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RESEARCH ARTICLE

ABO BLOOD GROUP POLYMORPHISMS IN RELATION TO DERMATOGLYPHICS: A CROSS-SECTIONAL STUDY

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ABSTRACT

Background: It has been identified that the ABO blood group system is controlled by a 2 loci gene system: locus ABO and locus H (*FUT1*), while Dermatoglyphics have been shown to be polygenic multi-factorial traits. Recent advances in genetic analysis have found a multitude of links between these two traits, but conclusive deductions are still pending. The current study was a cross-sectional study aimed at expounding Dermatoglyphics in different ABO blood types among a sex matched sample of 300 Ethiopian students from Jigjiga University, Ethiopia.

Results: The analysis revealed that there lies a significant association between fingerprint patterns and Dermatoglyphics (χ^2, $p<0.00001$). Pair-wise comparisons revealed higher loop frequencies for the A blood type relative to the B (OR= 1.52) and AB (OR= 1.96) blood types, lower loop counts in O relative to B (OR= 0.55) and AB (OR= 0.42) individuals, elevated whorl counts in A relative to B (OR= 1.72) and AB (OR=2.14) blood types, lower whorl counts in B (OR= 0.52) and AB blood types (OR= 0.42) relative to the O blood group, while none of the pair-wise comparisons revealed significant differences for the arch pattern. Further studies involving higher sample sizes and a thorough meta-analysis of the so far published findings are pivotal in order to come to conclusive deductions.

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INTRODUCTION

The ABO Blood Group System

The ABO blood group was the 1st blood group system to be discovered and described (Reid and Lomas-Francis, 2004). Following its discovery in 1901 by Karl Landsteiner, about 20 other independent blood group systems and nearly 600 discrete antigens have been identified (Daniels 2002; Reid and Lomas-Francis 2004). In the ABO system, the antigenic determinant oligosaccharide carbohydrate precursor molecule, a chain of 6 hexa-cyclic sugars that become fully functional when the sugar fucose is added to the terminal sugar, is attached to membrane lipids and proteins of RBC cell (Smith 2009). Two loci have been identified to be involved in the ABO system: the main Locus ABO, and the Locus H (*FUT1*)**.** The H locus, located in the first band on the long arm of chromosome 19 (specifically at 19q13.3), contains 3 exons that code for the enzyme *Fucosyltransferase*, and thus, can be said that it codes for the precursor molecule. On the other hand, the ABO locus consists of 7 exons located on the long arm of chromosome 9, the 3rd band, the 4th sub-band, and specifically between the 1st and 2nd regions within the 4th sub-band, i.e. 9q34.1- 9q34.2 [Yamamoto *et al.* (1990), Anstee, 2010]. The ABO locus shows a combination of complete dominance of both A and B over O, and, Co-dominance between A and B. Although there are many variant ABO alleles that encode a number of variant ABO phenotypes, they do not encode specific antigens other than the A and B antigens (Anstee, 2010). The locus codes for enzymes known as *Glycosyltransferases*, which transfer the determinant sugar molecules onto the terminal sugar in the chain. Thus, the A allele (I^A) codes for α-N-acetyl galactosamine transferase, which adds the sugar α-N-acetyl galactosamine onto the terminal sugar, while the B allele (I^B) codes for α-D-galactosyl transferase, which adds the sugar galactose onto the terminal sugar. The O allele (i^o or simply i) codes for no functional enzyme, and therefore fails to add any sugar residue to the precursor molecule.

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Dermatoglyphics and the ABO Blood Types: an overview

Dermatoglyphics are ridged patterns on the palmar and plantar surfaces of humans which develop approximately between the 13th and 18th weeks of gestation. They are complex polygenic multi-factorial traits ideal for population genetic, anthropologic, and clinical genetic studies, owing to several advantageous features they pose, including their manifestation of numerous quantitative and qualitative parameters ideal for comparisons and statistical procedures, including fingerprint patterns (Whorl, Loop, or Arch), finger ridge counts (TFRC and AFRC), palmar angles (ATD, ADT, and DAT), palmar a-b ridge counts, axial tri-radii (t, t', t''), and so on (Yohannes and Bekele, 2015).

Recent global trends of research on the genetic basis and clinical perspectives of Dermatoglyphics have revealed that a handful of quantitative and qualitative parameters manifest a significant association with ABO blood group phenotypes. Studies citable to this end that have expounded the associations between qualitative finger Dermatoglyphics (fingerprint patters) and the ABO phenotypes include: Bharadwaja *et al.* (2004), Sangam *et al.* (2011), Mehta and Mehta (2011), Bhavana *et al.* (2013), Rastogi and Pillai (2013), Eboh (2013), Ekanem *et al.* (2014), Deopa *et al.* (2014), Patil *et al.* (2014), Koneru *et al.* (2014), Ranjan *et al.* (2015), and Yohannes and Bekele (2015). The current report summarizes the findings of a university based cross sectional study done to analyze the polymorphisms of the ABO blood types with respect to Dermatoglyphic manifestations from a sample of students recruited from the University of Jigjiga, Ethiopia.

MATERIALS AND METHODS

Study Design

The study was conducted at the Jigjiga University, Jigjiga, Ethiopia from April to June 2015. The study followed a standard population descriptive clustered cross-sectional study methodology employed to sample 300 Ethiopian individuals (150 males and 150 females) from the major colleges within the university.

Ethical Considerations

The study protocols were approved by the CNCS department of biology. The selected participants explained of the purpose, procedures, details, importance, and outcomes of the study. They were further explained that participation was fully voluntary, and that they had a full right to withdraw from the study at any time they pleased without any constraints. Strict confidentiality of all the personal data was also assured. All participants were aged 18 years and above. Prior to participation, the participants were formally asked to sign a consent form.

Dermatoglyphic Data

Fingerprints were obtained by employing the standard ink-and-paper method (Cummins and Midlo 1964) using high quality forensic fingerprint ink.

The patterns were classified according to the standard methods of the Henry classification scheme into three basic types: Arches, Loops, and Whorls (Cummins and Midlo 1964).

ABO Blood Typing

Capillary blood was obtained from the fingertips by a trained laboratory technician using sterile disposable lancets. Two drops of blood were stained on a microscopic glass slide for blood typing using commercially available monoclonal A/B bodies.

Data entry and analysis

Data analysis was done using *SPSS (V.16) Statistical Analysis Package*. Chi-Square tests were employed to assess the overall significance of the associations between the blood groups and pattern scores. In order to quantify the specific differences in pattern frequencies between the ABO phenotypes, z-tests with Bonferroni's adjusted p-value proportion comparisons (with α=0.05 and α=0.01) were employed (Olejnik *et al.* 1997). Similarly, pair wise comparisons of blood groups for each pattern were made, entailing the quantification of Chi-Square association test p-values and odds ratios (OR) for each comparison pairs. Other Dermatoglyphic parameters including the Pattern Intensity Index, Dankmeijer's Index, and Furuhata's Index (Cummins and Midlo, 1964; Dankmeijer, 1938; Furuhata 1927) were quantified for further comparisons.

RESULTS

ABO Blood Group Distribution

The ABO blood group distribution in the study population (Fig. 1) revealed that the most common blood group is the O blood type (46.47%), followed by the A (27.33%) and B (19.80%) blood types. The least common blood group is the AB blood type (6.4%).

Fingerprint Pattern Distribution

The fingerprint pattern distribution in the study population (Fig. 2) has shown that the Loop pattern was the most common type of pattern (55.80%), followed by the Whorl pattern (38.33%). The least common pattern recorded was the Arch pattern (5.87%).

Pattern Distribution in the ABO Blood Group

The distribution of fingerprint patterns among the blood groups (Fig. 3) has shown that the sequence of patterns based on decreasing frequency in the blood types was in the order of Loop, whorls, and arches, except for the AB blood type, in which whorls were more common than the loops. Analysis of the distribution of blood groups with pattern types (Table 1) has revealed that the differences are highly significant ($\chi^2_{6\ d.f} = 72.19$, $p<0.00001$). Z-tests with Bonferroni's adjusted p-value proportion comparisons have revealed the following differences to be significant at the 0.05 level:

Table 1. Fingerprint pattern scores by ABO phenotypes with χ^2 results

Fingerprint Pattern	ABO Phenotypes				χ^2	D.F.[a]	p
	A	B	AB	O	72.187	6	<0.00001[b]
Loop	450	299	66	859			
Whorl	307	266	106	471			
Arch	63	29	20	64			

[a] Degrees of Freedom
[b] Very highly significant

Table 2. Pair-wise comparison of blood types with respect to their fingerprint manifestations, with χ^2 test results & risk analysis (odds ratios with lower & higher value confidence intervals)

Pattern	Blood groups compared	χ^2 P-value	OR	LCI 95%	HCI 95%
LOOP	A Vs B	0.002	1.516	1.168	1.968
	A Vs AB	0.002	1.962	1.272	3.025
	A Vs O	0.090	0.831	0.670	1.030
	AB Vs B	0.259	0.773	0.494	1.209
	B Vs O	0.000001	0.548	0.430	0.699
	AB Vs O	0.000047	0.424	0.278	0.646
WHORL	A Vs B	0.00006	1.717	1.319	2.235
	A Vs AB	0.0004	2.143	1.395	3.293
	A Vs O	0.348	0.900	0.721	1.112
	AB Vs B	0.325	0.801	0.515	1.247
	B Vs O	0.0000002	0.524	0.410	0.670
	AB Vs O	0.000032	0.420	0.276	0.638
ARCH	A Vs B	0.072	1.717	0.947	3.113
	A Vs AB	0.457	1.434	0.552	3.726
	A Vs O	0.098	1.452	0.931	2.263
	AB Vs B	0.731	1.197	0.428	3.351
	B Vs O	0.575	0.845	0.470	1.521
	AB Vs O	0.980	1.012	0.391	2.618

Table 3. Pattern intensity index (PII), Dankmeijer's index (DI), & Furuhata's index (FI) of the study population and their respective blood types

Blood Type	PII	DI	FI
A	12.98	20.52	68.22
AB	13.99	10.90	88.96
B	14.48	18.87	160.61
O	12.92	13.59	54.83
Pooled	13.25	15.30	68.70

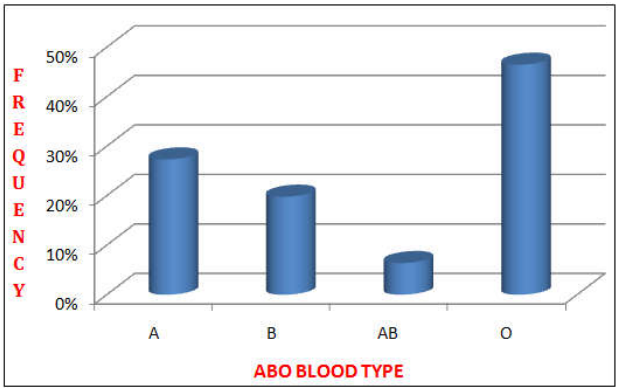

Figure 1. Percentage frequency of the ABO blood types in the study population

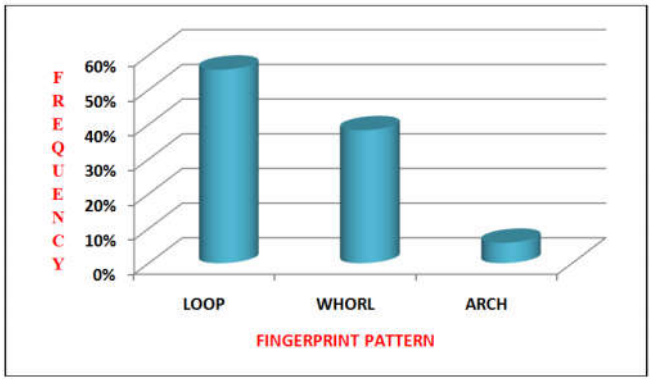

Figure 2. Percentage frequency of the fingerprint patterns in the study population

1) For the loop pattern, blood type O has higher loops than all the other 3 blood types; A and O blood types have higher loops than the AB blood type; AB blood type has a decreased frequency of loops compared to the other 3 blood types.
2) For the whorl pattern, the B blood type manifested higher whorl frequencies than the A and O blood types;
3) AB manifested higher whorl frequencies than the A and O; whorls were relatively decreased in frequency among the A and O blood types compared to the B and AB blood types.
4) For the arch pattern, A blood type manifested higher arch frequencies than the O blood types, while the AB blood type manifested higher arch frequencies than the B and O blood types.

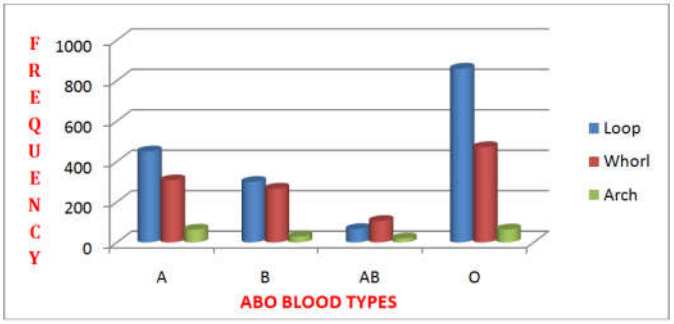

Figure 3. Frequency of the fingerprint patterns among the ABO blood types

Similarly, the z-tests have revealed the following differences to be significant at the 0.01 level:

1) For the loop pattern, blood type O manifested higher loops than all the B and AB blood types; A and B blood types have higher number of loops than the AB blood type; AB blood type has a decreased frequency of loops compared to the other 3 blood types.
2) For the whorl pattern, the B blood type manifested higher whorl frequencies than the O blood types; the AB blood type manifested higher whorl frequencies than the A and O blood types.
3) For the arch pattern, the AB blood type manifested higher frequencies than the B and O blood types.

Pair-wise comparisons of blood groups for each pattern (Table 2) have shown that the loop pattern differences were significant for A Vs B ($p=0.002$, OR= 1.52), A Vs AB ($p=0.002$, OR= 1.96), B Vs O ($p<0.001$, OR= 0.55), and AB Vs O ($p<0.001$, OR= 0.42), showing that the A blood type has higher loop frequencies than the B and AB blood types, while O blood type had higher loop counts than the B and AB blood types. Similarly, for the whorls, the pair-wise comparison differences among the blood groups returned significant results for the A Vs B ($p<0.001$, OR= 1.72), A Vs AB ($p=0.002$, OR= 2.14), B Vs O($p<0.001$, OR= 0.52), and the AB Vs O comparisons ($p<0.001$, OR= 0.42), showing that the odds of getting whorls is higher among the A blood type relative to the B and AB blood types, while it is lower among the B and AB blood types relative to the O blood group. In contrast, none of the pair-wise blood group pattern frequency comparisons revealed significant differences.

Pattern Indices

The pattern indices in the study population (table 3) scored mean values of 13.25, 15.30, and 68.70 for the PII, DI, and FI respectively. Specifically, the PII and FI scored the highest and lowest mean values for the for the B and O blood types respectively. In contrast, the highest and lowest mean DI values were recorded for the A and AB blood groups respectively.

DISCUSSION

Recent global trends of research on the genetic basis and clinical perspectives of Dermatoglyphics have revealed that certain quantitative and qualitative parameters reflect significant associations with ABO blood types. This issue has been debated by the researchers regarding the fingerprint patterns, with a hand full of findings reporting significant associations (Bharadwaja *et al.,* 2004; Sangam *et al.* (2011; Mehta and Mehta, 2011; Bhavana *et al.,* 2013; Rastogi and Pillai, 2013; Deopa *et al.,* 2014, Patil *et al.,* 2014; Koneru *et al.,* 2014; Ranjan *et al.,* 2015; Yohannes and Bekele, 2015), while a few have found no significant difference between Dermatoglyphic manifestations among the ABO blood groups (Eboh, 2013; Ekanem *et al.,* 2014). The current study has revealed that the association between the ABO blood types and the underlying finger Dermatoglyphic parameters is significant. For the loops, the A and O blood type manifested higher frequencies than the B and AB types. Similarly, the odds of getting whorls was higher among the A blood type relative to the B and AB blood types, while it is lower among the B and AB blood types relative to the O blood group. In contrast, none of the pair-wise blood group pattern frequency comparisons revealed significant differences for the arches.

Regarding the pattern indices in the current analysis, the PII and FI mean values for the studied population were found to be 13.25 and 68.70 respectively. These values are in concordance with the findings of another study done from another part of the same country (Ethiopia), which reported mean PII and FI values of 12.94 and 67.00 respectively (Yohannes and Bekele, 2015). On the other hand, the mean DI (13.59) was found to be slightly lower than the afore mentioned value of 20.71, which can be attributable to slight arch to whorl ratio differences among the two populations, with arches being more common among one of the ethnic groups within the population, namely the Bertas, in the previous study. Similar trends have also been observed for the pattern indices with respect to the blood types, with the mean values being in accordance with the study from Ethiopia, apart for some slight differences. The highest values for the PII, DI, and FI means were recorded for the B, A, and B blood types respectively, while they were reported among the B, AB, and B types respectively in the study of Mehta and Mehta (2011) from an Indian population, showing a difference for the DI scores of the studies.

Conclusions and Recommendations

The association of the ABO blood types with fingerprint patterns and other Dermatoglyphic parameters has been a recent topic of debate among various researchers.

This disagreement revolves not only around the issue that there is an association per se, but also for which blood types manifest peculiar differences relative to one another in each of the Dermatoglyphic parameters, and also the underlying genetic mechanism behind this association. The current study has revealed that there lies a significant difference in fingerprint pattern distributions among the ABO blood types, with this association primarily attributable to disparities of the loops and whorls among the blood types. Since various discrepancies are observable among the findings of studies so far that have tried to assess the link between the ABO blood types and Dermatoglyphic parameters, we suggest two approaches to come to more conclusive deductions. First, larger studies, and if possible, those incorporating comparable number of samples for each of the 4 ABO blood types, need be done.

Finally, a systematic review of the literature incorporating standard meta-analytic techniques would have profound benefits as to summarize the overall differences and to what extent these variations are significant.

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