# Variations of ABO Blood Groups. Gene Frequencies in the Population of Sindh (Pakistan)

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**The survey was carried out of allelic frequencies of ABO alleles in the population of different cities of Pakistan (Larkana, Jamshoro, Hyderabad, Karachi) and in different ethnic groups (Abro, Noohani and schedule cast Hindus). The analysis shows that there is no any constant pattern except the general fashion of blood group distribution i.e. the O group has highest frequency, A and B are in the mid and AB blood group is at least of all. Percentage distribution of ABO and their allelic frequencies are described in the districts/cities of the province of Sindh, Pakistan. Relationship between the distribution of ABO phenotypes and gene frequencies are discussed. A significant decrease in the AB phenotypes is seen in the cities. The average gene frequencies for ABO groups in the population of Sindh are 0.1972 + 0.017, 0.2104 + 0.019, 0.5986 + 0.015, for A, B, O respectively. The average percentage distribution out of total 49061 cases the distribution of blood groups was A = 25.83%, B = 28.17%, O=37.78% and AB = 8.30%.**

**Key words: ABO blood groups, pattern of inheritance.**

Blood transfusion used to be a risky operation as it is potentially dangerous drug. Some persons could accept the blood transfusion of other persons without complete injury, while with others, transfusion led to serious illness. Karl- Landsteiner found that people can be divided into four blood groups[1], now called as groups A, B, O, and AB. Blood groups are inherited according to Mendel's law, through three variant forms of a gene (IA, IB, IO). Antigens are inherited as mendelian allelomorphs, A1, A2, and B being dominants[2].

Brothers and sisters, parents and children may and quite often do, belongs to different blood groups. During world war 1, when many persons were in need of blood transfusions, it was discovered that the frequencies of four blood groups are rather different in persons native to different parts of the world. The incidence of individuals belonging to A,B,O and AB blood groups is different in different human populations. Boyd made an attempt to classify the racial groups of mankind according to incidence of known blood group[3,4,5]. Frequency distribution of blood groups has been investigated in different populations of the world and variations within population have been reported.

Several numerous investigations have been made and published since then specially in recent years to map the geographic distribution of blood groups. Shivaraman et al. (1971)[6] showed higher frequency for B allele in Punjab (India) than in Utter Pardesh (India). Regional and temporal variations in the ABO and Rh blood group allele frequencies in the country of Vesterbotten in northern Sweden were investigated by Beckman et al[7]. Imaizumi showed longitudinal and latitudinal clines for allele O in Great Britian. Shami and Kamboh investigated southwestward and northwestward clines for frequencies of alleles A,B,O and d in Punjab (Pakistan) [8,9]. Shami and Siddiqui investigated the clines for frequencies of alleles A,B,O and d in the Northern and Southern population of Sindh (Pakistan)[10]. Turaeva et al discovered the geographic and ethnic differentiation of Turkmen population among five distinct and main Turkman tribes[11].

The present study is also an attempt to establish the frequency distribution of ABO alleles in the population of different cities of Sindh (Pakistan). In different ethnic groups, the pattern of inheritance of blood group and the effect of different factors (genetic drift, migration breeding pattern) effecting the frequencies of ABO alleles. Walter et al investigated ethnic variability of ABO blood groups polymorphism in Iran and assumed that specific ABO allele frequencies found in different ethnic groups are connected with their different geographical origin[12].

Proper understanding of human blood group system made possible the safer and beneficial transfusion. Nowadays, at present the research on blood groups system have different aims. Now it insighting the pattern of inheritance, frequencies of genes controlling blood groups, nature of the genes and their products, associations with different other characteristics and diseases. The mode of inheritance of blood group, the genes that control them and the frequencies of the genes in population is of great interest to geneticists. The frequency of different types of blood groups particularly the ABO is also important from anthropological point of view[13]. At present researches on blood group system is advancing in different directions. Comprehensive research work on the relationship between heredity blood factors and the disease have been done in the past. Different factors are found to be associated with skin psoriasis, within last few years it has been shown that there is an association between ABO groups and certain diseases[14]. Just a few years back this blood group system was considered to be natural as far as the fitness is concerned. The recent workers however, have shown that a definite relationship exist between the ABO system and a few

diseases[15,16,17,18]. Moreover the blood groups are not natural to selection and fitness. It is interesting to find out that this has been most clearly demonstrated in the case of disorders of upper intestinal tract where the secretion of blood group substances is the highest. The strongest relation-ship is between duodenal ulceration and group O[19]. Cancer of stomach in individuals with group 'A' than in groups 'O' and 'B'. There is also strong evidence of an association between pernicious anaemia and diabetes-mellitus with group 'A'.

Most individuals secrete water-soluble blood group substance in saliva. Blood typing helps in finding paternity. It has importance in medico-legal paternity cases[2]. Blood is most precious fluid in the body, a fact expressed in such common terms as "The life blood".

**Results**

The mean for the percentage of ABO blood group out of 49061 of subjects belonging to different districts/cities of Sindh and different ethnic groups is A = 25.83%, B = 28.17%, O = 37.78% and AB = 8.30%. While for different cities, it is for Larkana A = 25.40, B = 32.09, O = 33.33 and AB = 9.18, for Karachi, A = 19.38, B =19.62, O = 40.78 and AB = 20.21, for Jamshoro, A = 23.67, B = 24.65, O = 48.99 and AB = 2.69, for Hyderabad, A = 15.60, B = 21.79, O = 60.15 and AB = 2.99, and for different ethnic groups, e.g. for Abro A = 46.67, B = 40, O = 13.33 and AB = 0.0, for Noohani A = 31.25, B = 31.25, O = 18.75 and AB = 18.75, and for schedule casts (Hindu, Bheel and Coolhi) A = 18.86, B = 27.76, O = 49.11, and AB = 4.27.

The mean frequencies of ABO blood alleles and the chi-square contribution (x23) is A = 0.1972 + 0.017, B = 0.2104 + 0.019, O = 0.5986 + 0.015 and x23 = 108.0639 while for different cities is, for Larkana A = 0.1891 + 0.0030, B = 0.2315 + 0.0037, O = 0.5773 and x23 =1.8065, for Karachi A = 0.1370 + 0.012, B = 0.1385 + 0.012, O = 0.6387 + 0.0155 and x23 = 598.5692 for Jamshoro A = 0.1525 + 0.0036, B = 0.1582 + 0.0027, O = 0.6999 + 0.0072 and x23 = 136.7518, for Hyderabad A = 0.0948 + 0.0032, B = 0.1294 + 0.0038, O = 0.7756 + 0.0040 and x23 = 0.1820 and for different ethnic groups is for Abro A = 0.4094 + 0.023, B = 0.3652 + 0.016, O = 0.3651 + 0.19 and x23 = 17.94, for Noohani A = 0.2741 + 0.0115, B = 0.2741 + 0.0115, O = 0.433 + 0.076 and chi-square = 1.1895 and for schedule cast(Hindu, Bheel and Coolhi), A = 0.1236 + , B = 0.176 + , O = 0.7008 + and x23 = 0.0083.

**Discussion**

Since from the discovery of ABO blood groups by landsteiner the blood grouping remains important in past as well as at present it plays important multiple role not only in transfusion but in relation of transplant surgery, hereditary diseases, genetics and migration of different races of the world[1]. As the blood group ABO are inherited by three variant genes A,B and O of which the A and B are Co-dominant to each other and dominant over O. The frequencies of these genes are variable in different nations, areas, and even in different ethnic groups of same area. According to Hardy-weinberg law the frequencies of the members of a pair of allele in a population are described by the expansion of the binomial equation. Mather, K, describes that if the members of the population are mating randomly and if no other factors are effecting allelic frequencies then the frequencies of various pairs of alleles should be very closed to those calculated with the Hardy-weinberg formula[20]. The factors that can effect the constancy of gene frequencies, are genetic drift (migration) and gene flow. The clines of gene frequency in man may be explained by the migration and inter-marriage of different races and also due to geogrophical differences in selection intensity with the diffusion effect of migration suggest that clines for ABO blood group gene frequencies in Japanese population show that the selection intensity may be primarily dependent on the temperature[21,22,23]. Shami and Kumboh5 considered that the temperature differences in the northern and southern Punjab are quite appreciable and it may be that the selection intensity there depends on temperature. They also showed that the age of the subjects is not associated with the changes in frequencies of ABO genes and likewise sexes show no differences in the distribution of these blood group genes.

The present study is carried out to estimate the ABO blood groups percentages and frequencies of ABO blood allele in different cities of Sindh (Pakistan) and in some different ethnic groups.

The results show that collectively the blood group 'O' has got the highest percentage (37.78), blood group 'AB' has the lowest percentage (8.30). It confirms the already existing fact that in Pakistan 'B' and 'O' groups are more prevalent as compared to 'A' and AB[24]. The pattern is similar to different cities of Pakistan i.e. in Quetta and in Multan [25,26]. In Sindh, here the collective percentage of blood group 'O' is some what lower in comparison to other cities of Pakistan. The percentage of group 'O' in Larkana is less i.e. (33.33) and in the ethnic groups of Noohani (18.75), Abro (13.33) where the percentage of blood group 'O' is lower even than the blood group 'A' and 'B'. In similar manner the mean of ABO blood alleles has got similar pattern i.e. the 'O' allele has highest frequency (0.5986) followed by the 'B' allele (0.2104), slightly lower to it is of 'A' allele (0.1972). the pattern is similar to the distribution of these alleles in different cities of Pakistan i.e. Multan (O = 0.5469, B = 0.2692 and A = 0.1815)[26]. The pattern is also similar to the pattern in some different parts of India i.e. Muslim group of Gujrat (O = 0.61, B = 0.22 and A = 0.20), Paphia et al. (1981)27, Sikhs of Punjab (O = 0.61, B = 0.21 and A = 0.20) and Kangra Rajput's of Himachal Pardesh (O = 0.59, B = 0.21 and A = 0.20)[28,29], while it is quite different from that in USA (O = 0.6708, B = 0.0708 and A = 0.2578), UK (O = 0.6856, B = 0.0560 and A = 0.2578) and Germany (O = 0.6557, B = 0.0792 and A = 0.2663) where the 'A' allele has significantly higher

frequency then 'B' allele but the blood 'O' allele has similarly highest frequency. In Vietnam a similar pattern to us, is found (O = 0.6708, B = 0.1894 and A = 0.1421). Though in general, collectively our total results follow the same pattern as of different cities of Pakistan and India but if we consider individually different cities and different ethnic groups we can see significant variations in the blood group percentages and in the frequencies of ABO blood alleles. The mean chi-square contribution (x23=108.0639) shows that overall our population is not at an equilibrium. The reason for that are may be mainly the genetic drift and gene flow. If we consider individually different cities the x23 values (Table2) shows that city Larkana (1.8065) and Hyderabad (0.1820) are at an equilibrium state while the city of Karachi (x23=598.5692) and Jamshoro (x23=136.7518) has very significant x23 values and are not at equilibrium state. This may be mainly because of the heterogenity of the population of these cities. In the similar manner the ethnic groups of Noohani (1.1895) and Hindu (0.0083) are at equilibrium state while the ethnic group of Abro (17.9400) is not at equilibrium state, while all of these three have similar pattern of marriages i.e. they strictly marry in their own ethnic groups and equilibrium here can be reason at least for Hindus (Bheel and Coolhi) that the effect of gene flow (i.e. their mating habits) are neutralizing by the genetic drift (i.e. migration). they tend to live in the form of small tribes. In this way they may have developed a variable distribution from tribe to tribe which collectively gives them an equilibrium state. This pattern is also quite different to one those of Australian Aborigines who have only group 'O' and 'A'[24].

Table:1 Distribution of Phenotypic Frequencies of ABO blood groups in the general population of Sindh (Pakistan).

| City | Blood Group A | Blood group B | Blood group O | Bloodgroup AB |
|---|---|---|---|---|
| Larkana | 25.40% | 32.09% | 33.33% | 9.18% |
| Jamshoro | 23.67% | 24.65% | 48.99% | 2.69% |
| Hyderabad | 15.60% | 21.79% | 60.15% | 2.99% |
| Karachi | 19.38% | 19.62% | 40.78% | 20.21% |
| Abro | 46.67% | 40.0% | 13.33% | 0.0% |
| Noohani | 31.25% | 31.25% | 18.75% | 18.75% |
| Hindu(Bheel & Coolhi) | 18.86% | 27.76% | 49.11% | 4.27% |
| Mean | 25.83% | 28.17% | 37.78 | 8.30% |

Table:2 ABO blood allelic frequencies and Chi-square contributions in general population of Sindh (Pakistan).

| City | A | B | O | X23 | P |
|---|---|---|---|---|---|
| Larkana | 0.1891+0.0030 | 0.2315+0.0037 | 0.5773+0.0082 | 1.8065 | 0.95 |
| Jamshoro | 0.1525+0.0036 | 0.1582+0.0027 | 0.6999+0.0072 | 136.7518 | 0.01 |
| Hyderabad | 0.0948+0.0032 | 0.1294+0.0038 | 0.7756+0.0040 | 0.1820 | 0.01 |
| Karachi | 0.1370+0.0120 | 0.1385+0.0120 | 0.6387+0.0155 | 598.5692 | 0.01 |
| Abro | 0.4094+0.023 | 0.3652+0.016 | 0.3651+0.19 | 17.9400 | 0.01 |
| Noohani | 0.2741+0.0115 | 0.2741+0.0115 | 0.4330+0.076 | 1.1895 | 0.99 |
| Hindu | 0.1236+0.017 | 0.1760+0.019 | 0.7008+0.015 | 0.0083186 | 0.95 |
| Mean | 0.1972+0.017 | 0.2104+0.019 | 0.5986+0.015 | 108.0639 | 0.01 |

(Table 3) shows the observed phenotypic frequencies, number and percentage observed with total number.

**Conclusion**

The variability of the distribution of ABO blood group and their allelic frequencies, the presence of equilibrium, even in the presence of factor like genetic drift and gene flow shows that the ABO frequencies depends upon a complex interaction between the factors effecting the gene frequencies. It is not necessary that the presence of two factors will tighten the effects of each other but the presence of one can neutralize the effect of others. The variation in gene frequency may be due to random genetic drift or may be due to patern of marriages[30,31]. The variation may be due to balanced effects of natural selection[32]. The possible explanation could be that selection is working against these phenotypes (The phenotypes having low frequencies for example AB)[5]. Mourant suggests that certain blood group phenotypes are more susceptible to certain diseases resulting in loss of fertility[33]. This would be an important selective factor under certain conditions. Gene frequency will be found different from country to country, city to city, nation to nation and ethnic groups to ethnic groups, and even time to time. It also seems that the variability in the gene frequencies is inversely proportional to the size of population or number of persons in comparison.

**References**


1. Landsteiner, K. 1901. Uber agglutination-reehenugen Narmalen Menschlihen blutes wein. Klin Wehschr 14:1132-1134.
2. William F. Ganong 1971. Rewiew of medical Physiology LMP. LOS ALTOS, california PP-382-383.
3. Boyd, W.C., 1950 Genetics and races of man. Boston: Little Brown: 335-342.
4. Boyd, w.c., 1953. The contribution of genetics to anthropology.PP 488-506. In: A Kroeber Anthropology, chicago, University of Chicago Press.

5. Shami, S.A., and Kumboh, M.I., 1979. Variation of ABO and Rh blood group Gene frequencies in the population of Punjab (Pakistan)-I. Biologia, 25 (special suppl.) 71-84.
6. Shivaraman, E. K., Saran, R. K. and Bhatia, H.M., 1971. The distribution of ABO and Rh blood groups in north Indian population. Hum Hered., 21:326-333.
7. Beckman,L., Cedergren, R., Collinder, E. and Rasmuson, M., 1972. Poulation studies in northern Sweden. III. variation of ABO and Rh blood group gene frequencies in time and space. Hereditas, 72: 183-200.
8. Imaizumi, Y., 1974. Genetic structure in United Kingdom. Hum. Hered., 24: 151-159.
9. Shami, S.A. and Kumboh, M.I., 1979. Geographic and age related variations in the gene frequencies of ABO and Rh blood groups in the population of Punjab, Pakistan-II. Biologia, 25 (special suppl.): 85-90.
10. Shami, S.S., and Siddique Z.H., 1992. Geogrophic and age related variations in the allele frequetions ABO and Rh blood groups in the population of Sindh, Pakistan. J. syst. And Exp. Biol. 2 (2), pp-123-138.
11. Turaeva, S.H.M., GLNTER, E. K., Revazov, A. A., Gar, Kavtseva, R.F., Kiyatkhanov, B. A., Chagylov, K. B., Sat Nikova, E. N., Solovieva N. P and asanov, A. Yu., 1984. Medicogenetical Studies of the population of Turkmen SSR, USSR: IV population geogrophy at hemoglobino-pathies. Genetica, 20: 1536-1541.
12. P. 1991. Investigation on the ethnic variability of ABO blood group polymorphism in Iran. Z. Morphol. Anthropol., 78(3): 289-306.
13. Walter, H., Farhud, D. D., Danker-Hopfe, H. and Amirshahi. P., 1991. Investigation in the ethnic variability of ABO blood group polymorphism in Iran. Z. Morphol. Anthropol., 78(3):289-306.
14. Islam, S. and Khan, I. M., 1978. Analysis of the gene frequencies of ABO and Rh blood group systems in Basrah, Iraq. Biologia. Vol. 24, no. 2. PP 409-411.
15. Abdul Ghafoor Qamar. 1996. Association of Psoriasis with ABO blood group system and Rhesus antigen. Specialist, Pakistan's. J. Med. Sci. Oct-Dec. Vol. No.1 PP-85-89.
16. Aird, I, Bentall, H. H. & Roberts, J. A. F. 1953. A releationship between Cancer od Stomach and ABO blood groups. Birt. Med. J. 1:799.
17. Jergensen, G. 1967. The ABO blood groups Polymorphism in the multifactorial Genetic System. Humangenetik 3:264.
18. Vogel, P., Pettenkoper, H. J. & Helmbold, W. 1960. Uber die populations genetik der ABO-Blutgruppen. Acta genet (Basel) 10:267.
19. Vogel, P & Kruger, U. J. 1968. Satistiche Beziehungen Zwischen den ABO-Blutgruppen une Krankheiten mit Ausnahme der infektionnakrankheiten. Blut.
20. Odeighah-PG. 1990. Influence of blood groups and secretor genes on suspectibility to duodenal ulcer. East-Afr-Med-J. Jul; 67(7):487-500.
21. Mather, K. (1949a), Biometrical Genetics (Istedn), Methuen, London.
22. Haldane, J. B. S., 1948. The theory of cline J. Genet., 48: 277-284.
23. Fisher, R. A., 1950. Gene frequencies in a cline determined by selection diffusion Biometorics, 6: 353-361.
24. Nei, M. and Imaizumi,Y. 1966a. Genetic structure of human population. I local differentiation of blood group gene frequencies in Japan. Heredity 21: 9-35.
25. Rathore, A.H., Arshad, M., Bajwa, S.A., and Hussain, R., 1993. ABO and Rh (D) blood groups in an industrial city of Pakistan. Pakistan's J Med Sci. Oct-Dec, vol.10, no.1: 59-62 ISSN 1017-4699.
26. Mian Afsar, Dasti, A.A. and Jabeen, F., 1985. Frequencies of ABO blood alleles in general human population of Quetta, Pakistan. J. Zool, 17 (3), PP.257-262.
27. Mian Afsar and Bhutta, M. Arif, 1993. Genetic studies on human population of Multan (Pakistan): Distribution of ABO and Rh blood alleles. Pakistan J. Zool. Vol. 25 (2) PP.149-151.
28. Papiha, S.S, Roberts, D.F., Shah, K.C and Shah, A.C., 1981. A genetic study of some Gujrat populations. Acta anthropologen, 5:23-40.
29. Chachal, S.M.S and Papiha, S.S, 1981. A poulation genetic study of the Jat Sikhs, Punjab, India. J. India Anthrop. Sco.16.251-260.
30. Chachal, S.M.S and Papiha, S.S, Roberts, D.F and sigh, I.P., 1982. Seriological and biochemical variation in gaddi tribes of Himachal Pardesh. India. Z. Morph. Anthrop., 73:197-208.
31. Wright, S. 1931. Evolution in mendelian populations. Genetics; 16: 73-88.
32. Wright, S. 1940. The statistical Consequences of mendelian heredity in relation to speciation. In the New Systematics ed. J. S. Huxley, Oxford.Ford, E.B. 1945. Polymorphism. Biol. Rev 20: 73-88.
33. Mourant, A.E. 1974. Blood group and diseases. Haematologia, 8: 183-194.