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Distribution of ABO & Rh blood group in relation to dermatoglyphics and BMI

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ABSTRACT

Inheritance of ABO & Rh blood group in a person is genetically determined and controlled by multiple alleles. Distribution of blood group pattern not only helps to know the pattern of distribution of different blood group alleles in the population as their distribution varies from place to place but also the probable susceptibility to certain health issues. Similarly body mass index (BMI) to some extent genetically controlled and finger print pattern in human being is unique and also genetically controlled. This study is carried out to find out the pattern of distribution of blood group and its relationship with BMI and finger print patterns in the students. It was observed that the blood group "B" is predominantly distributed in both boys and girls followed by "O", 93% of the students are Rh^{+ve}. The highest distributed allele is I^O followed by I^B. The blood group "B" is more prevalent in the students with BMI below 24.9 whereas "O" blood group is more in BMI above 24.9 category. Loop type of finger print is the commonest pattern distributed in the student population and the frequency of "B" blood group is more in both loop and the second largest finger print pattern "Whorl".

***Keywords*:** ABO blood group, Rh factor, Body Mass Index (BMI), Dermatoglyphics

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1. INTRODUCTION

ABO and Rhesus (Rh) blood group, which are examples for multiple allelic inheritance has its own pattern of expression in the population worldwide. Similarly Finger print pattern and obesity are also genetically controlled though in obesity life style also plays an important role. Study of distribution of blood group is helpful to understand the pattern of population migration and distribution thereby genetic variation, besides to solve medico legal and paternity as well as blood transfusion practices.

A total of 29 human blood group systems are recognized by the international society of blood transfusion (ISBT) including of ABO and Rh system (Thakare 2015).

ABO blood group is determined two antigens (A and B, chemically Mucopolysaccharides) present on the surface of RBC, involving three alleles located in the locus in chromosome nine (I^A, I^B and I^O, I^A = responsible for Antigen A and I^B = responsible for B antigen) producing well established four types of blood groups (A, B, AB and O). RBC with only "A" antigen is known as "A" blood group, RBC with "B" antigen only is known as "B" blood group, RBC with both "A & B" antigen is known as "AB" blood group whereas the RBC without "AB" antigens is known as "O" blood group. It is important to know that the blood plasma of "A" blood group has "anti-B antibodies" naturally, similarly "B" blood group has "anti-A antibodies", "O" blood group has both "anti-A & B antibodies", whereas "AB" blood group has no antibodies in their blood plasma. These plasma antibodies plays significant role in blood transfusion. Coombs test is used routinely in the screening of blood for blood group antibodies (Verma & Agarwal 1995).

Rh Antigen present on the surface of RBC is also an example for Multiple allele inheritance. According to Wiener"s hypothesis eight different alleles (R_0, R', R", R_1, R_2, R_X, R_y & R_z) are responsible for the production of Rh-Antigen (D-Antigen), presence of any one allele in the locus of Chromosome – 1 will produce Rh-Antigen. The recessive non producing allele is represented as "r". According to Fisher's Hypothesis, closely linked three genes namely CDE is responsible for the production of Rh Antigen. Presence of any one dominant gene among CDE can produce the Rh Antigen. Rh $^{-ve}$ person will not have Anti-D antibodies naturally in their blood, or Anti-D antibodies are produced only when Rh^{-ve} individual is exposed to Rh^{+ve} Antigen (Verma & Agarwal 1995).

Study of inheritance of Rh Antigen is of important because of its significance in producing Haemolytic disease of newborn which is one of the gravest diseases which need immediate care, evaluation and management (Rajesh kumar et al 2015).

Gene frequency is simply the proportion of different alleles for a gene that are present in the population. The proportion is computed by taking into consideration the number of various genotypes in the population. Hardy Weinberg law is applied to estimate the relative allele frequencies (Hoffbrand 1981).

Accumulation of excess fat in the body leads to obesity. The ratio of obese persons in the population is increasing alarmingly; in India more than 135 million individuals (of all age groups) were found to be obese. Many researches point out that obesity can lead to non communicable diseases like hypertension, diabetes (type-II), heart problems, sleepless ness, Osteoarthritis and cancers (Behere et al 2016).

According to Ruth McPherson (2006) 30% to 50% of the obesity phenotype is inherited, and there is evidence for a major recessive gene or genes with an allele frequency of 0.3. Overall, the genetic origins of obesity can be considered in three broad areas.

- First, genes coding for proteins that regulate food intake at the level of the hypothalamus (hunger, appetite etc).
- Secondly at the level of adipocyte (differentiation, triglyceride storage),
- Third genes regulate mitochondrial biogenesis and/or adaptive thermogenesis (spontaneous/intentional, basal thermogenesis).

Genome-wide association studies have identified single-nucleotide polymorphisms (SNPs) associated with Obesity, among which 97 genetic loci were associated with BMI (Joseph et al 2019**).** BMI may be influenced by more than 90 genes (Helix).

Nield and Kelly (2016) have reported the linkage of obesity with ABO blood groups. Parveen et al (2016) suggested that ABO system as a genotype marker for obesity. Studies done on patients with gastric cancer, duodenal ulcer, colorectal cancer, thyroid disorders, Ovarian tumours, upper urinary tract tumours, small cell carcinoma of lung, breast cancer, pancreatic cancer, coronary heart disease, hypercholesterolemia, diabetes mellitus and osteoporosis have shown association with ABO blood groups. These correlations have directed to the assumption that there is some definite correlation of various metabolic disorders with ABO blood group (Behere et al 2016). Obesity can be identified by calculating one's Body Mass Index.

Characteristic pattern of ridges present in the end of fingers which forms impressions as deep or shallow curves which enters the finger form one sided and escapes through the same (loop) or other side (Arch) of the Finger, sometimes coiling spirally (Whorl) are the basic three types of finger print patterns observed in the human beings since foetal life to death. (Encarta 2009).The study of fingerprint is called dermatoglyphics. Fingerprints on ten fingers are controlled by the same gene locus that has two alleles "Whorl gene (W) and "other gene" (O). It is also found that the number of whorl-shaped fingerprints of a husband was correlated to that of his wife, suggesting that the number of whorl-shaped fingerprints of a person will influence his/her selection of a spouse. (Yang et al 2016).

ABO blood groups and Rh factor are examples for multiple allele inheritance. Frequency of distribution of the alleles changes from location to location. Similarly Obesity and Finger print patterns are also genetically controlled and there are reports that they are linked with ABO blood group. Hence the present attempt was made to analyse the pattern of distribution of ABO blood group & Rh factor and to identify whether there is any relationship or influence on the BMI (Body Mass Index) and finger print type in the student community of The M.D.T. Hindu College, Tirunelveli, Tamil Nadu India.

2. MATERIALS AND METHODS

ABO Blood group and Rh typing was conducted for 472 undergraduate students (Boys-292, Girls-175) of The M.D.T. Hindu College Tirunelveli, Tamil Nadu, India. The age group of the students was between 18-20.

Agglutination test with anti sera A, B & D (for Rh) was followed to screen different blood groups and Rh^{+ve}. To a clean microscopic slide three drops of blood was collected as separate drops from each student.

To one drop antiserum-A was added, to another drop of blood antiserum-B was added and to the last drop antiserum-D (to identify Rh antigen) was added, mixed well and noted for agglutination.

If there is agglutination with antiserum-A only then the blood group is A, if agglutination is observed with B-antiserum only then the blood group is B, if agglutination is observed in both antisera then the blood group is AB and if no agglutination is observed then the blood group is O. Similarly if the blood shows agglutination with anti-D antiserum then it is Rh-positive otherwise Rh-negative.

2. 1. Calculation of Allelic frequency and Genotypic frequency

Allelic frequencies of blood group (I^A, I^B, I^O, I^D and I^d) were calculated using Hardy-Weinberg formula using the following equations (Raja et al 2016)

Calculation of expected phenotype frequency

Calculation of "O" allele frequency (r)

r^2 = frequency of "O" Phenotype

$$r = \sqrt{r^2}$$

Calculation of "A" allele frequency (p)

p = frequency of A phenotype + frequency of O phenotype

$$p^2 + 2pr + r^2 = (p + r)^2$$

$$p = \sqrt{(p^2 + 2\text{pr} + r^2)} - \boldsymbol{r}$$

Calculation of "B" allele frequency (q)

q = 1 – (p + r)

Calculation of "d" allele frequency (u)

u^2 = frequency of "d" phenotype

Calculation of "D" allele frequency (v)

v + u = 1

v = 1- u

2. 2. Body Mass Index

In order to id entify the state of obesity of the students, the height and weight of the students were collected and the Body Mass Index (BMI) was calculated using the following formula

BMI = Weight (Kg)/Height (M^2)

Body Mass Index (BMI) was categorised according to the proposed criteria of World Health Organization as following.

BMI	Category
<18.5 Kg/m^2	Under weight
18.5 – 24.9 Kg/m^2	Normal Weight
25 – 29.9 Kg/m^2	Over weight
>30 Kg/m^2	Obese

2. 3. Finger Print Identification

The left thumb finger impression of each student was obtained in a clear paper using stamp pad with ink. The primary three ridge patterns (Loop, Whorl and Arch) were identified using Magnifier lens.

3. RESULTS

Distribution of different blood groups in the student population (Boys-297 & Girls-175 = Total 472) of The M.D.T. Hindu College was observed, recorded and tabulated (Figure 1).

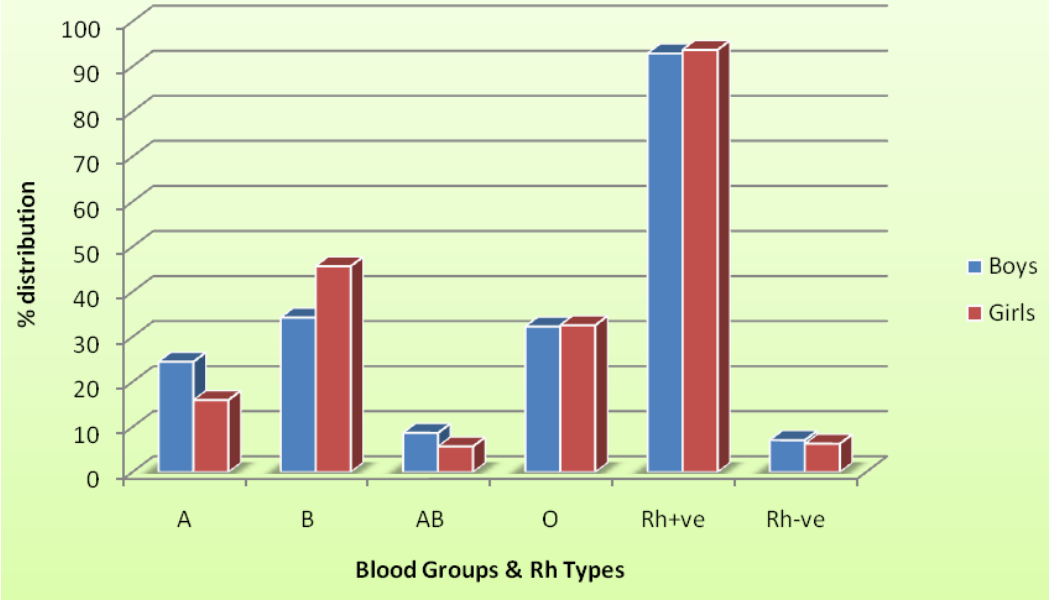

Fig. 1. % Distribution of ABO Blood group & Rh Antigen

It was observed that among boys the frequency of "B" blood group was more with 34.3%, followed by "O" blood group with 32.3%, "A" with 24.5% and "AB" with 8.7%. Similarly out of 175 girls 80 (45.7%) have "B" blood group and the distribution of other blood groups were, "O" with 32.6%, A" with 16% and "AB" with 5.7%.

It was observed that the distribution of blood groups in both boys and girls have followed similar pattern, ie most available blood groups is "B" (38.6%) followed by "O" (32.4%), "A" (21.4%) and least represented blood group is "AB" with 7.6%. However the percentage frequency of "B" blood group is slightly higher in girls when compared to boys.

In boys the Rh Antigen is present in 276 members (92.9%) whereas absent in 7.1% boys only. In girls, 93.7% of them were Rh^{+ve} and 6.3% were Rh^{-ve}. In girls the frequency of Rh^{+ve} individuals is marginally higher when compared to boys. The frequency of alleles responsible for different blood groups and Rh Antigen was calculated using Hardy Weinberg equation (Table 1). It was observed that in the sampled student population of The M.D.T. Hindu College Tirunelveli the more frequently present allele was "I^O" (0.569) followed by I^B (0.267) and I^A (0.164) allele. Similarly the frequency of I^D allele is 0.7393 and of I^d is 0.2607.

Table1. Allelic Frequency of different Blood group & Rh alleles

Alleles	Designated Alphabet	Nomenclature	Allele freguency
A	p	I^A	0.164
B	q	I^B	0.267
O	r	I^O	0.569
D	v	I^D	0.739
d	u	I^d	0.261

Table 2. Comparison of Observed and Expected Genotypic Frequency for different Blood Group & Rh.

Blood Group	Observed Frequency	Genotype	Expected Genotypic Frequency	
A	0.214	AA AO	0.0268 0.1866	0.2134
B	0.386	BB BO	0.0713 0.3038	0.3751
AB	0.076	AB	0.0875	0.0875
O	0.324	OO	0.3237	0.3237
Rh^{+VE}	0.932	DD Dd	0.5465 0.3854	0.9319
Rh^{-VE}	0.068	dd	0.0679	0.0679

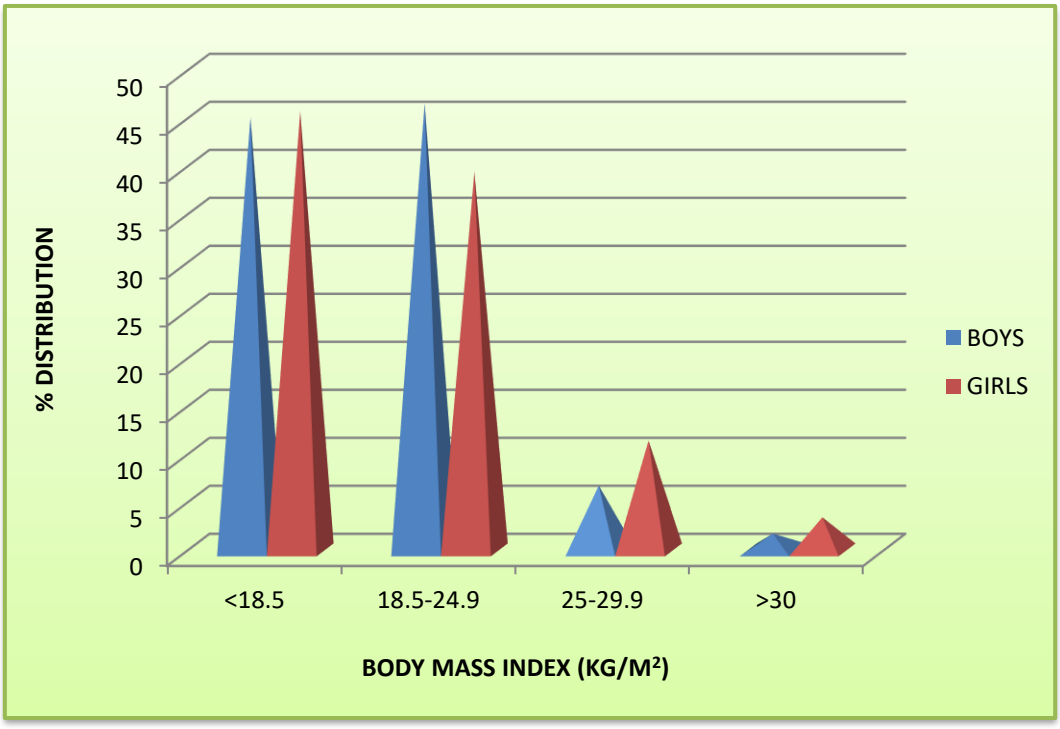

Fig. 2. Distribution of students based on their BMI.

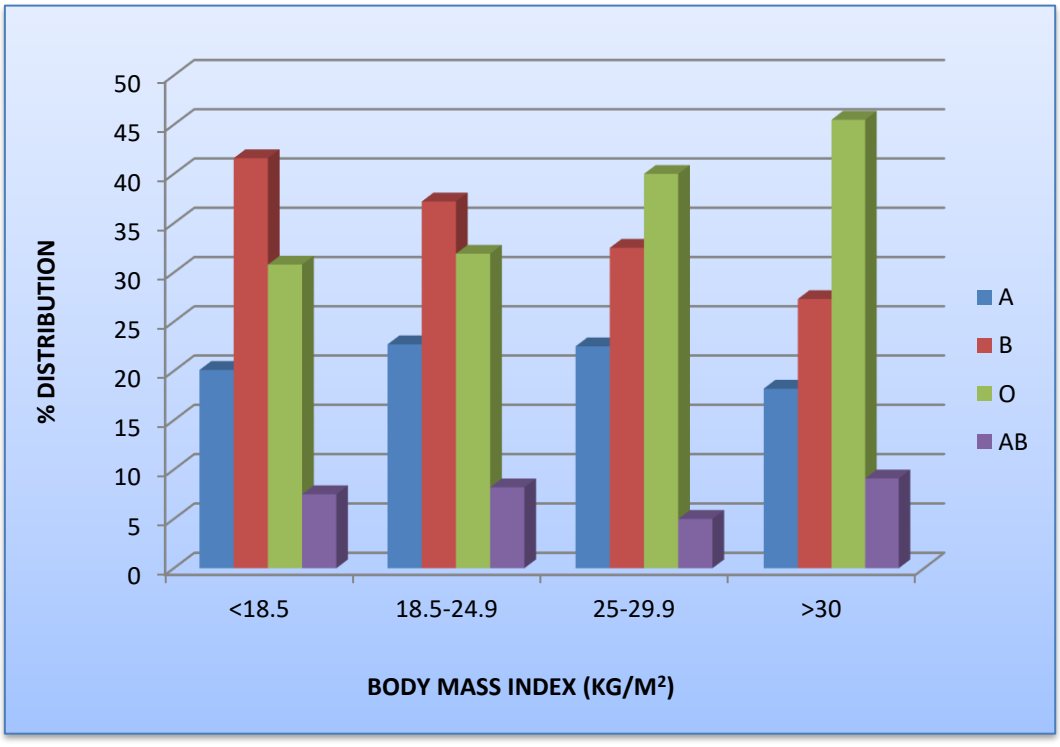

Fig. 3. BMI based blood group distribution.

The frequency of different genotypes responsible for different blood groups was calculated using Hardy Weinberg equation (Table-2). It was observed that the genotype of blood group "B" (0.386) is higher followed by the genotype of "O" (0.324). Similarly the observed genotype of Rh^{+ve} group is higher (0.932) when compared to Rh^{-ve} (0.068) genotype. It was also inferred that the observed frequency and the expected genotypic frequency for both blood groups and Rh antigen were almost same.

The students were classified according to their Body Mass Index (BMI) and their blood group was tabulated accordingly (Figure-2 & 3). In boys it was observed that 45.1% members were underweight, and the population of over weight boys was only 6.7%. It was observed that irrespective of BMI the "B" blood group was predominant in all the category and "AB" blood group was the least recorded blood group.

In girls the underweight students constituted 45.7% and the overweight girls population was 11.4%. In girls "B" blood group was more in Underweight and Normal weight category where as "O" blood group was high in over weight category. In general out of 472 students 214 (45.3%) were under weight and only 2.3% of the students were obese.

Inheritance pattern of Rh Antigen with reference to BMI in boys and girls was tabulated in Table 3.

Table 3. Relationship of Rh Antigen with reference to BMI.

BODY MASS INDEX	**Rh FACTOR**					
	Rh^{+ve} (%)		**Average**	**Rh^{-ve} (%)**		
	Boys	Girls		Boys	Girls	Average
<18.5	92.8	90.8	91.8	7.2	9.2	8
18.5 – 24.9	93.6	95.7	94.7	6.4	4.3	5.4
25 – 29.9	100	100	100	0	0	0
>30	60	100	80	40	0	20
TOTAL	92.9	93.1	93.2	7.1	6.3	6.7

It was observed that there is no much BMI dependent changes in the frequency of presence of Rh^{+v}e Antigen. However in normal weight category 100% of boys and girls were Rh^{+ve}. Finger print pattern of students were correlated with their blood group inheritance pattern (Figures – 4, 5 & 6). It was observed that more common finger print pattern in boys is loop (56.5%), followed by whorl (30.6%) and arch (12.8%). Similarly in girls also similar pattern of inheritance was observed (Loop-57.7%, whorl-29.1% and arch-13.1%). There is no gender dependent pattern distribution. Both boys and girls with loop & whorl type of finger print pattern the frequency of "B" blood group was more in frequency followed by "O". Whereas in boys with Arch type "A" blood group is more followed by "O" and in girls with arch type of finger print pattern "A & O" blood groups were in same frequency.

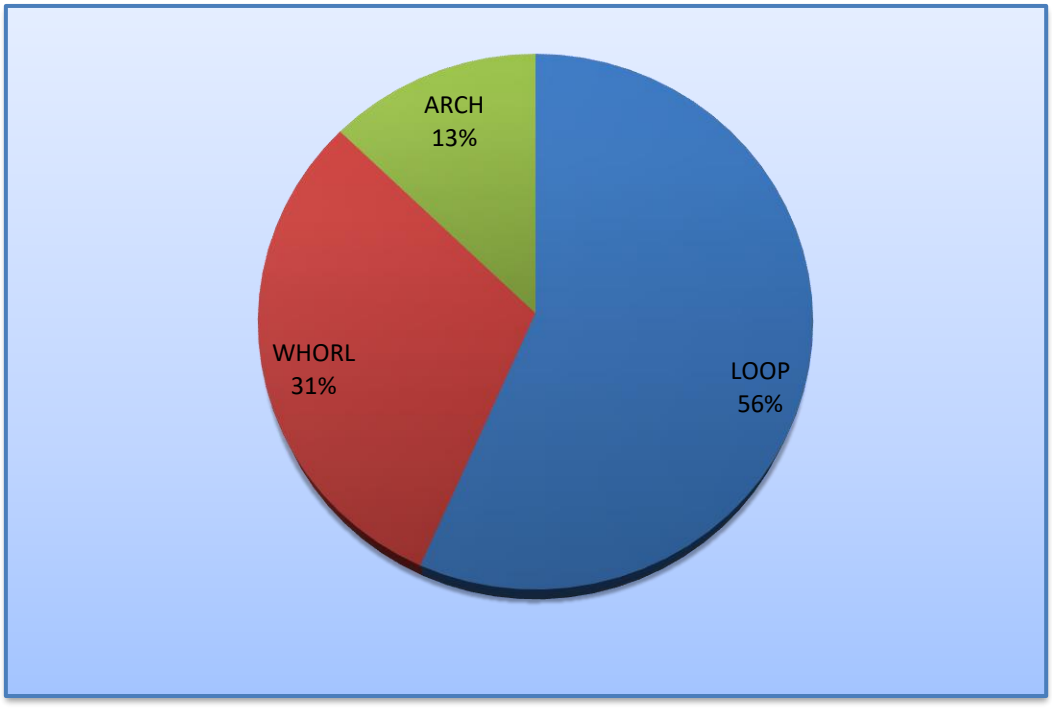

Fig. 4. Finger Print pattern in BOYS.

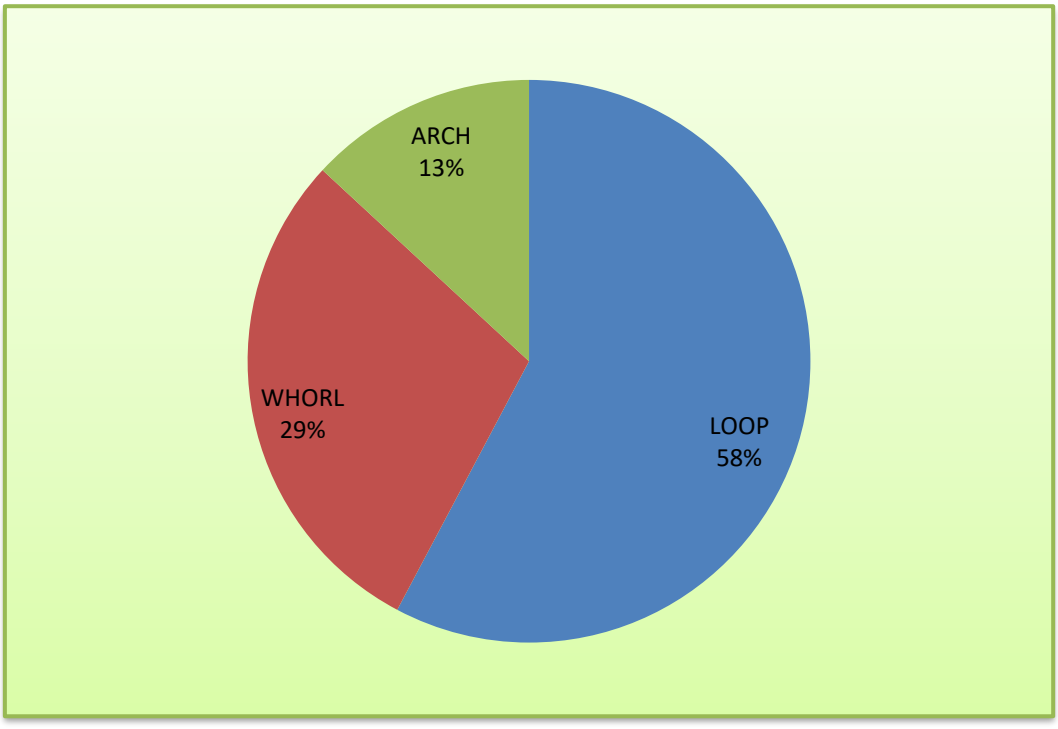

Fig. 5. Finger Print pattern in GIRLS.

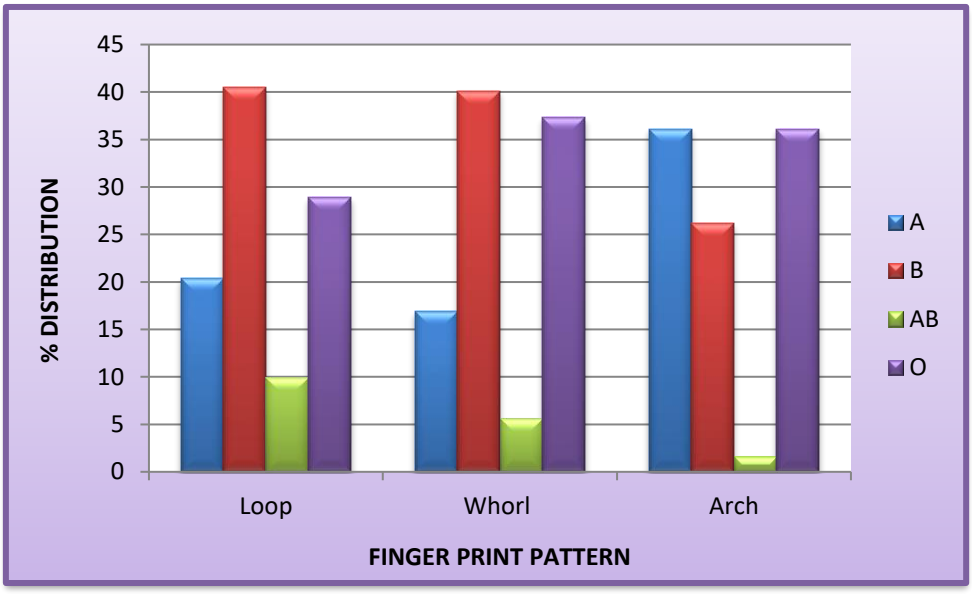

Fig. 6. Blood group distribution compared with Finger print pattern

Inheritance of Rh^{+ve} antigen also followed similar pattern of inheritance as like blood group ie, more Rh^{+ve} persons have "loop" type followed by whorl type of finger print pattern in both boys and girls (Table 4).

Table 4. Relationship of Rh Antigen with Finger Print patterns.

Finger Print	Rh FACTOR					
	Rh^{+ve} (%)		Average	Rh^{-ve} (%)		
	Boys	Girls		Boys	Girls	Average
Whorl	89	96	92.5	11	4	7.5
Loop	96.4	94.1	95.3	3.6	5.9	4.8
Arch	87.2	86.9	87.1	12.8	13	12.9
TOTAL	92.9	93.3	93.3	7.1	6.3	6.7

4. DISCUSSION

Blood groups plays an essential role in human evolution, genetic research etc. and is quite good evidence that individuals with particular blood groups are associated with selective diseases like diabetes mellitus, duodenal ulcer, erythroblastosis foetalis etc. The present study was undertaken to evaluate the frequency distribution of different blood group as well as its

distribution in relation to community, Body Mass Index and Finger print pattern among the students.

According to Lyko et al (1992) In Asian and Caucasians the prevalence of Blood group B is more followed by the sequence O, A and AB. In the present study involving 472 students (Boys-297, Girls-175) it was observed that "B" blood groups is predominantly present followed by "O", "A" and "AB" group, and about 93% of the students were Rh^{+ve}. There is no Gender dependent change.

Mahapatra et al (2014) observed that "B" blood group is the commonest blood groups in Northern and Western India whereas Eastern, Southern and Central India "O" is the most frequently occurring blood group. Suresh et al 2015 in Tirupati (AP) observed the distribution of blood group in the donor population as follows B(40.8%) > O(30.5%) > A(21.1%) > AB(7.6%). Eboh 2020 in Delta state University Abraka, Nigeria identified that female students had higher percentage of blood group O and B while male had higher percentage of Blood group A. Mahapatra et al 2014 have found the distribution of blood groups in the following order from more frequency to less frequency A>B>AB>O in the blood bank of Medical College and Hospital Cuttack, Odisha Eastern India.

Table shows the Frequency of ABO groups in different world population (Agarwal et al 2014).

Population	A	B	AB	O
India	22.88	32.26	7.74	37.12
Pakistan	21.15	40.76	7.56	30.50
Bangladesh	25.40	31.10	9.7	33.80

"O" group is the most frequently observed blood group followed by B, A & AB among the Desuri Reddis of Chittoor District, Andhra Pradesh (Reddy and Sudha 2009). Sai Prasad et al 2018 observed that in blood donors' population of Tirupati (AP) the frequency of blood group is as follows O^{+ve} (44.5%), B^{+ve} (40.8%), A^{+ve} (6.3%, AB^{+ve} (4.28%), B^{-ve} (1.8%), O^{-ve} (1.06%).

Allelic frequency of blood group and Rh alleles in different regions of India is tabulated along with the present study. In all the studies including the present study, it was observed that allele "O" was predominant followed by "B". In all studies the well established fact that the frequency of "D" (Rh) alleles is more, the present study also confirms the same.

ABO system and Rh phenotype allele distribution in different studies							
Location	**Author**	**Year**	**I^A**	**I^B**	**I^O**	**I^D**	**I^d**
Present study		2020	0.164	0.267	0.569	0.7393	0.2607
Srinagar, Uttarkand	Kumar et al	2017	0.2403	0.2475	0.5122	0.7452	0.2548

Surat, Gujarat	Raja et al	2016	0.1844	0.2477	0.5679	0.7794	0.2206
Tirupati (AP)	Suresh et al	2015	**0.1398**	**0.2148**	**0.6454**	**0.7321**	**0.2679**
Different parts of India	Agarwal et al	2014	**0.1653**	**0.2254**	**0.6093**	**0.7679**	**0.2321**

It was observed that the genotype of blood group "B" (0.386) is higher followed by the genotype of "O" (0.324) and the observed and expected genotypic frequencies did not differ significantly. Similar results were observed by Raja et al (2016) among the blood donors in tertiary care hospital of South Gujarat, India. In the present study in both genders "O" blood group was more commonly present in "OC" community where as in "BC, MBC and SC" it is "B". It was also observed that Rh^{+ve} is more in both sexes of "SC" communities, whereas it is marginally low in "OC" boys and "MBC" girls. Thakare (2015) among 100 girl's (in Maharastra) according to caste and category has observed that OBC – 14% O^{+ve} , 29% B^{+ve} and 13% A^{+ve} . In the present study irrespective of gender the percentage of underweight students was so significant (45%) and "B" blood group was more common among the students with BMI (Body Mass Index) below 24.9 kg/m^2. Though the numbers of Overweight and Obese students were less in the present study the blood group "O" is more common among them. Similar results were observed by Shireen Jawed et al (2018) in UG girl students of Faisalabad Medical college individuals with blood group "O" a more to be more prone to being overweight and Obese (29.7%). Jayakumar and Shruthi 2019 has observed that out of 1514 male donors at Karnataka more obese persons were belonged to blood groups "O" followed by blood group B, A and AB. Even though the blood group is a non modifiable risk factor, having knowledge of association between obesity and blood group can help to make healthy life styles. These healthy life styles can be implemented in early life of at risk individuals as a preventive measure before the development of obesity and its complications. Although obesity is very common in South India, studies on blood groups in obese individuals from rural Indian areas are lacking (Jayakumar and Shruthi 2019). The following table explains the disorders associated with the blood groups and the recommendations for blood group based balanced diet (DAdamo et al 1996 & Azhagiri et al 2018).

Blood Group	**Nature of Blood**	**Diet suggestion**	**Disorders**
A	Thicker blood and sensitive immune system	Should stick to fruit and vegetable (high carbs/low fat). Should not consume dairy product, animal fats and meat	Risk of cardiovascular disease, Diabetes, cancer, Gastric ulcer, Anemia, Gastritis, Aheumatoid Arthritis, Osteoarthritis

B	Have vast chance of by-passing or overcoming everday types of diseases, including heart disease and cancer.	Should consume balanced diet (fruits, vegetable, grains., fish, dairy but avoid chicken)	Ovarian Carcinoma, Anemia Gastritis, Diabetes, Hypertension
AB	--	Should consume only vegetable diet and only on a rare occasions some fish meat and dairy.	Hypertension, Gastritis, Peptic ulcer, Bronchial asthma
O	Thinner blood with greater resistance to blood clotting.	Should limit the intake of wheat, whole meat products, corn and avoid dairy products and most nuts	Affected with Hypothyroidism and high stomach acidity, Duodenal ulcer, Bronchial asthma, Hypertension, diabetes

In the present study it was observed that in the left thumb impression "Loop" type of finger print pattern is the commonest followed by "Whorl" and "Arch" type in both genders. In "Loop & Whorl" type of Finger Print "B" blood group is common followed by "O", whereas in "Arch" type "A" blood group is more frequent followed by "O". Similar result was observed by Shivhare et al (2017) among the Government Medical College students of Chhattisgarh India that in both males and females the occurrence of loops is more followed by whorls and arches. However Prateek and Keerthi (2010) reported that females have higher frequency of loops and arches compared to males with higher frequency of whorls. Eboh (2020) in Delta state University Abraka, Nigeria identified that female students had higher percentage of loop and whorl while male had higher percentage of arch.

5. CONCLUSIONS

- In both boys and girls most frequently observed blood group is "B" followed by "O" and "A".
- "AB" blood group is the rarest in both sex.
- In both boys and girls 93% are Rh^{+ve} and 7% are Rh^{-ve}.
- Allelic frequency of I^O is higher followed by I^B, I^A
- Allelic frequency of (Rh Allele) $I^D = 0.7393$ and $I^d = 0.2607$.
- Actual distribution of ABO blood group did not differ significantly from the calculated Genotypic frequency.
- In BMI below 24.9 (Under weight and Normal weight) "B" blood group is more and "O" blood group is more in over weight and obese category.
- "Loop" is the commonest Finger Print type present in both sexes (56% & 58%).
- In "Loop & Whorl" type of Finger Print "B" blood group is common followed by "O", whereas in "Arch" type "A" blood group is more frequent followed by "O".

References

[1] Agarwal A, Aseem Kumar T, Mehta N, Prasun B, Ravi W, Sunta T, Susheela K, ABO and Rh (D) group distribution and gene frequency; the first multicentric study in India. *Asian J Transfus Sci* 8(2) (2014) 121-125

[2] Azhagiri R, Anitha M and Hemapriya J, Analysis of left thumb print pattern among different human blood groups. *Int J Anat Var* 11(3) (2018) 103-106

[3] Behera S, Ayaskant S and Satyanarayana P, Relationship of blood group with body fat Percentage, visceral fat, and waist-hip ratio. *Nat J of Phy Pharm and Pharmacology* 6(6) (2016) 591-595

[4] Cummins H and Kennedy R W, Physiological Examination of visual organ and of the cutaneous system. *Am J Crim Law Criminol* 31 (1940) 343-356

[5] D'Adamo, Peter J and Whitney C. 1996. Eat right 4 your type. The individualized Diet solution to staying Healthy, living longer and Achieving your ideal weight. New York: Putnam.

[6] Eboh DEO, Fingerprint patterns in relation to gender and blood group among students of Delta State University Abrka Nigeria. *J of Expl and Clin Anatomy* 12 (2) (2020) 82-86

[7] Encarta, Microsoft Encarta Dictionary. *Microsoft Corporation* (2009) 1993-2008.

[8] Helix.com/genetics-body-mass-index-bmi-sec16b.

[9] Hoffbrand A V. Post Graduate Haematology. 2nd Edition, Heinmann Professional Publishing Ltd, London U.K. (1981) 270-350

[10] Jafari E, Sebghatollahi V, Kolahdoozan S, Elahi E and Pourshams A, Body mass Index and ABO Blood Groups among different Ethinicities of the Folestan Cohort Study subjects. *Govaresh* 17(1) (2012) 50-54

[11] Jayakumar P and Shruthi B, ABO Blood Groups and Risk for Obesity: A retrospective stury from Rural Tertiary Care Hospital of South Karnataka. *Int J of Health Sci and Research* 4(3) (2019) 16-19

[12] Joseph, P.V., Jaime-Lara, R.B., Wang, Y. *et al.* Comprehensive and Systematic Analysis of Gene Expression Patterns Associated with Body Mass Index. *Sci Rep* 9, 7447 (2019). https://doi.org/10.1038/s41598-019-43881-5

[13] Kaslick R S, Chasens A I, Tuckman M A and Kaufman B, Investigation of Periodontosis with periodontitis: Literature survey and findings based on ABO blood groups. *J. Perodontol* 42 (1971) 420-427

[14] Kumar S, Modak P K, Ali S H, Barpanda S K, Gusain V S and Roy R, A retrospective study: ABO and Rh phenotype blood group distribution among blood donors in H.N.B. Base Hospital Srinagar Uttarkhand India. *J of Family Med and Pri Care* 7 (2018) 34-38

[15] Lyko J, Gaertner H, Kaviti J N, Karithi M W and Akoto B, The blood groups antigens ABO Rh in Kenyans. *Hamdard Medicus* 35 (1992) 59-67

[16] Mahapatra S, Sahoo D, Patjoshi S, Sahu A, Parida P and Mishra S, Distribution and Prevalence of ABO and Rh Phenotype Blood Groups in Eastern India. *Pharm Biomed Sci* 4(8) (2014) 712-714

[17] Nield L and Kelly S, Outcomes of a community based weight management programme for morbidly obese populations. *J Hum Nutr Diet* 29(6) (2016) 669-676

[18] Offenbacger S, Periodontal diseases: Pathogenesis. *Ann Periodontol* 1 (1996) 821-878

[19] Parveen N, Rehman J, Hafeezul Hassan S, Hassan Z, Rehman M, Different blood groups; association with body mass index in Medical students of Karachi. *Prf Med J* 23(8) (2016) 1001-1004

[20] Prateek B and Keerthi R P, A study of fingerprints in relation to gender and blood group. *J Indian Aead Forensic Med* 32(1) (2010) 11-14

[21] Raja K A, Dobariya G H, Unagar C A, Pandya A N, Patel J N and Wadhwani S J, Frequency and distribution of ABO and Rh blood groups among blood donors in tertiary care hospital of South Gujarat India, *Int J Res Med Sci* 4(12) (2016) 5377-5381

[22] Raja K A, Gopi H D, Chirag A U, Amrish N P, Nitendra N P and Sangita J W, Frequency and distribution of ABO and Rh blood groups among blood donors in tertiary care hospital in Gandhinagar Gujarat India. *Indian Journal of Pathology and Oncology* 4(12) (2016) 5377-5381

[23] Rajesh Kumar C, Puja S, Vivek V B, Amit H, Shweeta R, Sawke G K, Shalaka A and Nilima S, A study of distribution of ABO and Rh blood group system among blood donors of a tertiary care hospital. *J. Evolution of Med and Dent Sci* 4(18) (2015) 3138-3142

[24] Reddy K S N and Sudha G, ABO and Rh (D) Blood Groups among the Desuri Reddis of Chittoor District, Andhra Pradesh. *Anthropologist* 11(3) (2009) 237-238

[25] Ruth McPherson, Genetic contributors to Obesity. *Can J Cardiol* 23 (2006) 23-27

[26] Sai Prasad B V, Khader Faheem M D and Rajesh Krishna N V H, Demographic distribution and prevalence of ABO and Rhesus Blood Groups in Blood Donors: Study from a Tertiary Care Centre in Southern Region of Andhra Pradesh. *IOSR J. Of Dental and Medical Sci* 17(7) (2018) 1-5

[27] Shireen J, Komal A, Saba T and Farah A, How good is the obesity associated with blood groups in a cohort of female university going students? *Pak J Med Sci* 34(2) (2018) 452-456

[28] Shivhare P R, Sharma S K, Ray S K, Minj A and Saha K, Dematoglyphic Pattern in relation to ABO and Rh Blood Group and Gender among the population of Chhattisgarh. *Int J of Sci Study* 4(11) (2017) 61-65

[29] Suresh B, Sreedhar Babu K V, Chandra Mouli P, Arun R and Jothibai D S, Distribution of ABO and rhesus blood group antigens among blood donors at a tertiary care teaching hospital blood bank in South India. *J Clin Sci Res* 4 (2015) 129-135

[30] Sutton H E, An Introduction to Human Gentics. 3rd Ed. Philadelphia USA: Saunders College (1980) 592.

[31] Tanzil S and Jamali T Obesity, an emerging epidemic in Pakistan – a review of evidence. *J Ayub Med Colle Abbottabad* 28(3) (2016) 597-600

[32] Thakare K K, Survey of blood groups among 100 girl's according to caste and category wise. *Adv. Res. J. of So. Sci* 6(2) (2015) 181-185

[33] Verma P S, Agarwal V K, Genetics, S. Chand & Company Ltd New Delhi (1995) 173-185, 475-494.

[34] Yang X, Xiaojun J, Yixuan Z and Hui L, Genetic rules for the dermatoglyphics of human fingertips and their role in spouse selection: a prelimnary study. *Springerplus* 2016; 5(1): 1396. doi: 10.1186/s40064-016-3072-x