SURVEILLANCE OF BLOOD GROUP "O" HUMAN WITH REFERENCE TO IODINE

Abdul Haris, Sarfraz Hussain, Tahir Mahmood Qureshi, Muhammad Nadeem, Muhammad Umar Nasir

Institute of Food Science & Nutrition, University of Sargodha, Pakistan.

Corresponding Author: Email: sarfrazuaf2002@yahoo.co.uk

ABSTRACT: *Pakistan Government is spending millions of rupees on combating deficiency of Iodine through supplementation of Iodine in table salt. The objective of this study was to test the hypothesis that blood group "O" individuals are most vulnerable to this deficiency. Pakistan has blood groups population as "B" 36%, "O" 33%, "A" 21%, and "AB" 9%. The study was carried out through selection of 127 subjects having blood groups "O' 32, "A" 30, "B" 28, "AB" 37. The iodine test was carried out through TSH serum concentration test response through Enzyme-Linked Fluorescent Assay and assessing nutritional status through anthropometric studies in Haider Family Hospital, and tehsil headquarter hospital, Arifwala. The nutritional status of blood group "O" was compared with other blood group individuals. Data was subjected to statistical analyses. Results confirmed the hypothesis that Blood Group "O" subjects were possessing lesser iodine levels i.e., 4.462 which was more than 4.0, the normal TSH value, which means that the subjects having more than normal value were deficient in iodine. While, mean values of BMI for subjects of Blood groups O, A, B, AB and, were found to be 24.33, 24.02, 25.83, and 22.4 respectively. Subjects having Blood Group "O" were found to be less obese than of "B" Blood Group and more obese as compared to subjects having Blood Group "A". It was concluded that major deficiency of Iodine is prevailing in population having blood group "O" and should be taken care for Iodine Intake. In other blood groups individuals a problem of over load may have deleterious effects on health. Studies also emphasize that diet relevant to blood groups should be promoted.*

Key Words; Blood group, Iodine, Diet, Diseases, BMI, TSH.

INTRODUCTION

Iodine is an essential trace element required for the biosynthesis of thyroid hormones "thyroxin and tri-iodothyronine". Most of the Iodine present in Human body is found in these hormones. But very small quantities of Iodine are needed to prevent its deficiency disorders (IDD). An adult person needs only 250 micrograms of iodine per day. The daily need for iodine is around a quarter of a milligram. Over a lifetime, the total quantity of iodine needed is only one teaspoonful [1].

Good indicators for iodine deficiency in body are Thyroid Stimulating Hormone (TSH), thyroglobulin serum concentrations in blood and Urinary Iodine Concentration. In iodine deficient bodies the serum TSH concentrations are higher than in a normal body. The normal range of TSH is between 0.4-4.10 mIU/L depending upon the kits being used [2].

Swear deficiency of Iodine may have adverse effects in human beings. According to recent estimates two billion individuals globally do not have sufficient iodine intake. South Asia and sub-Saharan Africa are the most affected areas by this deficiency. Approximately 50% of European population is suffering from mild iodine deficiency, while, intake of iodine in many other developed countries like United States of America and Australia has decreased during recent years. Iodine deficiency during pregnancy and infancy has also serious consequences which may result in impaired growth, under development of neurons in the offspring along with increased mortality rates [3, 4, 5, 6, 7].

National Nutritional Survey of Pakistan revealed that 3.9% people are suffering from severe deficiency of iodine, 14.6% people are suffering from moderate and 29.2% are suffering from mild deficiency of iodine [8].

Blood group "O" individuals have thyroid glands as focal gland to keep them healthy [9]. If we look upon the data of blood group distribution in the world, population of Pakistan has blood group "O" 33%, "A" 21%, "B" 36% and "AB" 9%, which mean that 33% population is most significant to be cared for deficiency of Iodine. Four hypotheses were presented by Qadri [9] about the requirement of specific minerals by individuals having blood groups as "O" require Iodine, "A" require Zinc/Magnesium, "B" require Iron and "AB" need Calcium. Two out of four hypotheses were tested by IFSN, UOS while, requirement of Iodine by blood group "O" is presented in this paper, except blood group "B" individuals having deficiency of Iron is still to be tested for its validity. It has been reported that these blood group individuals also have specific tissues as Epithelial in "O", muscular in "B", Connective in "AB" and Nervous in "A" [10].

Recent work of Peter D' Adamo [11], Dr. Lam [12] and other fellows on blood group diet revealed that not only diet but diseases are also specific to blood groups [13, 14, 15, 16, 17, 18, 19, 20].

Susceptibility to IDD in human beings is influenced by their genetic characteristics. The evolutionary significance of diseases in human beings was suggested by Haldane [21]. Immediately after discovery of "ABO" blood groups by Landsteiner, the geneticists were looking for the significance of the occurrence of

different blood groups by studying the association of certain blood groups to diseases [22]. It is estimated that 20-60% of the world population is facing iodine deficiency and more problem is in developing countries [23].

Iodine deficiency disorders (IDD) include miscarriages, stillbirths, congenital anomalies, as well as the more familiar goiter, cretinism, impaired brain function, and hypothyroidism in children and adults. Iodine is also essential for women during childbearing age, because the damage done to the brain in early pregnancy can occur before the woman is even aware that she is pregnant. Iodine deficiency can also result in abortion, mental retardation and all forms of growth retardation [24, 25].

During initial diet surveys conducted at the Institute of food Science & Nutrition, University of Sargodha Pakistan, it has been investigated that salt intake by blood group "O" individuals was much higher to regulate production of acid in the stomach. In Pakistan blood group "O" distribution is about 33.14% [17, 26] in which the related deficiencies as hyperthyroidism or hypothyroidism may prevail. Qadri [9] reported that deficiency of Iodine mostly prevails in individuals having blood group "O".

MATERIALS AND METHODS

The research work was conducted at the Institute of Food Science & Nutrition, University of Sargodha, Haider Family Hospital Arifwala and Tehsil Headquarter (THQ) Hospital Arifwala. The deficiency of Iodine was evaluated by TSH serum concentration test, while the nutritional status was accessed by anthropometric measurements. The detail of study design and methodology employed during this study is as under.

Nutritional Status

The nutritional status of subjects of all blood group types (A, B, AB, and O) was determined and further compared by calculating body weight, body height, body mass index and blood pressure.

Selection of Samples

Volunteer were selected from University of Sargodha, Haider Family Hospital Arifwala and Tehsil Headquarter Hospital Arifwala having different age groups, socio economic levels and level of activities after taking their consent.

Sample size was determined by Epi Info3.5.3. Epi Info (TM) is a series of programs for use by public health professionals in conducting out break investigations, managing databases for public health surveillance and other tasks, and general data base and statistics applications.

Collection of Personal Information of Volunteers

According to the instructions of World Health Organization for anthropometric measurements name, sex, age, contact number, E-mail address, postal address, social status, consent, activity level and other necessary information of subjects were recorded for any further inquiry and detailed information.

A. Anthropometric Measurements

Measurements of height and weight were recorded as important indicators of health and nutritional well-being to identify whether an individual's body measurements are appropriate for that individual chronological age. For children, body measurements are plotted on growth charts which indicate that whether a child's growth is normal or delayed and when a child is overweight or underweight. All the measurements were taken according to procedure of NHANES (National Health and Nutrition Examination Survey) Body Measurements guide**.** Adopted standard measurement procedures are mentioned as under;

i. Measurement of body Weight

For measuring body weight Staff Room of Institute of Food Science and Nutrition, University of Sargodha and Tehsil Head Quarter Hospital Arifwala were selected. The weighing machine was placed on clean cemented floor for its proper working and to obtain accurate and reliable readings. To check level of floor surface a spirit leveler was used, and then the weighing machine was placed on smooth surface.

At the start of each weight measurement session, a standard 2Kg mass was used to check that either the beam scale is working properly or not.

ii. Measurement of Standing Height

Subjects were asked to stand erect on the floor board of the stadiometer with back to the vertical backboard of the stadiometer. The weight of the subject was evenly distributed on both feet. The heels of the feet were placed together with both heels touching the base of the vertical board and feet pointed slightly outward at an angle of 60 degree. All other precautionary measures to obtain accurate measurements were taken in to consideration.

iii. Body Mass Index

The body mass index was calculated, from an individual's weight in kg divided by the square of the height in meters [27], using the formula given below:

Body mass Index (BMI) = weight (Kg)/ Height $(m)^2$

The BMI values calculated by above formula were compared with following values for interpretation:

Underweight: BMI=<18.5, Normal weight: BMI=18.5-24.9, Overweight: BMI=25-29.9, Obesity: BMI=30 or greater.

B. Observations for Vital Signs

Body temperature, blood pressure was measured along with a Performa [28] (Apendix-i) to check the deficiency symptoms of Iodine such as Goiter, growth retardation, hypo and hyperthyroidism, skin abnormalities and mental lethargy, etc. [29].

C. Estimation of Iodine Status in Human Body

i. Selection of Samples

Blood samples for estimation of Iodine level in human body were collected from University of Sargodha, Haider Family Hospital Arifwala and Tehsil Headquarter Hospital Arifwala from subjects belonging to different age groups, socio-economic levels and level of activities after taking their consent.

i. Determination of Blood Group

Blood group test of Subjects was performed by the nearest clinical laboratories which were performing this test as a routine practice.

ii. TSH Serum Concentration Test

Serum TSH concentration was measured by Enzyme-linked Fluorescent Assay (ELFA) using commercial kits (MiniVidas®, an Automated Immuno Assay System by Bio Merieux France) in a well-equipped clinical laboratory. The normal range of TSH concentration determined with this kit was 0.4 - 4.10 µIU/mL. If the serum concentration was found within a normal range, it indicated optimal iodine nutrition. The results were then compared with a series of defined standards and the iodine status was thus determined. The defined standards are presented in Table 1.

Statistical Analyses

The data was subjected to statistical analyses to determine the level of significance [30] Steel using two factor factorial design was applied and means were further compared through Duncan multiple range (DMR) test. For representation of distributions, Pearson chi-square formula was used and all response and behavior patterns were analyzed graphically by using Microsoft Excel Charts.

RESULTS AND DISCUSSION

Response and Comparison of "ABO" Subjects to TSH Serum Concentration Test

Subjects belonging to different age groups, socio economic levels, level of activities and different blood groups were selected for TSH Serum Concentration Test. Body Iodine level of all blood groups was assessed, interpreted and compared by using statistical tools. Data was analyzed by using the method of least squares analysis of variance.

Fig.1. displays analysis of blood groups across all groups indicated that total sample contains 23.62% subjects belonging to blood group "A" while 29.13% subjects were of blood group "B", 22.04% subjects were of blood group "AB" and 25.19% were belonging to blood group "O".

According to age frequency across all blood groups 26.77% subjects were of between 1-19 years of age, 33.07% subjects were of between 20-30 years of age, 30.70% subjects were of between 31-40 years of age while 9.44% subjects were above 40 years of age.

Statistical analysis shows that there is a significant difference among the groups with regard to test results means (F cal > F tab).

Table 2 enlists the mean TSH values for all blood groups. The mean values of TSH for blood groups A, B, AB and O were 2.771, 2.930, 3.332 and 4.462, respectively. The means sharing similar letters are statistically insignificant.

By Pearson Chi-Square formula, response of blood groups towards TSH Serum Concentration Test is mentioned in Table 3.

There were 127 subjects belonging to all age groups and blood groups. After TSH Serum Concentration Test, it was recorded that 88 subjects had normal iodine level, 9 subjects had excessive Iodine levels while 30 subjects were deficient in Iodine.

Among sample of 127, there were 30 subjects having blood group "A". After taking TSH test subjects 24 had normal level of Iodine, 2 were having excessive level of Iodine while 4 were deficient in sufficient Iodine level. It indicates that 80% subjects had normal iodine level, 6.66% had excessive level of iodine (hyperthyroid) while 13.33% were having deficiency of iodine in their body.

Among sample of 127, there were 37 subjects having blood group "B". After taking TSH test 27 subjects had normal level of Iodine, 3 were having excessive level of Iodine while 7 were deficient in sufficient Iodine level. It indicates that 72.97% subjects had normal iodine level, 8.10% had excessive level of iodine while 18.91% were having deficiency of iodine in their body.

Among sample of 127, there were 28 subjects having blood group "AB". After taking TSH test 20 subjects had normal level of Iodine, 2 were having excessive level of Iodine while 6 were deficient in sufficient Iodine level. It indicates that 71.42% subjects had normal iodine level, 7.14% had excessive level of iodine (hyperthyroid) while 21.42% were having deficiency of iodine in their body.

Among sample of 127, there were 32 subjects having blood group "O". After taking TSH test 17 subjects had normal level of Iodine, 2 were having excessive level of Iodine while 13 were deficient in sufficient Iodine level. It indicates that 53.12% subjects had normal iodine level, 6.25% had excessive level of iodine while 40.62% were having deficiency of iodine in their body.

Among sample of 127, in total there were 32 subjects having blood group "O". After taking TSH test 17 subjects had normal level of Iodine, 2 were having excessive level of Iodine while 13 were deficient in sufficient Iodine level. It indicates that 53.12% subjects had normal iodine level, 6.25% had excessive level of iodine while 40.62% were having deficiency of iodine in their body.

Study conducted by Ralph and Carole [31] also confirms that subjects having "O" blood group have low levels of TSH and are not deficient in iodine.

Comparison of Nutritional Status of "ABO" Blood Groups

A total of 63 people (belonging to different age, sex, blood group, socioeconomic status and level of activity) were participated in this study. The response rate was 100%.

Sample contains 13, 23, 18 and 9 subjects of "A", "B", "AB" and "O", respectively. An analysis of blood groups across all groups indicated that sample contains 20.63% subjects of blood group "A", 36.50% subjects of blood group "B", 28.57% subjects of blood group "AB" and 14.28 % subjects of blood group "O". Ages of the subjects were in between 20-50 years.

It has now been well established that the body mass index (BMI) is considered the most suitable tool for determining nutritional status among adolescents [24, 32, 33, 34].

Nutritional status can be evaluated using BMI as recommended by the World Health Organization based on age, sex and specific cut-off points [24], Body mass

index (BMI) is determined by weight of an individual in kilograms (kg) divided by their height in meter square (m^2) [35]. Body Mass Index (BMI) is a relationship between weight and height that is connected with body fat and health risks [36]. It is also considered as key index for relating a person's body weight to their height. Deficiency of Iodine may also result in retarded growth. Keeping in view the severity of the problem, Pakistan Government launched a program in which table salt was used as carrier of Iodine. It is also well known fact that mostly deficiency of Iodine is abundant in hilly areas of Pakistan. But, among Pakistani population living in hilly areas, blood group "O" is most affected.

Table 5 describes the distribution of respondents for BMI calculations according to their blood and age groups. It shows that among 13 subjects having blood group A, 46.15% were between 20-30 years of age, 30.76% were between 31-40 years of age while 23.07% were above 40 years of age.

Among 23 subjects having blood group B, 43.47% were between 20-30 years of age, 47.82% were between 31-40 years of age while 8.697% were above 40 years of age.

Among 18 subjects having blood group AB, 27.77% were between 20-30 years of age, 66.66% were between 31-40 years of age while 5.55% were above 40 years of age.

Among 9 subjects having blood group O, 66.66% were between 20-30 years of age, 33.33% were between 31-40 years of age while 0% were above 40 years of age.

Above mentioned graph indicates that subjects of blood group "B" have the highest mean value of body mass index (BMI) and those of blood group "AB" have the lowest value of body mass index, while "O" blood group are amongst the medium.

Table 7 indicates that among the sample of 63 subjects, 26.98% subjects have normal weights while 11.11% subjects were obese, 41.26% subjects were overweight and 20.63% subjects were underweight.

Among blood group "A", 46.15% subjects were having normal BMI, 7.69% were obese, and 38.46% were overweight while 7.69% subjects were underweight.

Among blood group "B", 20.08% subjects were having normal BMI, 17.39% were obese, and 47.82% were overweight while 8.69% subjects were underweight.

Among blood group "AB", 11.11% subjects were having normal BMI, 5.55% were obese, and 38.88% were overweight while 44.44% subjects were underweight.

Among blood group "O", 33.33% subjects were having normal BMI, 11.11% were obese, and 33.33% were overweight while 22.22% subjects were underweight.

Fig. 2 is a graphical representation of comparison of BMI levels between all blood groups. It is indicating that subjects of blood group "B" are found more obese as compared to other three (A, O, AB) blood groups subjects. Subjects of blood group "O" are found less obese than of blood group "B" and more obese as compared to blood group "A" subjects.

CONCLUSIONS

- After conducting the TSH serum concentration test for all four blood groups (A, AB, B and O), it was concluded that subjects having blood group "O" possessed lesser amount of Iodine as compared to other blood groups showing more prevalence of iodine deficiency.
- Studies revealed that blood group "B" subjects had highest value of BMI and that the rate of overweight conditions and obesity was higher in blood group "B" population.
- Subjects of blood group "O" were found to be less obese than blood group "B" subjects and more obese as compared to blood group "A" subjects

RECOMMENDATIONS

It is recommended that population having blood group "O" should be targeted to avoid any over load of Iodine in other three blood groups (A, B, and AB).

Table 1: Standard TSH values and corresponding thyroid status and iodine levels

TSH Value µIU/ml	Thyroid Status	Iodine Level
Less than 0.4	Hyperthyroid	Excessive
0.4-4.0	Normal	Normal
More than 4.0	Hypothyroid	Deficiency

Table 2: Table of mean TSH values for all blood groups

Blood Groups	N	Mean	SD	Std. Error
A	30	2.771A	1.821	0.332
B	28	2.930A	1.953	0.369
AB	37	3.332A	2.342	0.385
O	32	4.462B	3.241	0.573
Total	127	3.373	9.422	0.4213

Means sharing similar letters are statistically non-significant

Table 3: Distribution of respondents to TSH test according to their blood group and response

Blood Group.	Response			Total
	Normal	Hypo-thyroid	Hyper-thyroid	
A	24	4	2	30
	80%	13.33%	6.66%	100%
B	27	7	3	37
	72.97%	18.91%	8.10%	100%
AB	20	6	2	28
	71.42%	21.42%	7.14%	100%
O	17	13	2	32
	53.12%	40.62%	6.25%	100%
Total	88	30	9	127
	69.29%	23.62%	7.08%	100%

Chi-Sq = 1.301, DF = 9, P-Value = 0.998

Table 4: Ages and blood groups of subjects for BMI studies

Blood Group	No. of Subjects	20-30 Years	31-40 Years	41-50 Years
A	13	6	4	3
B	23	10	11	2
AB	18	5	12	1
O	9	6	3	0
Total	**63**	**27**	**30**	**6**

Table 5: Distribution of respondents for BMI calculations according to their blood and age groups

Blood Group	20-30 Years	31-40 Years	40+ Years	Total
A	6	4	3	13
	46.15%	30.76%	23.07%	100%
B	10	11	2	23
	43.47%	47.82%	8.69%	100%
AB	5	12	1	18
	27.77%	66.66%	5.55%	100%
O	6	3	0	9
	66.66%	33.33%	0%	100%
	27	30	6	63
Total	42.85%	47.61%	9.52%	100%

Chi-Sq = 8.392, DF = 9, P-Value = 0.000

Table 6: Table of mean BMI values for all blood groups

Blood Groups	N	Mean + SD
A	13	24.02^{A}±4.849
B	23	25.38^{A}±.225
AB	18	22.40^{A}±6.430
O	9	24.33^{A}±7.399
Total	63	96.14 ± 23.9

Means sharing similar letters are statistically non- significant

Table 7: Distribution of respondents for BMI calculations according to their blood group and response

Blood Group	Normal	Obese	Over-weight	Under-weight	Total
A	6	1	5	1	13
	46.15%	7.69%	38.46%	7.69%	100%
B	6	4	11	2	23
	26.08%	17.39%	47.82%	8.69%	100%
AB	2	1	7	8	18
	11.11%	5.55%	38.88%	44.44%	100%
O	3	1	3	2	9
	33.33%	11.11%	33.33%	22.22%	100%
	17	7	26	13	63
Total	26.98%	11.11%	41.26%	20.63%	100%

Chi-Sq = 13.072, DF = 12, P-Value = 0.364

ACKNOWLEDGEMENT

We are grateful to Ejaz Hussian Chatta MLT, family hospital Arifwala and special thanks to Syeda Mahvish Zahra and Farhat Rashid, research officers Fruit & Vegetables Project, IFSN, UOS, for their technical support.

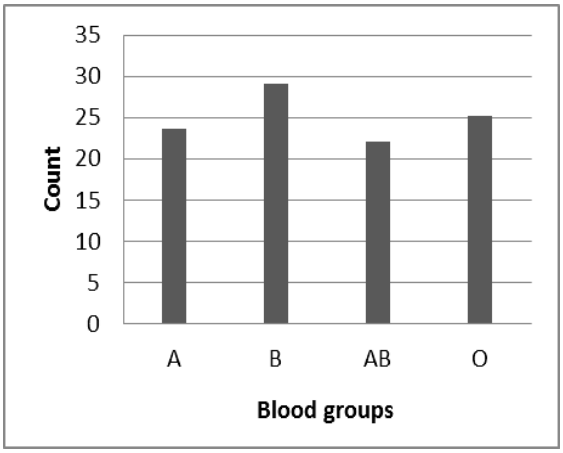

Fig. 1: Distribution of subjects having different blood groups for TSH test

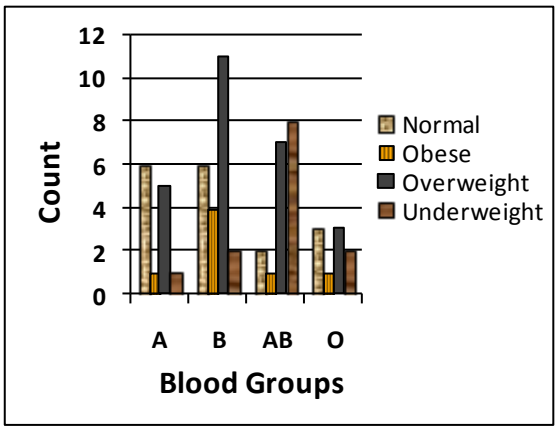

Fig. 2: Comparison of BMI levels between all blood groups

REFERENCES

1. Anonymous. Iodine Deficiency-What it is and How to Prevent it. Document WHO-EM/NUT/165/E/L/10.95/1000. World Health Organization, Regional Office for the Eastern Mediterranean, Alexandria, Egypt. Publisher Bafra Graphics, Alexandria, Egypt (1995a).
2. Delange, F., Camus, M., and Ermans, A. M., Circulating thyroid hormones in endemic goiter. *J. Clin. Endocrinol. Metab.*, 34: 891–895 (1972).
3. Basil, S.H., The Prevention and Control of Iodine Deficiency Disorders – Nutrition policy discussion paper No. 3. World Health Organization. CSIRO Division of Human Nutrition Adelaide, Australia. Baumann, F. (1896) Ueber das nomale Vorkommen von Jodim Thierkorper. *Z. Physiol. Chem.*, 21: 319-330 (1993).

4. Zimmermann, M.B., Iodine deficiency. *Endo. Rev.*, 30(4): 376-408 (2009).
5. Anonymous. Assessment of Iodine Deficiency Disorders and Monitoring- A guide for programme managers. 2rd Edition. WHO/NHD/01.1, Distribution: General, English only. World Health Organization (2001).
6. Anonymous. Assessment of iodine deficiency disorders and monitoring their Elimination-A Guide for Programme Managers. (3rd edition). World Health Organization, WHO Press, 20 Avenue Appia, 1211 Geneva 27, Switzerland (2007a).
7. Anonymous. National Iodine Deficiency Disorders Control Programme (NIDDCP). PIP Part D Disease Control Programme State Health Society-Haryana, India. Pp499-504 (2009-10).
8. Anonymous. Nutrition Survey of Pakistan. Nutrition wing. Cabinet division, Government of Pakistan, Islamabad, Pakistan (2011).
9. Qadri, B.S., Tehqeqat-e-insane-Blood group-Gheza, Tib& Homeopathy (Research on human blood group - diet, practices of herbal medicine & homeopathy) (In Urdu), Mesal Pub., Raheem Centre, Press market Amin Pur Bazar, Faisal Abad. pp384 (2005).
10. Bernard, J., Foods That Heal – A guide to understanding and using the healing power of natural foods. Health and harmony, Unisons Techno Financial Consultants (P) Ltd., 522, FIE, Patpar Ganj, Delhi-110 092. Pp49-53, 60-63 (2004).
11. Peter, J.D.A. and Catherine, W., Live Right 4 Your Type - 4 blood types, 4-programmes for a healthy life. Distributors Stacktheme Ltd, 59 Bridge Street, Dollar, FK 147DQ, Scotland, UK (2000).
12. DrLam.com
13. Faiz, M.F., Quliat-e-Tib-e-Islami (Keys to Islamic way of Healing) (In Urdu). Faiz Ul Hikmat, Islamia College ® 54-stop, Street No.1, Yasir Ghafar Town, Okara, Pakistan. P223 (2002).
14. O'Donnell, J., Laffan, M.A., The relationship between ABO histo blood groups factor VIII and von willebrand factor. *Transfus. Med.*, (4): 343-351 (2001).
15. Gates, M.A., Wolpin, B.M., Cramer, D.W., Hankinson, S.E. and Tworoger, S.S., ABO blood group and incidence of epithelial ovarian cancer. *Int. J. Cancer. J. Int. Du Cancer*, 128 (2): 482-86 (2010).
16. Glass, R., Holmgren, J., Haley, C., Khan, M.R., Svenerholm, M., Stoll, B., Hossain, K., Black, B., Yunus, M. and Barua, D. Predisposition of cholera of individuals with O blood group. Possible evolutionary significance. *Am. J. Epidem.*, 121(6): 791-796 (1985).
17. Hafeez-Ullah, W., Rao, A.A. and Joachim, H.W., Association of blood group A with increased risk of Coronary heart disease in the Pakistani population. *Pak J Physiol.*, 1(1-2): 1-3 (2005).
18. Meian, He, Brian W., Kathy R., JoAnn E.M., Eric R., Frank B.H., and Lu Qi., ABO Blood Group and Risk of Coronary Heart Disease in Two Prospective Cohort Studies. *Art., Thromb. And Vasc. Bio.*, 32: 2314-2320 (2012).
19. Vogel, F., ABO blood groups and disease. *Am. J. Hum. Genet.*, 22: 464-475 (1970).
20. Garratty, G. Do blood groups have a biological role? *Immuno bio. of Transf. Med.*, New York. Pp201-55 (1994).
21. Haldane, J.B.S., Natural selection in man. *Acta Genet. (Basel).*, 6: 321-33 (1957).
22. Voitk, A.J., Echave, V., Feller, J.H., Brown R.A. and Gurd. F. N., Experience with elemental diet in the treatment of inflammatory bowel disease. *Am. J. Sur.*, 107: 329-33 (1973).
23. Anonymous. United Nations Children's Fund, International Council for the Control of Iodine Deficiency Disorders. Assessment of iodine deficiency disorders and monitoring their elimination. 3rd ed. World Health Organization, Geneva (2007b).
24. Anonymous. Physical status, the use and interpretation of anthropometry. *Tech. Rpt. series No. 854*. World Health Organization. Geneva (1995b).

25. Basil, S.H. And Mark T.M., A Review of Experimental Studies of Iodine Deficiency During Fetal Development. Commonwealth Scientific and Industrial Research Organization, Division of Human Nutrition, Adelaide, 5000, Australia (1989).
26. Anees, M and Mirza, M.S., Distribution of ABO Group alleles in Gujrat region of Punjab, Pakistan. *Proc. Pak. Acad. Sci.*, (4): 233-238 (2005).
27. Deurenberg, P., Westrate, J.A., Seidell, J.C., Body mass index as a measure of body fatness: age and specific prediction formulas. *Brit. J.Nutr.,* 20: 132-134 (1991).
28. Sayyed, K.A., The NGDSP Pilot Project. University of Karachi, Karachi. 75270. Pakistan (2010).
29. Parsad, A.S., Halsted, J.A. and Nadimi, M., Syndrome of iron deficiency anemia, hepatosplenomegaly, hypogonadism, dwarfism and geophagia. *Am. J. Med.*, 31: 532-546 (1961).
30. Steel, R.G.D., Torrie, J.H. and Dieky, D.A., principles and procedures of statistics. 3rd Ed. McGraw Hill Book Company Incorporation. New York, USA (1997).
31. Ralph, C.M.D. and Candarole A.S., Clinical and Subclinical Thyroid Disorders Associated with Pernicious Anemia Observations on Abnormal Thyroid-Stimulating Hormone Levels and on a Possible Association of Blood Group O With hyperthyroidism. *Arch. Intern. Med.*, 142(8): 1465-1469 (1982).
32. Himes, J.H. and Bouchard, C., Validity of anthropometry in classifying youth as obese. *Int. J. Obs.*, 13: 183-193 (1989).
33. Must, A., Dallal, G.E. and Dietz, W.H., Referance data for obesity. 85th and 95th percentiles of body mass index and triceps skin fold thickness. *Am. J. Clin. Nutr.,* 53: 839-846 (1991).
34. Rolland, C.M.F., Body composition during adolescence, methods, limitations and determinants. *Horm. Rch.*, 39:25-40 (1993).
35. Afridi, A.K. and Khan A., Prevelance and etiology of obesity, An overview. *Pak. J. Nutr.*, 3(1): 14-25 (2004).
36. Adams, T. and A. Rini., Predicting 1-year change in body mass index among college students. *J. Am. Hlth.*, 55(6):361-5 (2007).