due to menstrual loss, pregnancy, parturition and lactation. However, the males have blood and blood-related problems such as nutritional deficiency, haemorrhage, etc. Thus, they may also have anaemia.

The question of sex difference in cognitive ability has a long history in psychology and education. In UK, National testing in England has provided data to show that girls outperform boys in assessments of English at age 7, 11 and 14, although differences in Mathematics and Science are less clear-cut. In public examinations at age 16, girls again achieve greater success than boys[16]. In Myanmar, there is no data regarding the issue in matriculation examinations at age 16. But it was obvious from female preponderance in medical course entry, as the academic score for male students matriculating each year has been lower than female students. Moreover, during medical course, it was also noted that this gender gap still exists with the underachievement of boys against girls in examination (1/2004, 2nd year M.B.,B.S, Final Exam, University of Medicine 2). However, it is still doubtful to say that the gender gap in examination attainment reflects sex difference in more fundamental cognitive domains. Therefore, this study aimed to find out sex difference in cognitive ability, emphasizing which domain is dominant for respective sex in medical students. Since cognitive ability is influenced by biochemical parameters, the present study also determined haemoglobin level and serum ferritin level in medical students to exclude anaemia and iron deficiency.

Aims

To study the cognitive ability in male and female medical students

Materials and Methods

It was a cross-sectional, comparative study conducted at Department of Physiology, University of Medicine 2, Yangon and Common Research Laboratory, University of Medicine 2, Yangon from January 2014 to June 2015. Male and female medical students between 16-22 years of age, BMI 18.5-24.9 kg/m^2 were included. Mean age in this study was 18 years for both groups. Those with acute illness (influenza, diarrhoea) and chronic infection (e.g. Tuberculosis), subjects with known cardiovascular diseases, metabolic diseases (e.g. diabetes mellitus), haematological disorders (e.g. Thalassaemia) and bleeding disorders (e.g. bleeding piles), smokers who smoke more than 20 cigarettes per day and those with history of taking medication affecting cognitive performance e.g. sedatives, antihistamines, CNS depressants were excluded. Individuals who smoke more than 20 cigarettes are known to affect the cognitive ability. So this study excluded the smokers who smoke more than 20 cigarettes per day.

Sixty two males and sixty two females, a total of one hundred and twenty four apparently healthy male and female medical students with normal haemoglobin and ferritin level participated in this study. Five ml of venous blood was taken by using a sterile disposable syringe for measurement of serum ferritin and haemoglobin levels. Serum ferrritin was measured by enzyme linked immunoassay (ELISA) method and haemoglobin level was measured by cyanmet-haemoglobin method. The blood samples were collected in two separate blood collecting tubes. One ml of blood was placed into a tube containing anticoagulant (ethylene diamine tetra acetate, EDTA) for determination of blood haemoglobin concentration and remaining four ml of blood was placed in a tube without anticoagulant for determination of serum ferritin level. Serum separation was done. The serum was kept in the aliquot tube and stored at -20°C until the blood samples were analyzed. Blood haemoglobin concentration was measured on the day of blood collection.

On day 2, cognitive function tests were done in the subjects who had normal haemoglobin concentration. Assessment of cognitive function was done by using two cognitive function tests - Raven's Standard Progressive Matrices and General Memory Scale. Five students were tested Raven's Standard Progressive Matrices sets at the same time. Each and every session for Raven's Standard Progressive Matrices sets lasts 12 minutes. On day 3, they answered the questions of GMS. The questions of GMS form were asked to students individually.

The score sheets of Raven's Standard Progressive Matrices were sent to Psychologists for further analysis. Scoring for GMS was done according to the instructions given so that uniformity was assured. For the validity of the test for GMS scoring, pilot study was done and trained to make scoring for GMS.

Statistical analysis

The data were statistically analyzed using the SPSS 16.0 software package. Cognitive ability between male and female medical students were assessed by using Student's unpaired "t" test.

Results

A total of one hundred and twenty four students participated in this study. Mental Control score, Logical Memory score, Digit Span, Paired associative learning and Raven's standard progressive matrices score of male and female medical students are presented in table 1. There was no significant difference in Mental control score, Logical memory score, Digit span score, Visual memory score, Paired associative learning score, General memory score and Raven's progressive matrices score between the two groups.

Table 1. Four domains score of male and female medical students with normal blood haemoglobin and serum ferritin level

		Male (n = 62) Mean ± SD	Female (n = 62) Mean ± SD	P value
Attention	Mental Control	5.09 ± 1.76	5.08 ± 1.48	0.956
Memory	Logical Memory	18.56 ± 5.35	18.19 ± 5.13	0.694
	Digit span	13.37 ± 1.42	13.20 ± 1.26	0.508
	Visual Memory	5.62 ± 0.46	5.58 ± 0.42	0.619
Learning	Paired associative learning	17.34 ± 6.12	16.24 ± 5.34	0.286
Reasoning	Raven's progressive matrices	41.62 ± 7.35	43.62 ± 7.35	0.133

Statistical analysis was done by Student's t-test. $P < 0.05$ was considered significant.

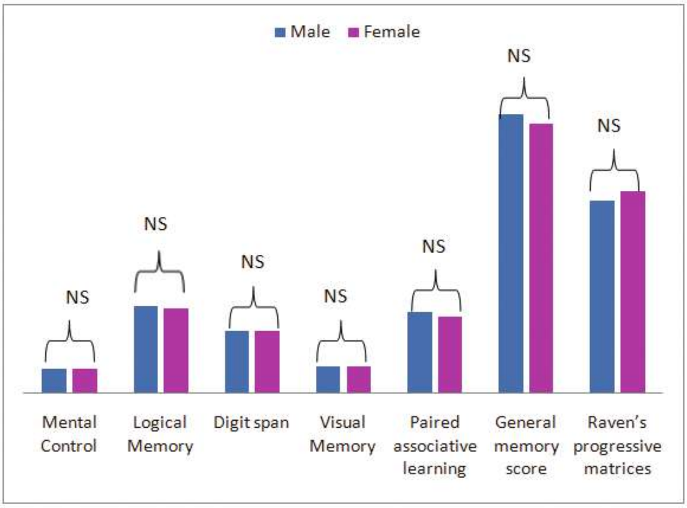

Figure 1. Mental control, Logical memory, Digit span, Visual memory, Paired associative learning, General memory score and Raven's progressive matrices score in male and female medical students
NS indicates not significant

Discussion

In the present study, there was no significant difference in attention score (5.09 ± 1.76 vs 5.08 ± 1.48) between the two groups. The present study agreed with Teleb and Awamleh (2012) who studied in 21 males and 27 females, aged 19-24years from Assist University from Egypt by using visual selective attention task and they found that no significant difference in attention score was seen between the groups[17]. Stress, boredom, sleep deprivation, poor nutrition, fatigue, adrenal insufficiency, abuse drugs and alcohol, some disease such as depression and anxiety reduce the attention. In the present study, all the subjects were selected after excluding the confounding factors. Those with the normal BMI were also selected. Therefore, it could be assumed that the attention score between male and female medical students in the present study was not different significantly.

Although women have smaller brain volume, even when correcting for body size they had also been found to have a faster blood flow rate in relation to brain weight than do men when performing the same cognitive tasks[18,19,20,21]. It is possible that the increased blood flow compensates for women's smaller brains[21]. That might be one reason that memory score was not significantly different between the subjects in the present study although male had larger brain volume.

In the present study, visual memory score was not significantly different between male and female medical students (5.62 ± 0.46 vs 5.58 ± 0.43). When subjects recall words, activity in their left frontal lobe and their left parahippocampus cortex increases, but when they recall pictures or scenes, activity takes place in their right frontal lobe and the parahippocampus cortex on both sides[22]. Women normally performed at a higher level than do men in recall and recognition of concrete pictures[23]. However, in recognition tasks of a more abstract nature (e.g., ink blots and snow crystals) the sex differences disappeared[24]. Men and boys, on the other hand, outperformed women and girls in memory for cars[25,26]. It is possible that this was the result of interest that people tend to remember things that they are interested in to a greater extent than objects that have lesser meaning to them. In this case it was likely that men had greater knowledge of and interest in cars, and perhaps women in meaningful pictures, whereas the pictures in the present study did not appeal to either men or women and therefore there was no difference in visual memory score.

In the present study, learning score (17.34 ± 6.12 vs 16.24 ± 5.34) did not significantly differ between the male and female medical students. Attention and motivation were considered to be the influential factor in paired associate learning. Campbell, Trelle and Hasher (2013) indicated that learning a list of word pairs requires one to limit attention[27]. Hence, learning any task depends to a certain extent on the attention of the person. Thirty-five years ago, females were found to have lower self-confidence than males in almost all achievement situations which resulted in lower success in learning[28,29]. It may be due to lack of motivation and difference in risk taking concerning females. Both genders of the subjects in the present study have self-confidence and are not much different in attention score, getting same correct answers; neither indicates underrepresentation, and both have motivation for learning. Accordingly, there was no difference in learning scores between male and female medical students.

The present findings also agreed with the previous study done by Bennett (2011), which studied 15 male and 15 female (age 19 year) using Wechsler Adult Intelligence Scale IV including 10 standard subtests[30]. There was no significant difference in intelligence between two groups. In Myanmar, Nwe Nwe Yee (2011) studied the cognitive ability by using Raven's progressive matrices score in nuns from Myawaddy Sarthintike before and after iron supplementation[31]. Raven's progressive matrices score was 39.83 ± 8.44 after correction of iron deficiency of anaemia and it was still lower than the score of male and female medical students in the present study. Therefore, educational level might be important for reasoning domain. All the subjects in the present study had similar education level, learning environment and normal haemoglobin and ferritin level. Therefore, the present study results point out that there was no sex difference in four domains of cognitive ability in medical students.

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References

1. Logsdon A. Learning disabilities: About.com. Available from <http://learningdisab ilities.about.com/od/glossar1/g/nonverbalintell.htm > [Assessed 27 February 2014]
2. Bobi J. and Drenovac M. Some psychological consequences of war imprisonment. Studia Psychologica (1997); **39**: p. 12.
3. Groopman JE. and Itri LM. Chemotherapy-induced anaemia in adults. *Journal of National Cancer Institute* (1999); **91 (19)**: p. 1616.
4. Barense MD, Fox MT, and Baxter MG. Aged rats are impaired on an attentional set-shifting task sensitive to medial frontal cortex damage in young rats. Learn Mem (2002); **9**: p. 191.
5. Fried P, Watkinson B and James D, Gray R. Current and former marijuana use: preliminary findings of a longitudinal study of effects on IQ in young adults. *Canadian Medical Association Journal* (2002); **166 (7)**: p. 887-891.
6. Crowley K, Callanan MA, Tenenbaum HR, and Allen E. Parents explain more often boys than girls during shared scientific thinking. *Psychological science journal*(2001); **12 (3)**: p. 258-261.
7. Bleeker MM, and Jacobs JE. Achievement in math and science: Do mothers' beliefs matter 12 years later? *Journal of Educational Psychology* (2004); **96**: p. 97-109.
8. Hyde JS. and Linn MC. Gender difference in verbal ability: meta-analysis, *Psychological Bulletin* (1988); p. 2-4.
9. Keehner MM, Tendick F, Meng MV, Anwar HP, Hegarty M, Stoller ML, Duh QY. Spatial ability, experience and skill in laparoscopic surgery. *The American Journal of Surgery* (2004); **188**: p. 71-75.
10. Geary DC and DeSoto MC. Sex difference in spatial abilities among adults from the United States and China. Evolution and cognition (2001); **7 (2)**: p. 172-177.
11. Hite TR (2003). Gender, Spatial Learning Trials, and Object Recall. Electronic Thesis and Dissertations. East Tennessee State University; p. 787
12. Petranovi D, Tak V, Dobrila-Dintinjana R, Ron I, Klementina R, Janovi S, Crnari I, Duleti A, and Mijandru BS. Correlation of Anaemia and Cognitive Functions Measured by the Complex Reactiometer Drenovac. Collegium. Antropologium (2008); **32 (1)**: p. 47-51.
13. Beard JL, Connor JR, and Janes BC. Brain iron: Location and function. *Prog Food Nutr Sci* (1993); **17**: p. 183-221.
14. Ludwig H and Strasser K. Symptomatology of anaemia. Seminars in Oncology (2001), **28**: p. 7.

15. Murray-Kolb LE and Beard JL. Iron treatment normalizes cognitive functioning in young women. *Americal Journal of Clinical Nutrition* (2004); **85 (3)**: p. 778-787.

16. Strand S, Deary IJ, and Smith P. Sex differences in cognitive abilities test scores, A UK National Picture. *British Journal of Educational Psychology* (2006); **76 (3)**: p. 463-480.

17. Teleb AA and Awamleh A. Gender Differences in cognitive abilities. Current Research in Psychology (2012); **3 (1)**: p. 33-39.

18. Dekaban AS. Changes in brain weight during the span of human life: Relation of brain weights to body heights and body weights. *Annals of Neurology* (1978); **4 (4)**: p. 345-356.

19. Ankney CD. Sex differences in relative brain size: The mismeasure of woman, too? Intelligence. *Special Issue: Biology and Intelligenc* (1992); **16 (3)**: p. 329-336.

20. Gur RC, Gur RE, Obrist WD, Hungerbuhler JP, Younkin D, Rosen AD. Sex and handedness differences in cerebral blood flow during rest and cognitive activity. Science (1982); **217 (4560)**: p. 651-661.

21. Gur RE, and Gur RC. Gender differences in regional cerebral blood flow. Schizophrenia Bulletin (1990); **16 (2)**: p. 247-254.

22. Barrett KE, Boitano S, Barman SM, Brook HL. Central and peripheral neurophysiology. Learnig, Memory, Language and Speech. In: Ganong's review of medical physiology (2012); chapter 15, 24th edition. p. 283-290. The McGraw-Hill Companies.

23. Herlitz A, Airaksinen E, and Nordström E. Sex differences in episodic memory: The impact of verbal and visuospatial ability. Neuropsychology (1999); **13 (4)**: p. 590-597.

24. Goldstein AG, and Chance JE. Visual recognition memory for complex configurations. Perception and Psychophysics (1970); **9 (2B)**: p. 237-241.

25. Davies G, and Robertson N. Recognition memory for automobiles: A developmental study. *Bulletin of the Psychonomic Society* (1993); **31 (2)**: p. 103-106.

26. McKelvie S.J. Sex differences in memory for faces. *The Journal of Psychology* (1981); **107**: p. 109-125.

27. Campbell KL, Trelle A, and Hasher L. Hyper-binding across time: Age differences in the effect of temporal proximity on paired-associate learning. *Journal of Experimental Psychology* (2013): Learning, Memory, and Cognition. Advanced online publication.

28. Lenny E. Women's self-confidence in achievement settings. Psychological Bulletin (1977); **84 (1)**: p. 1-13.

29. Sutherland SL. The unambitious female: Women's low professional aspiritations. Signs (1978); **3 (4)**: p. 774-794.

30. Bennett N (2011). Sex Differences in Intelligence Areas and Response Time Tasks. Honors Research Thesis. Ohio State University; p. 1-31.

31. Nwe-Nwe-Yee (2011). The effect of iron supplementation on cognitive ability in young women with iron deficiency anaemia. Ph.D Thesis (Physiology). University of Medicine, Mandalay.