JOURNAL OF CLINICAL AND DIAGNOSTIC RESEARCH

How to cite this article:
MITRA A, THAKUR G. IS IQ IN NORMAL MALE STUDENTS RELATED TO THE GLUCOSE DISPOSAL RATE AND MAJOR BLOOD LIPID COMPONENTS? Journal of Clinical and Diagnostic Research [serial online] 2007 October [cited: 2007 October 1];5:347-351.
Available from
http://www.jcdr.net/back_issues.asp?issn=0973-709x&year=2007&month= October &volume=1&issue=5&page=347-351&id=57

ORIGINAL ARTICLE

Relationship of IQ with Glucose and Lipid Level

MITRA A, THAKUR G

ABSTRACT

IQ is the score derived from a set of standardized tests of intelligence. 190 male fresh students, in the B Tech and the integrated MSc and other courses, who get admitted in Indian Institute of Technology at Kharagpur and other institutes are considered for the study to see the relationship of IQ with glucose assimilation, utilization and metabolism in respect to a glucose load and also the corresponding changes in serum insulin levels. The study also deals with relationship of IQ with some common bio-chemical parameters like lipid profile and serum bilirubin. It is being observed that with an increase in IQ level, the blood glucose absorption remains high with a rise in serum insulin level. Logically this will lead to more cerebral blood glucose availability. Correlation of IQ with different blood biochemical parameters shows a positive relationship with total cholesterol, high density lipoprotein cholesterol, low density lipoprotein cholesterol, very low density lipoprotein cholesterol and triglycerides and with serum bilirubin the correlation is found to be negative.

Key words
Intelligence, IQ level, Glucose assimilation, Serum bilirubin

Introduction

The score derived from a set of standardized tests of intelligence is the intelligence quotient or IQ of an individual. Intelligence tests are of many forms. Most of the tests yield an overall score as well as different individual subtest scores. Regardless of design, all IQ tests have the fallacy of measuring the general intelligence or g only. General intelligence has a large number of biological correlates. Strong correlates are mass of the prefrontal lobe, glucose metabolization rate within the brain and overall brain mass. Brain size has long been known to be correlated with *g* [1]. An MRI study on twins [2] showed that frontal gray matter volume was highly significantly correlated with *g*. General intelligence correlates significantly with overall body size. There is conflicting evidence regarding the correlation between *g* and peripheral nerve conduction velocity, with some reports of significant positive correlations, and others of no or even negative correlations. The Flynn effect describes a rise in IQ scores over time.

The Flynn effect is the year-on-year rise of IQ test scores, an effect seen in most parts of the world, although at greatly varying rate. The average rate of rise seems to be around three IQ points per decade. Attempted explanations have included improved nutrition, a trend towards smaller families, better education, greater environmental complexity, heterosis [3] and an increased familiarity of the general populace with IQ tests. There is no strong consensus as to whether rising IQ scores imply an increase in *g*. Statistical analyses of IQ subtest scores suggest a *g*-independent input to the Flynn effect [4] . IQ also correlates with sex, educational

Corresponding Author: Dr. Analava Mitra
School of Medical Science and Technology
Indian Institute of Technology,
Kharagpur- 721302, India
Tele: 913222282656/57 - Fax: 913222282221Email:
amitra@adm.iitkgp.ernet.in; analavamitra@rediffmail.com

achievement, job performance, socioeconomic advancement, and social pathologies.

Materials and Methods

Selection of Samples

Kharagpur has an entry of large number of male students through the examination for its B Tech and integrated MSc programmes and other programmes. Depending on their similarities in socio-economic and socio-cultural conditions and food habits (Questionnaire and interview) 500 residential fresh male students who are being otherwise normal and all aged around 19 years are initially screened for the study. As per ICMR protocol they are being explained of the study. Of them, 390 students are chosen in total whose initial blood glucose values are in the range of 70-100 mg/dl (values above and below are not chosen due to medical reasons). Of them 190 students give written consents for the study. Institute ethical committee is being approached for clearance as per ICMR protocol.

Equipment used

Alexandra Battery and WAIS, Accu-chek active (Roche, Ireland, Serial No G No 1795843, Art No 03533565001), Photometer 4010 of Boehringer, Germany [6], estimation of serum insulin (radio-immunoassay).

Methodology

The students IQ are being measured by similar and identical tests and it ranges from 110 to 140. Four groups are made: 110-115 the first group, 115-120 the second group, 120-125 the third group and 125-140 the fourth group respectively. The students live in different residential hostels. The wardens of the hostels are being requested to give identical food to all the students in these two hostels to maintain similarities and for masking effects. Clinical and anthropometrical evaluations of the volunteers are being done. On the day just before the day of experimentation food being served to the halls on usual hour of 7-30 pm and the volunteers are observed that they are asked to take meal and not to consume anything outside. On the day of experimentation they are being kept in fasting conditions till 7 AM and then 75 g of glucose is given to each of them. No food is given to them till capillary blood glucose (CBG) is measured at 9 AM (Accu-chek active, Roche, Ireland, Serial No G No 1795843, Art No 03533565001). CBG is being measured at 30 minutes interval and values are observed and are being analyzed statistically. Blood samples (10 cc of blood) are being drawn from anti-cubital vein with all protections for testing of lipid profile values by using Photometer 4010 of Boehringer, Germany [5] and Serum insulin values (radio-immunoassay). As students have an increased incidence of jaundice, serum bilirubin tests [5] are being done for all the volunteers. Regarding other indices of liver function tests like enzymes, total protein etc are not being done due to financial inadequacies of the research team. The volunteers are being observed for one hour after blood testing as a precautionary step and though institute hospital caters to all health related problems of students, the volunteers (all students) are being requested to report to the principal investigator of the study in case of any difficulties.

Statistical Analysis

Let us write the four IQ groups viz. 110-115, 116-120, 121-125 and 126-140 as groups 1, 2, 3 and 4 respectively, and the four time points, after 30 minutes, 1 hour, 1 hour and 30 minutes and 2 hours of intake of 75 gram of glucose as t_1, t_2, t_3 and t_4 respectively. On the basis of the data obtained, it is statistically observed that both of μ_i (t), the mean glucose level, and η_i (t), the mean serum insulin level are increasing in i for all $t=t_1, t_2, t_3, t_4$. Firstly, we consider Analysis of Variance (ANOVA), and get the null hypothesis of equality of mean values of the four groups rejected. (This is done by standard F-test for ANOVA). Once the equality of mean values is rejected, then the next question arises- is all the mean values different from each other or a particular pair of means is different? This could be done by pair-wise comparisons. These tests of pair-wise comparison of mean values are conducted separately for each of $\mu_2(t)$ and $\eta_1(t)$ standard (student's) t tests.

Result

The students underwent clinical and anthropometrical evaluation before the study. The characteristics of the students are:

Average age: 19.2 ± 0.29 years, (Mean ±SD)

Average weight: 53.36 ± 4.08 kg

Body Mass Index (BMI) = 19.32 ± 1.23.

Blood samples analyzed for plasma glucose utilisation in respect of IQ are shown in [Table /Fig 1]. It is being observed that in the group where IQ is 110-115 (n=37) FBS is 84±9 mg/dl. With 75 gm of glucose the blood sugar values are 95±13 mg/dl, 110±12 mg/dl, 105±9 mg/dl and 95±7 mg/dl respectively for the four different time intervals

Table/Fig 1: Relationship of IQ and glucose disposal rate

IQ of volunteers (N=190)	Blood Sugar levels				
	Fasting sugar	30 minutes after 100 g of glucose	1 hour after 100 g of glucose	90 minutes after 100 g of glucose	2 hour after 100 g of glucose
110-115 (n=37)	84±9	95±13	110±12	105±9	95±7
116-120 (n=63)	85±11	98±11	115±9	110±11	97±10
121-125 (n=53)	86±12	104±9	123±11	115±12	98±9
126-140 (n=37)	87±11	108±12	129±9	120±10	98±9

mentioned above, e.g., at 30 minutes, 1 hour, 1 hour 30 minutes and 2 hours after the glucose intake. In the second group where IQ values range from 116-120 (n=63), FBS value is 85±11 mg/dl while it rises to 98±11 mg/dl after 30 minutes of glucose intake. Blood sugar values are 115±9 mg/dl, 110±11 mg/dl and 97±10 mg/dl after 1 hour of intake, 1 hour and 30 minutes of intake and after 2 hours of intake respectively. In the third group (n=53) IQ values are in the range from 121 to 125. FBS value is 86±12 mg/dl. With 75 gm of glucose the blood sugar values are 104±9 mg/dl, 123±11 mg/dl, 115±12 mg/dl and 98±9 mg/dl respectively after those four intervals. In the fourth group IQ values range from 126-140 (n=37) and FBS value is 87±11 mg/dl while the corresponding blood sugar values after those time intervals are 108±12 mg/dl, 129±9 mg/dl, 120±10 mg/dl, and 98±9 mg/dl respectively.

Table/Fig 2: P values statistically showing the relationship of IQ and glucose disposal rate

($P_{11} \leq 0.05$)	($P_{12} \leq 0.05$)	($P_{13} \leq 0.05$)	($P_{14} \leq 0.05$)
$P_{21} \leq 0.025$	($P_{22} \leq 0.025$)	$P_{23} \leq 0.25$	$P_{24} \leq 0.025$
$P_{31} \leq 0.025$	$P_{32} \leq 0.025$	$P_{33} \leq 0.025$	$P_{34} \leq 0.025$

On the basis of the data obtained, it is statistically observed that μ_2 (t), the mean glucose level is increasing in i for all $t = t_1, t_2, t_3, t_4$. These tests are conducted separately for each of μ_2 (t) using standard (student's) t test.

Let P_{ij} be the p-value for the test $H_0: \mu_i(j) = \mu_{i+1}(j)$ against the alternative $H_1: \mu_i(j) \leq \mu_{i+1}(j)$. The p-values thus obtained are listed in [Table /Fig 2].

Table/Fig 3: Relationship of IQ and Serum insulin values at different times after glucose load

IQ of volunteers (N=190)	Serum insulin levels in pmol/l				
	Fasting values	30 minutes after 100 g of glucose	1 hour after 100 g of glucose	90 minutes after 100 g of glucose	2 hour after 100 g of glucose
110-115 (n=37)	27 ±3	333±12	250±8	152±8	106±8
116-120 (n=63)	26 ± 4	360±8	182±10	148±8	103±7
121-125 (n=53)	24±4	400±12	242±6	144±6	100±6
126-140 (n=37)	23±5	410±9	186±12	140±6	94±8

Analyzing [Table/Fig 3] (Relationship of IQ and Serum insulin values at different times after glucose load), it is being observed that serum insulin values are 27 ±3 iu, 26 ± 4 iu, 24±4 iu, 23±5 iu respectively in different groups at the fasting stages. Serum insulin values are 333±12 iu, 360±8 iu, 400±12 iu and 410±9 iu respectively half an hour after glucose intake. One hour after oral glucose intake, serum insulin values are 250±8 iu, 182±10 iu, 242±6 iu and 186±12 iu respectively. One and half hour after glucose intake, values are 152±8 iu, 148±8 iu, 144±6 iu and 140±6 iu respectively. Two hour after glucose intake, values are 106±8 iu, 103±7 iu, 100±6 iu and 94±8 iu respectively.

Let P^*_{ij} be the p-value for the test H_0: $\eta_i(j) = \eta_{i+1}(j)$ against the alternative $H_1: \eta_i(j) \leq \eta_{i+1}(j)$. The p-values thus obtained are listed in [Table /Fig 4].

Values showing the relationship of IQ with serum lipid profile values (measured in fasting blood only) are being shown in Table 5. Regarding TLC, in the group where IQ is in the range 110-115, TLC values are 97±9 mg/dl, in the second group TLC values are 99±7 mg/dl, while in the third and fourth groups TLC values are 103±8 mg/dl and 107±8 mg/dl respectively (p=0.232). Regarding LDLC the values are 57 ±9 mg/dl, 61±8 mg/dl, 63 ±6 mg/dl and 66 ±6 mg/dl respectively in four different groups (p=0.242). In VLDLC the values in different groups are 15±4 mg/dl, 14±5 mg/dl, 16±5 mg/dl

Table/Fig 4: P values statistically showing the relationship of IQ and Serum insulin values at different times after glucose load

$P^*_{11} \leq 0.025$	$P^*_{12} \leq 0.025$	$P^*_{13} \leq 0.025$	$P^*_{14} \leq 0.025$
$P^*_{21} \leq 0.05$	$P^*_{22} \leq 0.05$	$P^*_{23} \leq 0.05$	$P^*_{24} \leq 0.05$
$P^*_{31} \leq 0.05$	$P^*_{32} \leq 0.05$	$P^*_{33} \leq 0.05$	$P^*_{34} \leq 0.05$

and 15±5 mg/dl respectively (p=0.316). In HDLC the values are 24±5 mg/dl, 23 ±5 mg/dl, 24±5 mg/dl and 26 ±5 mg/dl respectively in different groups (p=0.276). In TG the values were 118±7 mg/dl, 117 ±8 mg/dl, 120±7 mg/dl and 127 ±8 mg/dl respectively (p=0.367).

It is being observed that serum bilirubin value changes with IQ (Table 6). Serum bilirubin values (measured in fasting blood only) in the four different groups are 0.51±0.04 mg/dl, 0.47±0.023 mg/dl, 0.43±0.12 mg/dl and 0.3±0.07 mg/dl respectively (p = - 0.323).

Table/Fig 5: Relationship of IQ with lipid profile values

IQ of volunteers	IQ (110-115)	IQ (116-120)	IQ (120-120)	IQ (121-140)
Total cholesterol (mg/dl) (TLC)	97±9	99±7	103±8	107±8
Low density lipoprotein cholesterol (mg/dl) (LDLC)	57 ±9	61±8	63 ±6	66±6
Very Low density lipoprotein cholesterol (mg/dl) (VLDLC)	15±4	14±5	16±5	15±5
High density lipoprotein cholesterol (mg/dl) (HDLC)	24±5	23 ±5	24±5	26 ±5
Triglycerides (mg/dl) (TG)	118±7	117 ±8	120±7	127 ±8

Discussion

The score derived from a set of standardized tests of intelligence is the intelligence quotient or IQ of an individual. A standardized test is a test administered and scored in a standard manner. The tests are so designed that the questions, conditions for administering, scoring procedures, and interpretations are consistent and are administered and scored in a predetermined, standard manner [6]. Brand et al. [7] found the correlation between reasoning IQ and neonatal blood glucose levels was weak and not statistically significant. Haier et al. [8] found that IQ was related to cerebral blood flow. Thompson et al. [3] elaborated genetic influences on brain structure and Posthuma et al. [9] reported association between brain volume and intelligence is of genetic origin. Meisenberg [10] reported strong linkage of heredity factors and g but the linkage pathways are currently unknown. The heritability of most test performance is thus attributed to G. Bouchard and McGue[11]have reviewed such correlations reported in 111 original studies. The mean correlation of IQ scores between monozygotic twins was 0.86, between siblings, 0.47, between half-siblings, 0.31, and between cousins, 0.15. From such data the heritability of IQ can be estimated, varying between 0.40 and 0.80. While most of IQ determinates are heritable this study shows that in students with higher IQ glucose assimilation from a standard glucose load is more and the higher sugar value persists for a longer time in the body with rapid decline towards the fasting level. Whether this is heritable or not is yet to be found and needs further researches. Several aspects of our present knowledge on (A) the relations of blood sugar to brain waves and on (B) the occurrence of epileptic attacks at different blood sugar levels summarized reveal a significant positive correlation between the electroencephalographic 21/2 per second wave and spike on one hand and the blood sugar level on the other [12].

Table/Fig 6: Relationship of IQ with serum bilirubin values

IQ of volunteers	IQ (110-115)	IQ (116-120)	IQ (120-120)	IQ (121-140)
Serum Bilirubin (mg/dl)	0.51±0.04	0.47±0.023	0.43±0.12	0.3±0.07

Conclusion

IQ is very important as it reflects intelligence and as such thought to be related to the academic performance. Many of the factors related to a higher IQ is hereditary and cannot be changed. To increase IQ or academic performances many workers are concentrating their works on changeable and achievable objectives. Studies are done showing IQ is related to cerebral blood glucose level and overall brain size. The study as done here shows that IQ is strongly correlated with glucose assimilation after a glucose load, overall utilization and metabolism. Further, IQ is also showing relationship with lipid profile values and serum bilirubin level. Further studies are needed to establish this.

Acknowledgement

The authors are indebted to Prof. A.K. Nanda of Mathematics and Statistics Department for statistical workouts. The authors are also indebted to Prof. M.B. Sharan of Humanities and Social Science Department. The authors thank Prof. S. Dey, Head of Bio-Technology Department, all in IIT, Kharagpur for the help and use of the laboratory facilities. The authors were also indebted to Prof. A. K. Basak. Head, Chemistry Department for expert suggestions, help and active participation. The authors are grateful to Dr. D. Gupta, Dr. S. Chowdhury, Mr. L. K. Pradhan, Mr.S. Mondal, Mr. A .K .Roy, Mr. R.R. Mishra, Mr. L. Chingri, Mr. K. Pattanayek, of B. C. Roy Technology Hospital and Prof. A. K. Roy, Head of School of Medical Science and Technology and Doctors of that School for assistance in the monitoring process and for continuous help in the work. The authors thank Mr. Biswanath Dutta of Information Cell of IIT, Kharagpur for information's and data processing. The authors acknowledge gratefulness to Dr. Arunava Mitra of Crompton Greaves Limited for financial assistance and active participation in the project.

References

[1] Jensen AR. Rising IQ without increasing g? A review of The Milwaukee Project: Preventing mental retardation in children at risk. Development Review 1989; 9:34-258

[2] Thompson MP, Cannon DT, Narr LK, Erp T, Poutanen V, Huttunen M, Lönnqvist J, Standertskjöld-Nordenstam C, Kaprio J, Khaledy M, Dail R, Zoumalan IC, and Toga WA. Genetic influences on brain structure. Nature neuroscience December 2001;4 12: 1253-1258.

[3] Mingroni MA. The secular rise in IQ: Giving heterosis a closer look. Intelligence 2004; 32: 65–83

[4] [4] Wicherts JM, Dolan CV, Hessen DJ, Oosterveld P, Baal van GCM, Boomsma DI, Span MM Are intelligence tests measurement invariant over time? Investigating the nature of the Flynn effect. Intelligence 2004; 32:509–537.

[5] Boehringer Mannheim. Instruction sheets for manual assays GmbH diagnostica 1983: GmbH diagnostics Catalogue no.124 095 (cholesterol), diagnosticsCatalogue no 543 004 (HDLC), diagnostics Catalogue no 124 966 (Triglycerides), Catalogue no.263 826 (Glucose), Catalogue no.400 971and catalogue no. 543 004 (LDLC) and catalogue no. 123 919 (bilirubin).

[6] Popham J Why standardized tests don't measure educational quality. Educational Leadership 1999;56 (6):8-15.

[7] Brand PLP, Molenaar NLD, Kaaijk C, Wierenga WS Neuro developmental outcome of hypoglycemia in healthy, large for gestational age, term newborns. Arch Dis Child. 2005; 90: 78–81.

[8] Haier R, Siegel B, Nuechterlein K, Hazlett K, Wu J, Paek J, Browning H, Buchsbaum M. Cortical Glucose Metabolic Rate Correlates of Abstract Reasoning and Attention Studied with Positron Emission Tomography, Intelligence 1988;12:199-217

[9] Posthuma D, De Geus EJ, Baare WF, Hulshoff Pol HE, Kahn RS, Boomsma DI.The association between brain volume and intelligence is of genetic origin. Nature Neuroscience 2002;5 (2):83-4.

[10] Meisenberg G. Genes for intelligence. A review of recent progress. Mankind Quarterly 36 Winter 2005; 139-164.

[11] Steger, M. F., Hicks, B. M., Kashdan, T. B., Krueger, R. F., & Bouchard, T. J. Jr. Genetic and environmental influences on the positive traits of the Values in Action classification: Findings from a twin study. Journal of Research in Personality 2007;41: 524-539.

[12] Rudolf Engel, Franz Halberg, Fae Y. Tichy, Robert Dow. Electrocerebral activity and epileptic attacks at various blood sugar levels. Journal of Neural Transmission March 1954;9 (1-4):147-167