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Association of Parental ABO Phenotypes with Gender of the Child

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ABSTRACT

Background: The study of blood groups is not only important in blood transfusion and organ transplant practices but prevalence of its types is also important in genetic research, anthropology and inheritance related studies.

Objective: To find the association of parental ABO phenotypes with the gender of the child born.

Material and Methods: This was a prospective, observational study, performed from Nov 2016 to June 2017on 332 fertile couples experienced child birth in a teaching tertiary care hospital. ABO & Rh Blood grouping of these couples was performed by microplate hem-agglutination method and maternal record of all the couples was recorded for live birth including gender of child.

Results: There were total 555 live births from 332 fertile couples including 279 females (50.3%) and 276 males (49.7%) with average of 1.67 births per mating in which B-B and AB-A had maximum rate of 1.80 each and lowest as1.40 in A-AB. AB-O combination had maximum male child (72.7%) and A-A had female child (70.4%). Overall sex ratio was 1.01.Association of the gender of the child born and parents mating type was found insignificant (p=0.269). Further it was found that O type father had maximum female child (55.6%) and AB type had maximum male child (55.3%). Statistically it was also found insignificant (p >0.050).

Conclusion: It was concluded that different mating types of the parents having same and different ABO and Rh phenotypes and type of paternal phenotype has no effect on the gender of the child born. These results may help the researchers in the genetic and anthropology related studies and to understand the inheritance related issues.

Key Words: Mating types, ABO & Rh Phenotypes, Gender of the child, Paternal phenotype

INTRODUCTION

Since Landsteiner's discovery in 1901, that human blood groups existed, a vast body of serological, genetic and biochemical data on red cell (blood group) antigens has been accumulated and more recently the biological function of some of these antigens have been appreciated. [(1)] A total of 36 blood group systems have been described till date in the numeric catalogue of red cell antigens maintained by International society of Blood Transfusion working party.[(2)] Each system is identified by the presence of series of red cell antigens which are determined either by a single genetic locus or very closely linked loci. Alternative forms of a gene coding for red cell antigens at a locus are called alleles and individuals may inherit identical or non-identical alleles. Most blood group genes have been assigned to specific chromosomes e.g. ABO system on chromosome No. 9 and Rh system on chromosome No. 1. The expression of ABO antigens is controlled by three separate genetic loci: ABO located on chromosome 9, FUT1 (H) and FUT2 (Se) on chromosome 19. The genes from each locus are inherited in pairs as Mendelian dominants.[(1)]ABO antigens although most important in relation to transfusion are also expressed on most endothelial membranes and are important histocompatibility antigens. [(3)]

In Humans, there are total 46 chromosomes arranged in 23 pairs including 22 pairs of autosomes and one pair of sex chromosomes (X and Y). The type of sex chromosome always determines the sex of a person i.e. females have two X chromosomes whereas males have one X and one Y chromosome. X chromosome is relatively large as compared to the Y and contains many genes. The Y chromosome on the other hand contains only a few genes. The female always passes X Chromosome to her offspring through the female gamete (egg). The male can pass on either the Y or the X chromosome through the male gamete (sperm). During chance

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of fertilization, if the male gamete having X chromosome meets the egg, then the growing embryo will develop into a girl and if the male gamete having Y chromosome meets the egg, then the growing embryo will develop into a boy. So, therefore gender or sex of the new born is always dependent on the chance of type of male gamete to unite with the female gamete or we can say that gender of child always depends on whether the sperm which fertilizes the egg is carrying an X or a Y chromosome. Characters and traits are always inherited from biological parents to their children irrespective of the gender. These traits may be in the form of pathological, physiological or genetical disorders or in the form of personality wise characteristics. Children usually resemble their parents in many ways including the physical appearance, mental abilities or disabilities, personality, behaviour and other characteristics due to inheritance of genes from both. Observation of different disease processes and their likely association with genetical characters like blood group may have motivated the scientists to establish these associations at molecular level and in which they have succeeded also.

The study of blood groups is not only important in blood transfusion and organ transplant practices but prevalence of its types is also important in genetic research, anthropology and inheritance related studies. Now there are many studies which have indicated the probable association of different disease processes with ABO and other blood groups systems. Many of these explored the most important ABO system which is the most elaborated system till date. Most of these studies found association of blood groups with different attributes of the human pathology, physiology, personality, behaviour etc. So, to further explore the subject of inheritance, this is one of the original research planned in the dept. of Obstetrics and Gynaecology (OBG) and dept. of Blood Transfusion & Immunohematology of Punjab Institute of Medical Sciences (PIMS), Jalandhar with the aim and objective to find the association of maternal and paternal ABO phenotypes with the gender of the child born. This is the first ever research conducted in this region.

MATERIAL & METHODS

This was a prospective, observational study, performed on the 332 fertile couples who experienced child birth, attended the department of Obs. and Gynae (OBG) of Punjab Institute of Medical Sciences (PIMS) Jalandhar from Nov 2016 to June 2017. ABO & Rh Blood grouping was performed by microplate Hem-agglutination method on fully automatic Immunohematology analyser Galileo-Echo (Immucor, USA) in the dept. of Blood Transfusion and Immunohematology. All discrepant and further advance immune-haematological investigations were performed using conventional tube technique (CTT) and ID-Gel technology. All the Rh-D Negative groups were retested for weak-D antigen. Samples for subgroup typing were sent to Immucor Reference Laboratory. The maternal record of all the couples was recorded for live birth including gender of child through a questionnaire with the consent of participants.

Statistical Analysis:

The tabulated data was analysed by using IBM SPSS Statistics 23 software and tested for significance of association between gender of child with the phenotypes of parents.

Observation and Results:

From the total 332 selected fertile couples, 159 couples had only one child, 134 had two, 31 had three, 6 had four, two couples had five and six children each including 279 females and 276 males.156 couples had only one female child, 48 couples had two girl children, 9 couples had three girl children and 112 couples had only female children in their family.

Table 1: Gender wise child birth status in the fertile couples (n=332)

	Live Birth		Couples having Female Child			Couples having Male Child		
No. of couples	No. per couple	Total Live Birth	No. of Couple	No. per Couple	Total No.	No. of Couple	No. per Couple	Total No.
159	1	159	119	0	0	112	0	0
134	2	268	156	1	156	169	1	169
31	3	93	48	2	96	46	2	92
6	4	24	9	3	27	5	3	15
1	5	5						
1	6	6						
332		**555**	**332**		**279**	**332**		276

169 couples had single male child, 46 had two, 5 had three male child and 119 couples had only male children in their family (Table 1).

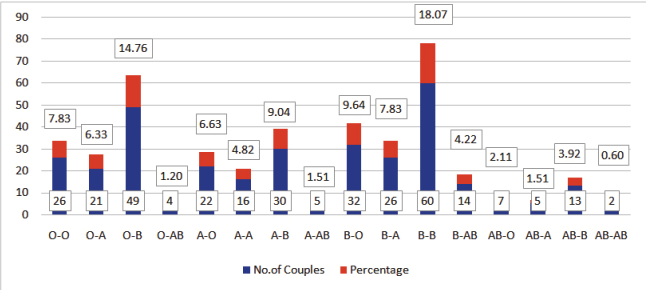

Figure 1: Different mating types in the study population

On analysing the child birth status as per different combination of the mother and father mating, there were total 16 mating types among the 332 couples and maximum of 60 couples (18.07%) had B-B mating type and minimum of only two couples (0.60%) had AB-AB.

Table 2: Status of Live Birth in the different mating types of study population (n=555)

Mating Type	No. of Couples	Live Births	Male	Female
O-O	26 (7.83)	45 (1.73)	15 (33.3)	30 (66.7)
O-A	21 (6.33)	35 (1.67)	16 (45.7)	19 (54.3)
O-B	49 (14.76)	81 (1.65)	42 (51.9)	39 (48.1)
O-AB	4 (1.20)	6 (1.50)	4 (66.7)	2 (33.3)
A-O	22 (6.63)	35 (1.59)	18 (51.4)	17 (48.6)
A-A	16 (4.82)	27 (1.69)	8 (29.6)	19 (70.4)
A-B	30 (9.04)	48 (1.60)	26 (54.2)	22 (45.8)
A-AB	5 (1.51)	7 (1.40)	5 (71.4)	2 (28.6)
B-O	32 (9.64)	53 (1.66)	23 (43.4)	30 (56.6)
B-A	26 (7.83)	42 (1.62)	25 (59.5)	17 (40.5)
B-B	60 (18.07)	108 (1.80)	57 (52.8)	51 (47.2)
B-AB	14 (4.22)	22 (1.57)	10 (45.5)	12 (54.5)
AB-O	7 (2.11)	11 (1.57)	8 (72.7)	3 (27.3)
AB-A	5 (1.51)	9 (1.80)	5 (55.6)	4 (44.4)
AB-B	13 (3.92)	23 (1.77)	12 (52.2)	11 (47.8)
AB-AB	2 (0.60)	3 (1.50)	2 (66.7)	1 (33.3)
Total	**332**	**555 (1.67)**	**276 (49.7)**	**279 (50.3)**
p value		0.269		

There were total 555 live births from 332 fertile couples including 279 females (50.3%) and 276 males (49.7%) with average of 1.67 births per mating in which B-B and AB-A had maximum rate of 1.80 each and lowest of 1.40 in A-AB mating type. (Table 2)

Among the different mating types, AB-O combination had maximum male child (72.7%) and A-A had maximum of female child (70.4%) and vice versa for the same. Overall sex ratio is 1.01 in the observed results. The results when tested for significance of association of different mating types with gender of the child born was found insignificant (p=0.269).

There were three types of mating combinations observed as far as the Rh phenotype of the couples was concerned i.e. Rh Neg. wife with Rh +ve husband (Group 1), Rh +ve wife with Rh +ve husband (Group 2) and Rh +ve wife with Rh Neg. husband (Group 3) having 22, 295 and 15 couples respectively. Male dominancy was observed in group 1 and female in group 2. The Rh-negative group was more prevalent in female partners than male partners. (Table 3).

Table 3: Live Birth Status and Rh Phenotype combinations of parents (n=332)

Group	Rh Mating types	No. of Couples	Total Live Births	Female	Male
1	Wife (-ve) + Hus (+ve)	22	37 (1.68)	16 (43.2)	21 (56.8)
2	Wife (+ve) + Hus (+ve)	295	486 (1.65)	248 (51.0)	238 (49.0)
3	Wife (+ve) + Hus (-ve)	15	32 (2.13)	15 (46.9)	17 (53.1)
	Total	**332**	**555 (1.67)**	**279 (50.3)**	**276 (49.7)**
	p value		0.609		

When the results were observed from another aspect to find the association of gender with phenotype of the father, then it was found that from the total 332 couples, 87 fathers had O Phenotype, 68 had A, 152 had B and 25 fathers had AB Phenotype. O phenotype type fathers were responsible for 144 live births with 64 male children (44.4%) and 80 females (55.6%). A type fathers had 133 live births including 54 males (47.8%) and 59 female children (52.2%). B type father had 260 live births including 137 males (52.7%) and 123 female children (47.3%). AB type father had 38 live births of 21 male (55.3%) and 17 female children (50.3%)(Table 4)

Table 4: Paternal phenotype and status of live birth in the study population (n=555)

Father's Phenotype	No. of Couples	Live Births	Male	Female
O	87 (26.2)	144 (1.66)	64 (44.4)	80 (55.6)
A	68 (20.5)	113 (1.66)	54 (47.8)	59 (52.2)
B	152 (45.8)	260 (1.71)	137 (52.7)	123 (47.3)
AB	25 (7.5)	38 (1.52)	21 (55.3)	17 (44.7)
Total	**332**	**555 (1.67)**	**276 (49.7)**	**279 (50.3)**
p value		0.368		

Apparently on seeing the results from table 4 it was found that O type father had maximum female child i.e. 55.6% and AB type had maximum male child i.e. 55.3% and vice versa. But when tested statistically then it was found that phenotype of the father had no effect on the gender of the child born or we can say that gender of the child and phenotype of the father were both independent attributes (p=0.368).

DISCUSSION

On review the different literatures for association of blood group with different attributes like disease, personality, behaviour etc, we found that some of the studies established the association of blood group with these attributes at molecular level and some are based on the observations.

Blood Group and diseases

Group A individuals rarely may acquire a B antigen from a bacterial infection that results in the release of a deacetylase enzyme. This converts N-acetyl-D-galactosamine into α- galactosamine, which is similar to galactose, the immunodominant sugar of group B, there by sometimes causing the red cells to appear to be group AB. In the original reported cases, five out of seven of the patients had carcinoma of gastrointestinal tract. Case reports attest to the danger of individuals with an acquired B antigen being transfused with AB red cells, resulting in a fatal haemolytic transfusion reaction following the production of hyperimmune anti-B. (1)

Table 5: Type of diseases associated with blood groups and their risk profile

S. No.	Associated disease	Risk Profile	Blood group
1	Squamous cell carcinoma of skin[7]	Low	O
2	Basal cell carcinoma of skin[7]	Low	O
3	Breast cancer[8]	High	O
4	Cervix cancer [8]	High	B O
5	Lung cancer[8]	High	B
6	Buccal cancer[8]	High	B
7	Ovarian cancer[9]	High	B
8	Gastric cancer[10]	High Low	A O
9	Pancreatic cancer[7,11]	Low	O
10	Ischemic heart disease[12]	High	AB
11	Otitis media with effusion[13]	Low	O
12	Venous thromboembolism[14]	High	A,B,AB
13	Malaria[14]	Low	O
14	Cholera & GI infections by E.coli[14]	High	O
15	Smallpox[14]	High	A
16	Plague[14]	Low	O
17	H.pylori infection &GI Ulceratio[n[14]]	High	O
18	Diabetes mellitus type 2 (15)	High	B

The inheritance of ABH antigens is also known to be weakly associated with predisposition to certain diseases. Group A individuals have 1.2 times the risk of developing carcinoma of the stomach than group O or B; group O individuals have 1.4 times more risk of developing peptic ulcer than non-group O individuals; and non-secretor of ABH have 1.5 times the risk of developing peptic ulcer than secretor. (4) The ABO group also affects plasma von Willebrand Factor (VWF) and Factor VIII levels, group O healthy individuals have level around 25% lower than those of other ABO groups. (5) ABO blood group appears to mediate its effect by accelerating clearance of VWF but the mechanism is not yet clear. (6) ABH antigens are also frequently more weakly expressed on the red cells of persons with leukaemia.

Table 5 shows the association of different diseases with different blood groups and their respective risk profile. From this table, it is apparent that risk profile of Cervix cancer, lung cancer, Buccal cancer and Ovarian cancer is high in B type phenotype. Risk of Squamous cell carcinoma of skin, Basal cell carcinoma of skin, Pancreatic cancer, malaria, otitis media, and plague was found low in O type and this group faces substantial risk of Breast cancer, cholera and GI infections by E. coli and infection by H. pylori & GI ulceration. Group A people are in high risk zone of Gastric cancer, venous thromboembolism and small pox and Group AB of IHD. Blood group B people are at elevated risk while individuals with blood group O are at low peril of evolving type 2 diabetes.

Not sufficient literature is available on this topic except the research work of **Rex-Kiss B,** who concluded that due to the feto-maternal blood group incompatibility the sex ratio of the newborn will be higher. The most probable explanation for this fact is that the feto-maternal blood group incompatibility exerts a negative effect on the X chromosome, in consequence of which the elimination rate of the zygotes fertilized by Y chromosome-carrying sperms decrease and thus the sex ratio will be higher. The highest sex ratio was found among the D-negative new born of D-positive mothers (172.7), whereas the lowest one among the D-positive children of D-positive mothers (113.5). The incompatibility existing in the other antigens of Rh-system and in the ABO-system also elevated the sex ratio to a minor degree.(16)

CONCLUSION

It was concluded from the observations that different mating types of the parents and paternal phenotype has no effect on the gender of the child born. As no such study is available for reference which indicates any association of parental phenotype with the gender of the child. So, there is further scope of research on this topic with much bigger study population. These results may help the researchers in

the genetic and anthropology related studies and to understand the inheritance related issues.

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