Repeatability of Human Intelligence Quotient and its Relationship with Some Trace Elements in Blood Serum

Bilal JM Aldahham, Louay M. Al-Ani and Huda M. Mahmood

Abstract--- *The aim of this study is to estimate the repeatability of human intelligence quotient and to find out the relationship between the human intelligence and the concentration of Zn, Mg, and Cu in serum. The relationship between Zn, Mg, and Cu concentrations and intelligence were investigated for 102 students in University of Anbar, their ages were 20 -23 years old. Intelligence quotient (IQ) was evaluated using the Raven Matrices Test (RMT). Four ml of blood was withdrawn from the students to determine the concentration of Zn, Mg, and Cu. The obtained data were analyzed by regression analysis. The repeatability estimates of the IQ quotient shows low values, which was 0.032± 0.19. There were significant and positive relationship between Zinc ($p< 0.05$), Magnesium ($p<0.01$), and Copper ($p< 0.05$) with IQ. The results of this study participate in building an idea of improving the IQ. Also this research remove some ambiguity about some essential micronutrients of human and their relation with intelligence using scientific international ways.*

Keyword--- *IQ Percent, Zinc, Copper, Magnesium, Raven Matrices Repeatability.*

I. INTRODUCTION

Intelligence is one of hybridized properties which is affected by genetic and environmental factors [1].Repeatability, a concept derived from quantitative genetics theory, is a statistic that describes the degree to which variation within individuals contributes to total variation in a population. Its usual application has been to set an upper limit on heritability but it may also be useful for studies of stereotypy of behavior [2]. A genetic parameter called "heritability" (h^2) of the trait is the ratio of variation that is related to genetic differences and the left over variation ($1-h^2$) is related with environmental variances and errors of measurements among the individuals [3]. The capability to hoard new data in neural nets rest on the degree of synaptic plasticity links, in addition to the number of existing connections. Therefore, for learning and memory optimal functions the number of synapses are very critical. Diet, in combination with other environmental factors, has a critical share in modeling cognitive capacity of brain[4].

To boost learning and memory functions the number and plasticity of synapses should be increased this might be achieved by looking for new dietary ingredients. Human tissues contain different trace elements and Zn^{++}which is come in second rank after iron, its quantity is2.5 grams [5]. Zn^{++}also acting a significant function in nervous system performance. Increasing signs that recommends the Zn^{++}works as a common mediator of signaling of central neural

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system [6, 7]. Brain has enormous quantities of chelatable Zn^{++},mainly in neutrophil of the neocortex and hippocampus, substantially localized to a subpopulation of synaptic vesicles within excitatory buttons [5].

The fourth most plentiful ion in body is the magnesium (Mg^{2+}), which is a cofactor for over 300 enzymes, one main job of magnesium in brain is modulating the voltage-dependent block of N-methyl D-aspartate NMDA receptors (NMDAR), directing their opening during coincidence recognition that is critical for synaptic plasticity [8,9]. Magnesium is progressive enhancer of synaptic plasticity, therefore increasing concentration of Mg^{++} in the extracellular fluid within the physiological range leads to permanent improvement of plasticity synaptic in cultured hippocampal neurons [10].

Brain have copper in relatively great levels and is dispersed heterogeneously. Neural distribution of copper correlates with neural functions of copper [11]. In domestic and laboratory animals evidence suggests that copper deficiency changes behavior and harmonization, proposing involvement of CNS[12].

There are several theories for explaining the role of nutrition to improve the intelligence. First; the action of nutrients as antioxidant agents to protect the necessary lipids and thereby the brain will perfectly do its functions. Second; the nutrients help to generate energy for the body as well as the brain, and the nutrients actually affect the learning and behavior [13]. Mental problems are increasing day by day especially the difficulties of learning and the disability of concentration. Therefore, the aim of this study was to estimate the repeatability for human intelligence and explore the relationships between the human intelligence and the concentration of zinc, magnesium, and copper in serum which give us a good thoughts about the effects of these metals to improve memory and learning ability and definitely the intelligence.

II. MATERIALS AND METHODS

Subjects

This study was undertaken on 102 students, aged 20-23 years, from different colleges of University of Anbar, Iraq. All the students were in good health and they did not suffer from any medical or psychological problems.

Intelligence Quotient (IQ) test

The students were tested using the Raven Matrices Test (RMT) [14] to evaluate their IQ. The test was carried out in a quiet and separate room. During the period of the test students were set for 5 minutes in comfortable statues before they started the test.

Materials and Instrument

Kits for laboratory study of Zinc and copper were obtained from LTA company, Italy. Magnesium laboratory kit was obtained from BIOLABO company, France. The instruments used in this study were double beam UV VIS spectrophotometer, from Biotech Engineering Management Company, UK.

Method

After completing the IQ test of subjects, blood samples (3-5) mL were obtained from subjects by vein puncture. The whole blood was left for (10-20) minutes at room temperature.

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After coagulation, the serum was separated by centrifugation at 3000 xg for 10 min. Serum specimens were then frozen at -20^{o}C until assayed. The concentrations of (Zn, Mg, and Cu) were measured using the laboratory spectroscopic kits.

Repeatability is defined as:

$$r = (V_g + V_e) / V_t$$

Where V_g is the genotypic variance, V_e is the general environmental variance, and V_t is the total phenotypic variance. Standard errors (S. E.) of repeatability was computed using the square root of the sampling variance of the intraclass correlation according to [15].

Statistical analysis

Statistical analysis of the results was done using regressions, descriptive statistics and Pearson correlation. The rejection level was set at 0.05(SPSS V 23) [16].

III. RESULTS AND DISCUSSION

The intelligence is multifactorial trait which is an important features of human being that is affected by both genetic and environmental factors [17].The repeatability estimates of the IQ quotient shows low values, which was 0.032± 0.19. Because of low repeatability for IQ quotient, it is very advantageous to consider non-genetic factors such as trace elements for improving this trait. The appropriate environment is very important since the genetic factors do not explain the severity of performance of mind and social levels. The environmental effects include vast range of variables which are influence on the intelligence such as malnutrition, poison exposure, and prenatal stress, all of these factors decrease the intelligence. The results in this study indicated that there is a significant relationship between serum zinc concentration and IQ ($p<0.05$). Figure (1) showed increasing IQ according to increasing in serum zinc concentration. Table (1) gives the mean and corresponding standard deviation for zinc concentration 99.74±11.27 µg/dl, whereas the minimum and maximum for the zinc concentration were 79.69 and 120.12µg/dl respectively.

Table 1: Descriptive statistics of different parameters included in this study

	No.	**Mean± S.D**	**Minimum**	**Maximum**
IQ%	102	55.30 ± 19.15	18.57	88.15
Cu µg/dl	102	103.62± 20.19	69.67	141.26
Mg µg/dl	102	2.05 ± 0.18	1.68	2.39
zinc µg/dl	102	99.74 ± 11.27	79.69	120.12
Cu/ Zn		~ 1		

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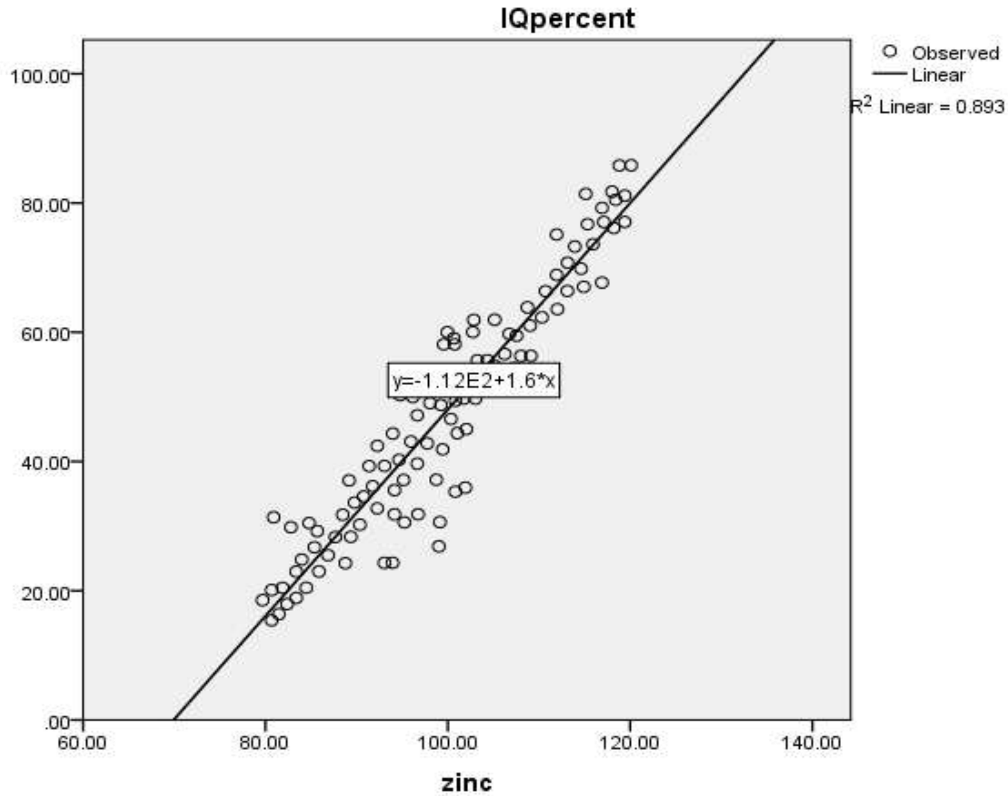

Figure 1: Relationship between zinc concentration and IQ%

The normal range of human serum zinc is 80 -120 µg/dl [18]. Zinc have very important physiological and clinical roles. It is included in about 300 enzymes like carbonic anhydrase, alkaline phosphatase, alcohol dehydrogenase, and RNA and DNA polymerase [19]. Also zinc binds with parts in protein via histidine and cysteine forming tetrahedral complexes called “zinc figure” which plays active role in gene expression as binding factors with DNA molecules in RNA transcription [19]. Zinc is a trace element and it is one of necessary micronutrients to human health [20]. Zinc divalent ion plays very important role in neural system functions [21], because Zn^{++} is a mediator in neural signaling in CNS [6, 22]. Most chelated (Zn^{++}) are in brain. The estimation of serum zinc gives real imagination about the real zinc in brain [18]. The increasing of serum zinc indicates (between normal range limits) to increasing of brain Zn^{++} which is in synapses. Then it participates in increasing the transfer the neural signals which has direct effect on learning and intelligence. These results suggested an relationship between of zinc and copperlevels in serum and autism spectrum disorder, and the ratio of Zn/Cu may possibly considered as a biomarker of autism spectrum disorder[23].

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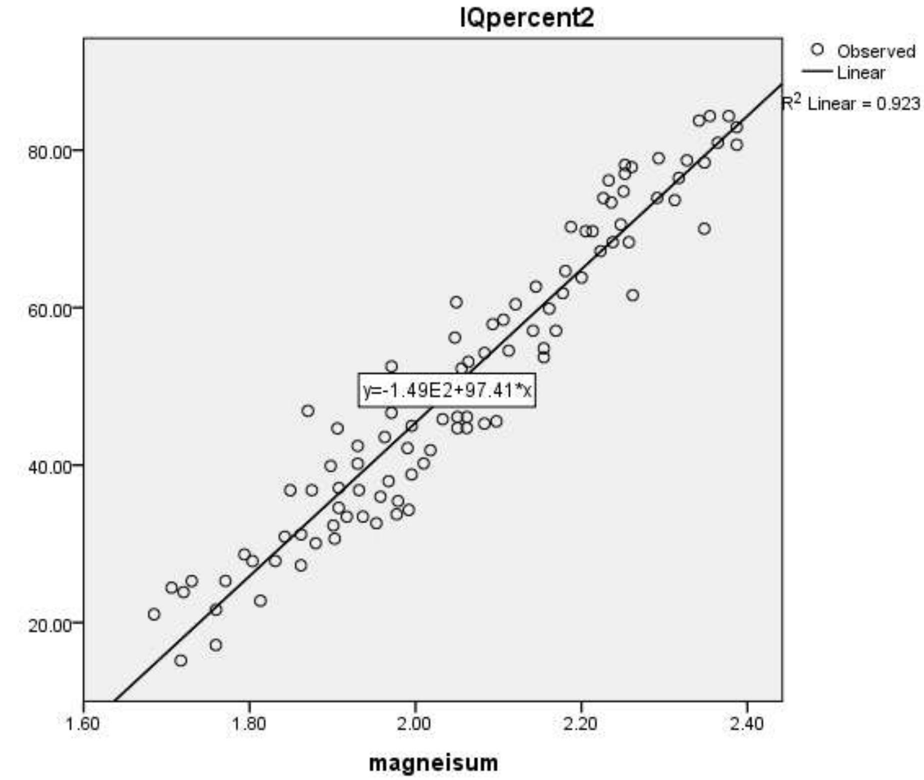

Figure 2: Relationship between magnesium concentration and IQ%

The results in figure (2) showed a highly significant relationship between IQ and serum magnesium concentration ($p<0.01$). Table (1) gives the mean and corresponding standard deviation for magnesium concentration 2.0575±0.18252, whereas the minimum and maximum for the magnesium concentration were 1.68 and 2.39 µg/dl respectively.

Figure (2) showed increase in IQ according to the increasing in serum magnesium concentration. The normal range of serum magnesium concentration is 1.7-2.4 µg/dl[18]. The Mg^{++} concentration in spinal fluid is higher than in plasma [24]. This graduated concentration is regulated by active transport which seems to regulate the arrival limits quantity of magnesium to the brain [24].Increasing of blood magnesium by 100-300% via vein lead to rise Mg^{++} concentration by 10-19% in brain [25]. Eating food lead to upsurge the concentration of magnesium in the brain, which is proved that the higher concentration improves the memory and learning ability [24]. Magnesium plays important role in glucose metabolism [26] which is the best source of energy in brain therefore, the brain performance would be improved when the glucose metabolism fired up.

The results in this study indicated that there is significant relationship between serum copper concentration and IQ ($p<0.05$). Figure (3) showed increasing IQ according to increasing in serum copper concentration. Table (1) gives the mean and corresponding standard deviation for copper concentration 103.6212± 20.19542, whereas the minimum and maximum for the copper concentration were 69.67and 141.26µg/dl respectively.

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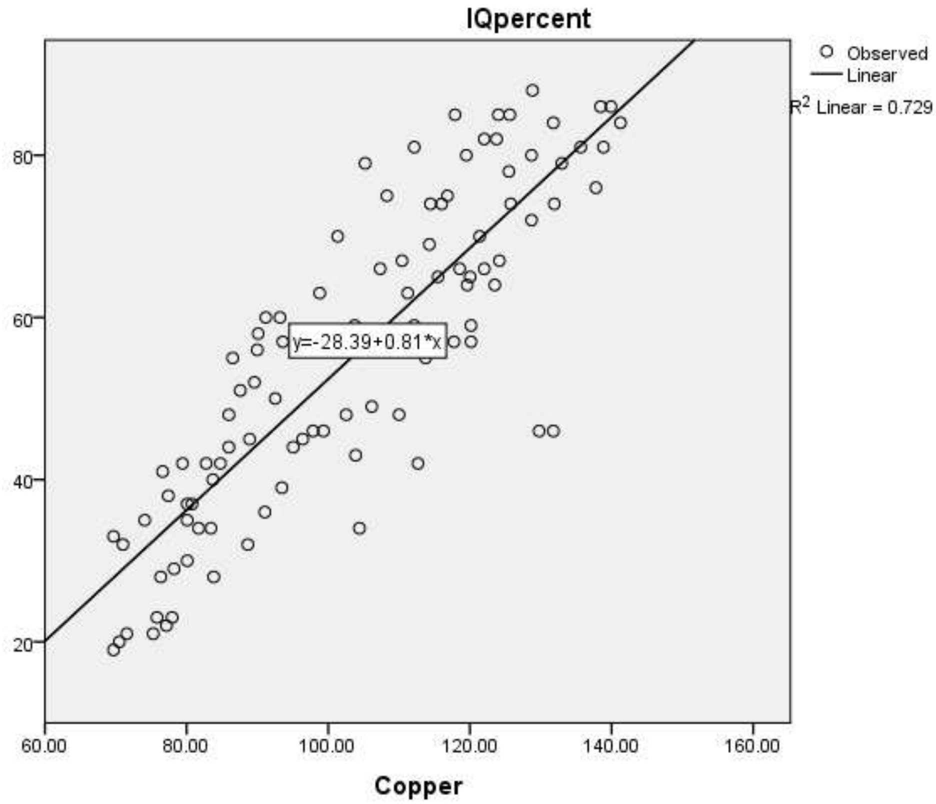

Figure 3: Relationship between copper concentration and IQ%

The normal range of copper in serum is 70 -140 µg/dl [18]. The explanation of copper effect on intelligence may be through the copper role in neurotransmitters action. Copper is the essential metal for communication and electric transfer, and in the same time the vital for bioactive enzymes and protein in the brain which rest on the role of copper [27]. Relationship between weakened of brain function and Cu^{++}deficiency where known in almost 75 years old [28].

Copper homeostasis is of great importance to human health. Deficit of Cu causes neuronal degeneration and at the same time high Cu concentration lead to drop in intelligence in young adolescents. Metabolism and appropriate absorption of Cu needs correct balance with the Zn. Therefore, the ratio of plasma/ serum of Cu to Zn is important and the optimal is 0.70–1.00 which is clinically more significant than concentration of either one alone of these trace metals in blood. Raise Cu levels have adverse effect on school age children and adults cognition [29-32].Table (2) showed the ratio was ~1, and this ratio within the optimal range for both trace metals.

Table 2: Pearson Correlation among different metals

		Cu	Mg	Zn
Pearson Correlation	**Cu**			
	Mg	.340*		
	Zn	.295*	.227*	

*P≤0.05

Table (2) showed a significant correlation between differentmetals concentration in serum.

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IV. Conclusions

In conclusion these significant finding of low value of repeatability and the effects of trace elements open new avenue in utilizing the natural food and food supplement as a source for micronutrients to enhance the human intelligence. Food has equilibrated constituents without toxicity in normal use. Perhaps, the fruits and vegetables which have one or more of our metals will improve and enhance the intelligence. The thought of intelligent food (the nutrients which can improve and enhance the memory and intelligence) is a new program and it will be carried out completely after continuing in working to prove some relations. The results of this study participate in building an idea of improving the IQ. Also this research remove some ambiguity about some essential micronutrients of human and their relation with intelligence using scientific international ways.

V. Data Availability Statement

All data generated or analyzed during this study are included in this published article.

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