

Original Article

ABO, Rh, Gene Frequency: A Comparative Study between Different Countries

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ABSTRACT

People have always been fascinated by blood, ancient Egyptians bathed in it, Aristocrats drank it. Currently, 30 different blood group systems are known, 9 of which are considered to be the major blood group systems. The ABO and Rh blood groups are among the most important blood groups. Different population exhibits significant differences in the frequency of each blood group, so the aim of this work is to study the geographic variation and prevalence of ABO blood group, Rh factor and gene frequency of ABO blood group and Rh factor. The study was done on medical students from Egypt (Faculty of Medicine in Menofiya University), Libya (Faculty of Medicine in El Zawya-Al Gabal Algharby University) and India (Government Medical Collage Kashmir). ABO blood group and Rh were done by standard rapid tile method. The result of this study showed that blood group 'O' was the most prevalent in Libya and India (48.9% and 40.8%, respectively) followed by group A (37.9%) and group B (12.8%) in Libya, in India, A (20.9%) is second in prevalence followed by B (31.6%). In Egypt, blood group A (37.9%) is the most prevalent one, which is in contrast to previous studies where O was the most prevalent, which is now in second place (27%), followed by B (25.1%). All the three countries showed AB as the least common blood group in its population with the predominance of Rh positive. Expected A gene frequency in Egypt is the highest one (0.279), followed by Libya (0.214) and India (0.149). Gene B frequency is more prevalent in India than Egypt and Libya (0.215, 0.195 and 0.094, respectively), while O gene is more frequent in Libya (0.962), then India (0.637) and Egypt (0.526). In Libya and India, males showed high frequent blood group O (44.9% and 44.5%, respectively), while in Egypt both males and females showed high frequency of blood group A (41.7% and 33.3%, respectively). This work concluded that blood group O is the commonest blood group in Libya and India, whereas in Egypt there is a shift from previous prevalence of O blood group to now A. More than 85% of the population is Rhesus positive in all the three countries. A gene is more frequent in Egypt, B gene is more in India, while O gene is more in Libya. There is significant relation between ABO and gender.

Keywords: ABO blood groups, Rhesus, Variation, Population, Regions

INTRODUCTION

The ABO blood group system was the first to be discovered by Karl Landsteiner in 1901¹. Later Landsteiner and Wiener defined the Rh blood group in 1937². Together these two systems have proved to be most important for advancement of transfusion medicine and opened the door to birth of spectrum of discoveries in the field of immunohaematology. Up to now, 30 blood group systems are recognised by International Society of Blood Transfusion³. Across the 30 blood groups, over 600 different red cell antigens have been described, many of these are very rare or are mainly found in certain ethnic

groups only, the vast majority of which are inherited in a simple Mendelian fashion⁴. The genes of ABO and Rh are located on chromosome 9 and 1, respectively. All human populations share the same known blood systems, although they differ in frequencies of specific types, considering the evolutionary closeness of apes and monkeys, some of them share a number of blood typing systems with humans. The study of blood group antigens besides being useful in management of blood banks and in blood transfusion services, it is also useful in population genetic studies to determine the genetic variation within and between the populations and to evaluate the ethnic

variation and affiliation between different population, researching population migration patterns, as well as resolving certain medico-legal issues, particularly of disputed paternity⁵. Interestingly, both Rh and ABO blood groups exhibit extensive polymorphism in different population and the frequency at which each of the blood groups exist shows considerable variations. There are also variations in blood type distributions within human subpopulations. Historically, it is believed that Cro-Magnons around 40,000 BC were our first direct ancestors who emerged in sub-Saharan Africa who were basically hunters, carnivorous and it was at this time that the digestive attributes of blood group O reached its full expression with its highly efficient acid and pepsin production geared for digestion of meat. Depletion of large game in Africa coupled with climatic change encouraged migration in the Neolithic Period or new stone age and due to subsequent major changes in diet, sedentary lifestyle resulted in new mutation in digestive tract and immune system and many of them became carriers of blood group A, which allowed humans to tolerate and better assimilate grains and other agricultural products. Blood group A initially appeared in the early Caucasian people sometimes between 25000 and 15000 BC somewhere in western Asia or the middle-east, later carried to western Europe and Asia during the movement of Neolithic societies. The gene for blood group B first appeared in significant numbers somewhere around 10–15000 BC in the area of Himalayan highlands now part of present India and Pakistan. To modern day anthropologist, blood group B continuous to be an 'Eastern' blood group found in high frequency in Chinese, Japan, Mongolia and Siberia. In a country like United Kingdom, the Viking invaders may also have had a relatively high percentage of B gene, since many of towns of Britain and western Europe that are linked to coast by internal lines of communication such as rivers have disproportional amount of B blood group, hence, showing a correlation between distribution of blood group to the successive invasions and migrations, including Vikings, Danes, Saxons, Celts and Normans, who contributed the genes to the populations⁶.

FUTURE OF ABO BLOOD GROUPING

A person's blood group is one of his characteristics, just

as dark skin may be, or blue eyes or a hooked nose. Like other physical characteristics, blood group can be used to divide mankind into races. *The patterns of ABO and Rh distributions are not similar to those for 'skin colour' or other so called 'racial traits'*, the implication of this is that the 'specific' causes responsible for the distribution of human blood types have been different than those used to categorise people into 'races'. Since it would be possible to divide up humanity into radically different groupings using 'blood types' instead of depending on other genetically inherited traits such as 'skin colour', we have more conclusive evidence that the commonly used typological model for understanding human variation is scientifically unsound as unlike the more familiar physical characteristics, blood groups are inherited in known ways. The A,B,O blood groups are controlled by a single-gene series consisting of three genes, the M and N are controlled by a single-gene series consisting of two genes, The Rh blood groups are controlled by a single gene consisting of eight genes and in each case we know which genes are dominant. This provides an ideal opportunity for the study of human variation without cultural prejudice. In a very real sense, 'race' is a distinction that is created by culture not biology. Since blood group of a person is a hidden characteristic, you cannot tell a person's blood group by looking at him hence it keeps a person from making judgments of his own about his neighbour's race and from building up superstitious and prejudices about it, maybe in future this fact may have a role to play to decrease the discrimination based on skin colour, which still continues. A popular belief in Japan is that a person's ABO blood type is predictive of their personality, character and compatibility with others, this belief is also wide spread elsewhere in Asia, notably in Taiwan and South Korea, based on these theory of historical 'Scientific Racism', the militarist government of the time (1927) even commissioned a study aimed at breeding better soldiers, though the fad faded soon but it was again revived in 1970's by Masahiko. Nomi a broadcaster with no medical background⁷. It is a known fact that an individual has the same blood group for life, but very rarely an individual's blood type changes through addition or suppression of an antigen in infection, malignancy or autoimmune disease^{8,9,10}. An example of

this rare phenomenon is the case of ‘Demi-Lee-Brennan’, an Australian citizen, whose blood group changed after a liver transplant^{11,12}. Another more common cause in blood type change is ‘bone marrow transplant’ performed for many leukemia and lymphomas, among other diseases. If a person receives bone marrow from someone who is different (e.g., a type A patient receives a type O bone marrow), the patient’s blood type will eventually convert to the donor’s type¹³. A fact that in future with the advancement of tertiary health care may need to be considered in dealing with medico-legal cases.

METHOD AND MATERIAL

Setting and Subjects

The study included medical students of both sex of three different regions in three different countries, namely, Egypt, Libya and India. The subjects were randomly selected. From Egypt, the total of 467 subjects of each sex, males (254) and females (213), were included in this study from Faculty of Medicine, Menoufiya University. From Libya, the number of subjects were 305 (167 males and 138 females) from Faculty of Medicine, El Gabal Al Gharby-Al Zawya. From India, the study was on 432 persons (346 males and 85 females) from Government Medical Collage Kashmir. The relevant data were collected from the students after taking consent from the university ethics committees and the essential information was noted on a printed Performa from individual students, confidentially of the data was maintained. The blood sample was collected by finger prick with sterile lancet after warming and cleaning the puncture site with 70% of ethyl alcohol. The ABO blood sampling was done by the standard rapid tile method. This involved mixing one volume of individuals’ blood with one volume of commercially obtained anti-A and anti-B sera (Biotec Laboratories, LTD-38 Anson Road, Martiesham- Health pswish Suffolk IPS 3RG, UK), respectively, on an opal glass tile. The cell and sera in each square were mixed and the tile rocked gently, this was then viewed with the aid of good light within 2–5 min and the presence or absence of agglutination noted. This tile method was also used for the determination of rhesus group using commercially obtained anti-D sera (Biotec Laboratories) as control.

| Reaction with anti A | Reaction with anti B | Group blood |
|----------------------|----------------------|-------------|
| + | + | AB |
| + | - | A |
| - | + | B |
| - | - | O |

(+) = Agglutination, (-) = No agglutination

When agglutination occurred with anti-D, then the group was considered as Rh positive. If there was no agglutination, then it was considered as Rh (-) ve blood.

Gene Frequency of ABO and Rh were done by Hardy–Weinberg law

Analysis includes frequency of ABO and frequency of Rh in each country, gene frequency of ABO, gene frequency of Rh, ABO with gender and Rh with gender, frequency of ABO with Rh. Gender variation in distribution of ABO blood grouping and Rh factors.

Statistical Analysis

The data were recorded, tabulated and statistically analysed using SPSS10 statistical programme. Data expressed as number and percentage and analysed by χ^2 , level of significance was set as *P*-value <0.05.

ABO frequency in Egypt, Libya, India

The total numbers of subjects who were examined for the frequency of ABO in Egypt, Libya and India were 467, 305 and 432, respectively (Table 1). The study in Egypt revealed that the most prevalent blood group was A (37.9%) followed by group O (27%), group B (25.1%) and group AB (10/1%). In Libya and India, blood group O is the most prevalent one (48.9% and 40.8%, respectively), in Libya it is followed by group A (33.1%), B (12.8%) and AB (5.2%), while in India it is followed by group B (31.6%), A (20.9%) and AB (6.7%).

ABO gene frequency in Egypt, Libya, India

Expected A gene frequency in Egypt is the highest one (0.279), followed by Libya (0.214) and India (0.149; Table 2). Gene B frequency is more prevalent in India then Egypt and Libya (0.215, 0.195 and 0.094, respectively), while O gene is more frequent in Libya (0.962), then India (0.637) and Egypt (0.526).

Table 1: ABO frequency in Egypt, Libya, India

| Blood group | Country | | | | | |
|-------------|---------|------|-------|------|-------|------|
| | Egypt | | Libya | | India | |
| | No. | % | No. | % | No. | % |
| A | 177 | 37.9 | 101 | 33.1 | 90 | 20.9 |
| B | 117 | 25.1 | 39 | 12.8 | 136 | 31.6 |
| O | 126 | 27 | 149 | 48.9 | 176 | 40.8 |
| AB | 47 | 10.1 | 16 | 5.2 | 29 | 6.7 |
| Total | 467 | 100 | 305 | 100 | 431 | 100 |

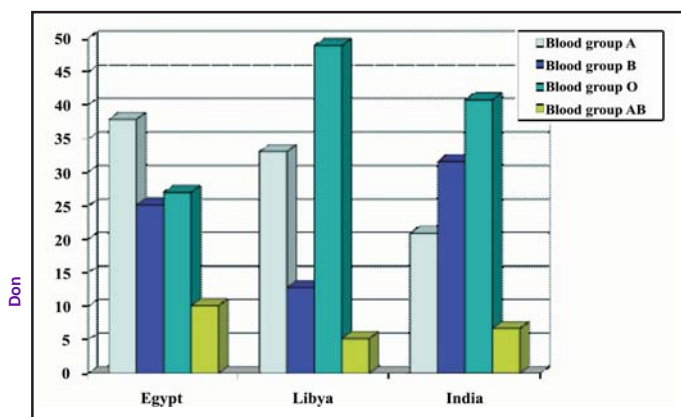


Table 2: ABO gene frequency in Egypt, Libya, India

| Gene | Country | | |
|------|---------|-------|-------|
| | Egypt | Libya | India |
| *P | 0.279 | 0.214 | 0.149 |
| Q | 0.195 | 0.094 | 0.215 |

*P, Q, R denotes gene frequencies of A, B and O, respectively

Rh frequency in Egypt, Libya, India

The majority of population in Egypt, Libya and India were Rh positive (87.7%, 87.2% and 90.3%, respectively). Rh negative frequency was less (12.2%, 12.8% and 9.7%, respectively; Table 3).

Rh gene frequency in Egypt, Libya, India

Gene frequency of Rh positive was the highest in India (69), while the frequency was nearly similar in Egypt and Libya (65 and 64, respectively). Gene frequency of

Table 3: Rh frequency in Egypt, Libya, India

| Rh | Country | | | | | |
|-------|---------|--------|-------|--------|-------|--------|
| | Egypt | | Libya | | India | |
| | No. | % | No. | % | No. | % |
| Rh+ve | 410 | (87.7) | 266 | (87.2) | 289 | (90.3) |
| Rh-ve | 57 | (12.2) | 39 | (12.8) | 42 | (9.7) |
| Total | 467 | (100) | 305 | (100) | 431 | (100) |

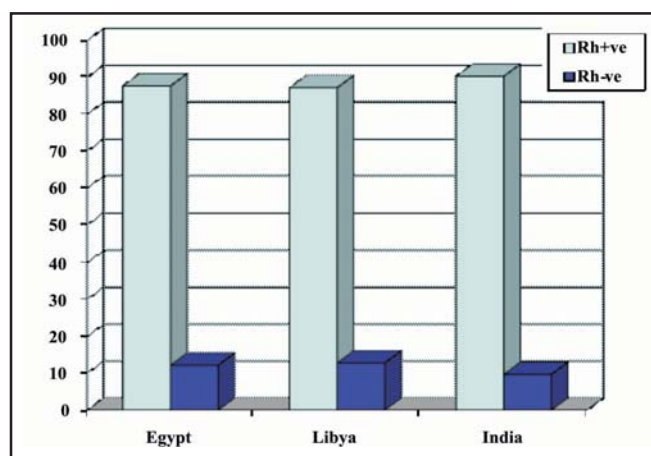


Table 4: Rh gene frequency in Egypt, Libya, India

| Rh | Country | | |
|----|---------|-------|-------|
| | Egypt | Libya | India |
| *D | 65 | 64 | 69 |
| D | 35 | 36 | 31 |

*D denotes gene frequencies of Rh positive and negative phenotypes.

Comparative relationship of ABO frequency with sex

Among Egyptian male and female subjects, blood group A was found to be the most prevalent group (41.75% and 33.3%, respectively), in males it is followed by group O (27.25%), B (19.3%) and AB (11.8%), while in females it is followed by B (31.9%), O (26.8%) and AB (8%; Table 5). Among Libyan male and female subjects, blood group O was the most prevalent one (44.9% and 53.6%, respectively), followed by group A (39.5% and 25.4%, respectively), B (12% and 13.85%, respectively) and AB (3.6% and 7.25%, respectively). The distribution of ABO and sex in Egypt is significant by using χ^2 as *P*-value <0.05, while in Libya and India this relation is highly significant as *P*-value <0.001.

Comparative relationship of Rh frequency with sex

Among Egyptian and India subjects, the frequency of Rh positive blood group was high in males (88.6% and 93.6%, respectively) than in females (86.9% and 76.5%, respectively), while in females the frequency of negative

is more in females (13.1% and 23.5%, respectively) than in males (11.4% and 6.4%, respectively; Table 6). The opposite was in Libya, Rh positive frequency was high in females (90.6%) than in males (84.4%), while in Rh negative was more in males (15.6%) than in females (9.4%). This relation in Libya and India was highly significant by using χ^2 as P -value <0.001 , but in Egypt it was not significant as P -value=0.05.

Comparative frequency of ABO and Rh in Egypt, Libya, India

Among Egyptian Rh positive subjects, the frequency of ABO was A>O>B>AB (33.4%, 23.8%, 21.2% and 9.4%, respectively), while among Rh negative subjects it was A>B>O>AB (4.5%, 3.9%, 3.2% and 0.6%, respectively). This relation was statistically not significant by using χ^2 as P -value $>0.05\%$. In Libya, along with Rh positive cases it was O>B>A>AB (44.6%, 30.2%, 9.8% and 2.6%, respectively), while along with Rh negative cases, blood group O was the most frequent(44.6%), groups A and B had the same percentage (3%) while blood group AB was the least frequent (2.6%). This relation was highly significant by using χ^2 as P -value <0.001 . In India, the distribution of ABO blood group along with Rh positive was O>B>A>AB (38.5%, 28.5%, 19.5% and 3.7%, respectively), while along with Rh negative cases blood

groups B and AB had the same frequency (3%) followed by O (2.4%) and A (1.4%). This relation was highly significant by using χ^2

Comparative frequency of ABO and Rh among males

Among Egyptian Rh positive male subjects A>O>B>AB (35.8%, 24%, 17.3% and 11.4%, respectively), but along with Rh negative male cases the frequency was A>AB>O>B (5.9%, 4%, 3.1% and 2%, respectively; Table 8). This relation was statistically not significant by using χ^2 as P -value $>0.05\%$. In Libyan Rh+ male cases blood group O was the most frequent (39.5%) followed by A (34.1%), B (8.4%) and AB (2.4%). Among Rh negative cases, the percentage of blood groups O and A was the same (5.4%), followed by B (3.6%) and AB (1.2%).

Comparative frequency of ABO and Rh among females

Among Egyptian Rh positive females, blood group A>B>O>AB (30.5%, 25.8%, 23.5% and 7%, respectively), while in Rh negative cases blood group AB>B>O>A (9%, 6.1%, 3.3%, 2.8%, respectively; Table 9). This relation was statistically not significant by using χ^2 as P -value $>0.05\%$. Among Libyan Rh positive

Table 5: Comparative relationship of ABO frequency with sex

| Blood group | Egypt | | | | Libya | | | | India | | | |
|-------------|--------------|--------|----------|--------|-------------|--------|-----------|--------|--------------|--------|-----------|--------|
| | Male | | Female | | Male | | Female | | Male | | Female | |
| | No. | % | No. | % | No. | % | No. | % | No. | % | No. | % |
| A | 106 | (41.7) | 71 | (33.3) | 66 | (39.5) | 35 | (25.4) | 60 | (17.3) | 30 | (35.3) |
| B | 49 | (19.3) | 68 | (31.9) | 20 | (12) | 19 | (13.8) | 113 | (32.7) | 23 | (27.1) |
| O | 69 | (27.2) | 57 | (26.8) | 75 | (44.9) | 74 | (53.6) | 154 | (44.5) | 22 | (25.9) |
| AB | 30 | (11.8) | 17 | (8) | 6 | (3.6) | 10 | (7.2) | 19 | (5.5) | 10 | (11.8) |
| Total | 254 | (100) | 213 | (100) | 167 | (100) | 138 | (100) | 346 | (100) | 85 | (100) |
| Statistic | $\chi=11.23$ | | $P<0.05$ | | $\chi=78.6$ | | $P<0.001$ | | $\chi=20.99$ | | $P<0.001$ | |

Table 6: Comparative relationship of Rh frequency with sex

| Sex | Egypt | | | | Libya | | | | India | | | |
|-----------|-------------|--------|----------|--------|-------------|--------|-----------|--------|--------------|--------|-----------|--------|
| | Rh+ve | | Rh+ve | | Rh+ve | | Rh+ve | | Rh+ve | | Rh+ve | |
| | No. | % | No. | % | No. | % | No. | % | No. | % | No. | % |
| Male | 225 | (88.6) | 29 | (11.4) | 141 | (84.4) | 26 | (15.6) | 324 | (93.6) | 22 | (6.4) |
| Female | 185 | (86.9) | 28 | (13.1) | 125 | (90.6) | 13 | (9.4) | 65 | (76.5) | 20 | (23.5) |
| Total | 410 | (87.8) | 57 | (12.2) | 266 | (87.2) | 39 | (12.8) | 389 | (90.3) | 42 | (9.7) |
| Statistic | $\chi=0.32$ | | $P>0.05$ | | $\chi=25.6$ | | $P<0.001$ | | $\chi=22.78$ | | $P<0.001$ | |

Table 7: Comparative frequency of ABO and Rh in Egypt, Libya, India

| Blood group | Egypt | | | | Libya | | | | India | | | |
|-------------|-------------|--------|----------|--------|------------|--------|-----------|--------|--------------|--------|-----------|-------|
| | Rh+ve | | Rh+ve | | Rh+ve | | Rh+ve | | Rh+ve | | Rh+ve | |
| | No. | % | No. | % | No. | % | No. | % | No. | % | No. | % |
| A | 156 | (33.4) | 21 | (4.5) | 92 | (30.2) | 9 | (3) | 84 | (19.5) | 6 | (1.4) |
| B | 99 | (21.2) | 18 | (3.9) | 30 | (9.8) | 9 | (3) | 123 | (28.5) | 13 | (3) |
| O | 111 | (23.8) | 15 | (3.2) | 136 | (44.6) | 13 | (4.3) | 166 | (38.5) | 10 | (2.4) |
| AB | 44 | (9.4) | 3 | (0.6) | 8 | (2.6) | 8 | (2.6) | 16 | (3.7) | 13 | (3) |
| Total | 410 | (87.1) | 57 | (12.2) | 266 | (87.2) | 39 | (12.8) | 389 | (90.3) | 42 | (9.7) |
| Statistic | $\chi=2.62$ | | $P>0.05$ | | $\chi=271$ | | $P<0.001$ | | $\chi=44.86$ | | $P<0.001$ | |

Table 8: Comparative frequency of ABO and Rh among males

| Blood group | Egypt (No:254) | | | | Libya (No:167) | | | | India (No:346) | | | |
|-------------|----------------|-------|----------|--------|----------------|--------|-----------|--------|----------------|--------|-----------|-------|
| | Rh+ve | | Rh+ve | | Rh+ve | | Rh+ve | | Rh+ve | | Rh+ve | |
| | No. | % | No. | % | No. | % | No. | % | No. | % | No. | % |
| A | 91 | 35.8 | 15 | (5.9) | 57 | 34.1 | 9 | (5.4) | 57 | (16.5) | 3 | (9) |
| B | 44 | 17.3 | 5 | (2) | 14 | (8.4) | 6 | (3.6) | 108 | (31.2) | 5 | (1.4) |
| O | 61 | (24) | 8 | (3.1) | 66 | (39.5) | 9 | (5.4) | 149 | (43.1) | 5 | (1.4) |
| AB | 29 | 11.4) | 1 | (4) | 4 | (2.4) | 2 | (1.2) | 10 | (2.9) | 9 | (2.6) |
| Total | 225 | 88.6) | 29 | (11.4) | 141 | 84.4) | 26 | (15.6) | 324 | (93.6) | 22 | (6.4) |
| Statistic | $\chi=2.79$ | | $P>0.05$ | | $\chi=55$ | | $P<0.001$ | | $\chi=57$ | | $P<0.001$ | |

Table 9: Comparative frequency of ABO and Rh among females

| Blood group | Egypt (No:213) | | | | Libya (No:138) | | | | India (No:85) | | | |
|-------------|----------------|--------|----------|--------|----------------|--------|-----------|-------|---------------|--------|----------|--------|
| | Rh+ve | | Rh+ve | | Rh+ve | | Rh+ve | | Rh+ve | | Rh+ve | |
| | No. | % | No. | % | No. | % | No. | % | No. | % | No. | % |
| A | 65 | (30.5) | 6 | (2.8) | 35 | (25.4) | - | - | 27 | (31.8) | 3 | (3.5) |
| B | 55 | (25.8) | 13 | (6.1) | 16 | (11.6) | 3 | (2.2) | 15 | (17.6) | 8 | (9.4) |
| O | 50 | (23.5) | 7 | (3.3) | 70 | (50.7) | 4 | (2.9) | 17 | (20) | 5 | (5.9) |
| AB | 15 | (7) | 2 | (9) | 4 | (2.9) | 6 | (4.3) | 6 | (7.1) | 4 | (4.7) |
| Total | 185 | (86.9) | 28 | (13.1) | 125 | (90.6) | 13 | (9.4) | 65 | (76.5) | 20 | (23.5) |
| Statistic | $\chi=3.56$ | | $P>0.05$ | | $\chi=359$ | | $P<0.001$ | | $\chi=6.18$ | | $P>0.05$ | |

females, blood group O (50.7%) was more frequent followed by A (25.4%), B (11.6%) and AB (2.9%), but Rh negative cases blood group AB was more frequent followed by blood group O and B (4.3%, 2.9% and 2.2%, respectively). This relation was statistically very highly significant by using χ^2 as P -value $<0.001\%$. Indian Rh positive females showed high prevalence of blood group A (31.8%) followed by O (20%), B (17.6%) and AB (7.1%), while among Rh negative cases blood group B (9.4%) was more prevalent than O (5.9%) and AB (4.7%) and lastly A (3.5%). This relation was statistically not significant by using χ^2 as P -value $>0.05\%$.

DISCUSSION

The need for blood group prevalence studies is important not only for blood transfusion and organ transplantation,

but also in future genetic research and in evolving evolution's branching tree. Distribution of the ABO and Rh blood group phenotype frequencies were studied among the medical students from Egypt (467 subjects), Libya (305 subjects) and India (432 subjects).

In Libya, the percentage of blood group O (48.9%) is the highest, followed by A (33.1%) and B (12.8%), which is similar in frequency to the study in Egypt in 1965¹⁴, this is consistent with previous studies also where blood group O is predominant and said to be the characteristic of Arabia as it occurs in high frequency in desert population. High incidence of blood group O has also been found in other Arabian countries like Saudi Arabia^{15,16}, Kuwait¹⁷, Iran¹⁸ and other countries as England¹⁹, Greece²⁰. This in contrast to other countries like Germany, Lebanon,

Turkey, France and Hungary where A is more prevalent and exceeds B, O, AB in that order²¹. This study has revealed a change in Egypt ABO frequency as now blood group A (37.9%) is dominating followed by O (27%), then B (25.5%). This in accordance with a study done in Egypt between 2000 and 2005²² on 1,02,244 donors. The shift may be attributed to migration, which took place in that region, natural selection is affected by tradition and habits. In India (Kashmir), the predominant blood group was found to be O (40.8%) followed by B (31.6%) then A (20.9%), which is similar to a study done 2005–2006, but is in contrast to a study done in Kashmir (1974) on 9,315 persons, where blood group B was most common (37.5%) followed by O (35.5%), A (5.9%). The difference may possibly have been to real shift in genetic frequencies caused by a dramatic rural to urban migration for better opportunities for education or may also be due to significant improvement in blood group determination technology. Another significant fact we noticed was that in Kashmir where blood group O is highest, whereas in rest of India A is highest, this is not surprising since the composition of Kashmiri population is essentially composed by different racial groups, which includes migrants or invaders from Central Asia, Mongolia, Persia, Tibet and Afghanistan²³. The second most frequent blood group is B, this is not surprising for this region since is the pattern in some Asian countries such as India, Malaya, Korea and usually has a gene frequency between 0.2 and 0.4%²⁴. Our study has also revealed the gene frequency of blood group B in the same range as 0.2. All the three studies were similar in blood group AB being least common, which coincides with all previous studies done in different countries like India, Hadharmout, Pakistan and Turkey^{23,25,26,27}. Blood group O was the most common in frequency (only second in frequency in Egypt). In general, all over the world, blood group O is the most common, blood type A is next and blood type B after that, AB is the least common²⁷. AB is the least common, reason may be since genetically blood group B is not popular, and hence, chance of conceiving an AB blood group in offspring is less like. Whereas blood type O is the most common due to the fact that O people have no antigens of A or B. The blood type O has a more common chance of being in a child if one of the parents was O and the one was A or B, O has a special genetic side to it

which stays in more children over the others, like if one parent was O and the other A or B then there is 85% chance of it being an O child. Phenotype A is most frequent in Egypt (37.9%) followed by Libya (33.1%) and in India (20.9%), this corresponds to gene frequency of 0.279, 0.214 and 0.149, respectively, in the three countries. Phenotype B is more frequent in India (31.6%), followed by Egypt (25.1%) then Libya (12.8%), corresponding to gene frequency of 0.215, 0.195 and 0.094, respectively. Phenotype O is more dominant in Libya (48.9%) followed by India (40.8%) then Egypt (27%) with gene frequency of 0.692, 0.637 and 0.526, respectively.

Egypt and Libya are very close in frequency of Rh positive cases (87.7% and 87.2%) and Rh negative (12.2% and 12.8%, respectively), which is expected since the two countries are geographically close and is in accordance with previous studies, expectantly in our study we found the Rh gene frequency in Egypt as 65 and in Libya as 64. While in India Rh negative is lower in frequency compared to Egypt and Libya suggesting that cases of Rhesus isoimmunisation would be lower in India then in Egypt and Libya. The Rh gene frequency of India was 31, which is lower in frequency from Egypt and Libya where it is 35 and 36, respectively.

Gender Relation to Blood Group

In Egypt, most common blood group in males was A (41.7%) this may be because blood group A is the most dominant blood group in this region. This coincides with a study done in Palestine in 2006. But the frequency in females is different in both the countries in Egypt A>B>O and in Palestine it is A>O>B²⁹. In Libya, both males and females had blood group O predominant (44.9% and 53.6%, respectively) followed by A then B in both the sex. This again is expected as ABO frequency is found in this order in Libyan population. Similar findings were documented in studies done in Nigeria 2007²⁸ and Hadharmout²⁵ in 2003, with blood group O dominating followed by A. Blood group O is said to be the characteristic of Arabia as it occurs in high in frequency in desert population and this is confirmed from our study also. In India, blood group O (44.5%) predominates in males and in females blood group A (35.3%)

predominates, followed by B (32.7%, 27.1%) in both the sex. In a similar study done in Pakistan, blood group B dominates (32.7% and 31.7%) in both the sexes followed by O (28.9% and 28%), which though unlike India but nearly similar in percentage of occurrence, this may be because of geographical proximity²³.

In studying the relationship between gender and Rh frequency, we found in Egypt and India males were more Rh positive (88.6% and 93.6%) as compared to females (86.9% and 76.5%, respectively), the difference being more significant in India (23.5% females Rh negative), which coincides with a study done in Pakistan²⁶, this may be attributed to the common history of these populations, similar Rh positive frequency has also been documented in Hadharmout²⁵. In Libya, females were more Rh positive (90.6%) as compared to males (84.4%), this coincides with a study done in Nigeria²⁸. The frequency of Rh negative in males was 15.6% as compared to females 9.4%. Though there is a difference in Rh frequency between males and females in Egypt and Libya but may be too low to be significant and may require further evaluation on a larger sample population.

In studying relationship between ABO and Rh and later comparing between the three countries, we found in Egypt Rh positive and negative were more common in blood group A (33.4% and 4.5%, respectively), followed by blood groups O and B in Rh positive subjects, which is similar to a study done in Turkey and in Egypt in 2007²²⁻²⁷, but in Rh negative cases though blood group A dominates in both countries followed by B>O>AB in Egypt and O>B>AB in Turkey with very less percentage difference, but in Libya we found both Rh positive and Rh negative predominant in blood group O, followed by A then B, which is similar in pattern to the frequency of ABO distribution in Libya itself and also coincides with a study done in Hadharmout²⁴. In India, we found Rh positive is most common in blood group O (38.5%) followed by B (28.5%) than A (19.5%), which is again following the ABO frequency pattern and also in sync to a study done in Pakistan, but we found Rh negative cases are more common in blood group B and AB (3%) then O (2.4%) followed by A (1.4%) not coinciding with Pakistan study where blood O negative is followed by A and then B²⁶.

In studying the gender relation to ABO blood group, we found in Egypt males predominantly showing blood group A in both Rh positive and negative cases followed by O and B, which is similar to the frequency found among Palestinians²⁸, though the frequency of percentage between Palestine and Turkey varies in Rh negative case but is too less to be significant²⁷. In Libya, males presented with blood group O followed by A and B in Rh positive cases, whereas in Rh negative cases blood group A and O followed by B was the norm, which is in sync with study done in Nigeria²⁸. In India, in Rh positive males, blood group O was followed by B and then A, which is similar to distribution of ABO frequency in India.

In studying the gender relation, Egyptian females showed blood group A predominance followed by B and O in Rh positive cases, whereas in Rh negative cases AB followed by B then O. In Libya, Rh positive females had blood group O, A, B in that order in frequency, which is again similar to study in Nigeria²⁸. In Rh negative cases, blood group AB was followed by O then B, which is comparable to our study in Egypt in AB being the most dominant blood group in Rh negative cases. In India, in Rh positive females, blood group A was followed by O and B, which is similar to Turkey and Palestine study^{27,28}.

RECOMMENDATIONS

1. Generation of a simple database of blood group not only provides data about the availability of human blood in case of regional calamities but also serves as a forewarning of future burden of diseases. Hence, such studies need to be carried out at all regional level, wherever humanity resides.
2. An association of blood group with several diseases especially cardiovascular diseases has been reported, over the years data generated by such studies can be used by health planners while making efforts to face the future health challenges for the region where study has been done.
3. In our study, the number of subjects were not many, if the number of subjects are increased with proportionate representatives of different sub-groups, the percentage distribution of different blood groups might give insight into the ethnic origins of different

groups of people living in an area, hence, blood group study can be used as one of the important tools for anthropological studies of ethnic origin of people, for determining migration pattern of races besides study of blood group antigens can be used as genetic markers to characterise population, can also provide valuable database of historical and serological frequencies for native donor population and can be used to implement direct donor-typing policies and programmes to enable subsequent targeted transfusion provisions.

4. Such studies can go a long way in planning, maintaining and storage of specific blood group predominate in that region for easy availability in that region for easy availability in times of need like surgery, accidents, natural calamities etc.

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