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Research Article

Blood group genetics with special reference to the tribe's health of Nagaland

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ABSTRACT

India's race, religion, and caste are quite diverse. Even within the same nation, regional variations exist in the ABO blood type and the Rh system. The current research examined the relationship between diseases and the ABO blood type among Nagaland's Chakhesang ethnic communities. This research considered the population of sick people with ABO blood types. One hundred persons, including men and women from the Chakhesang tribe, served as research respondents. The Chakhesang Naga tribe was selected for this study because of the documented higher prevalence of hypertension and diabetes mellitus within this group compared to the broader regional population. The study also aimed to explore a possible association between these health conditions and blood type A. The ABD antisera typing Kit's standard methodology was followed for blood group testing. S2 ABO software was used to compute the Hardy-Weinberg model, and the chi-square test was used to compare the results. In this research, we discovered that blood type A was more likely to develop hypertension and diabetes than blood types B and O (blood type A, $X^2 = 16.3$, $P = 0.00$*; blood type B, $X^2 = 18$, $P = 0.00$*; blood type O, $X^2 = 0.085$, $P = 0.87$). This might imply that blood type A may be genetically predisposed to diabetes and hypertension more than other blood types. Our research shows that, compared to healthy individuals, the prevalence of hypertension and diabetes was much higher in the general population. The Chakhesang Naga tribe has the highest prevalence of blood type B, while those with blood type A are the most afflicted and sensitive to hypertension and diabetes. A key limitation of the study is that the findings are based on a specific population and may not be generalizable. Larger and more diverse cohorts are needed to evaluate their broader applicability.

1. Introduction

Two systems of antigens or proteins on the surface of red blood cells, the ABO and the RhD systems, determine the blood types that most people are acquainted with O-negative or AB-positive.[1] The RhD system assigns a positive or negative label based on whether the RhD antigen is present. In contrast, the ABO system classifies people's blood as type A, B, or AB if they contain A or B antigens or type O if they do not.[2] Recent research has shown that individuals with blood type A and/or B may have an increased risk and severity of several diseases.[3] Although the relationship between blood types and disease is well recognized, it has yet to be investigated in many circumstances. Clinicians may be able to identify patients who need to be monitored closely and include blood type information in prediction models if they are aware of the variations in risk and severity of illness between various groups.[4] The blood type systems are the same across all human groups, although ABO and RhD antigen frequencies differ. ABO and Rh systems have intricate global distribution patterns.[5] In addition to differences across species, variations within members of the same species have also been well documented. Even though the relevant antigens are fixed throughout

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life, the phenotypes of the *ABO* and *Rh* genes differ significantly across racial and regional boundaries.[6] Many studies have been done on the frequencies of ABO and Rh traits in various populations.[7]

Contrary to numerous other studies conducted in different regions where blood type O has been reported to be the highest and most common, studies conducted in Western parts of India, such as in Ahmedabad, Surat, and Maharashtra, showed that blood type B is the most common followed by A and AB.[8,9] According to the study, blood type O was discovered to be more widespread in India, despite previous reports that blood type O was more common in South India and blood type B in Northern India.[10,11] Several more investigations have been done where variances in the species' individuals have been observed. The ABO blood type polymorphism is still crucial for population genetic research, predicting the supply of compatible blood, assessing the likelihood that a newborn may have a hemolytic illness, settling paternity/maternity disputes, and forensic applications.[12]

The Chakhesang Naga tribe is among the most prominent in Nagaland, with their health concerns indicative of genetic composition, physical activity levels, and limited access to healthcare services.[13] They may be genetically predisposed to certain diseases; when combined with conditions such as poor diet and reduced physical activity, they may develop hypertension and diabetes. This understanding is essential for effectively intervening and addressing the needs of the community in question. This study aims to elucidate the interaction between genes and the environment, with the expectation that the findings may assist in identifying and potentially mitigating health disparities impacting indigenous populations. Although the ABO blood type antigens are constant throughout life, the distribution of blood types among different communities, ethnic groups, and geographical boundaries vary over time, even within the same region.[14] The ABO blood types appear to be markers for various human diseases, including cardiovascular, neoplastic, and infectious conditions.[15] It has also been suggested that they are associated with certain personality characteristics. Hence, knowing the distribution of ABO and Rh blood types within communities is important and helpful for safe blood transfusion and health care programs.[16]

Many investigations revealed that the ABO blood type has little but significant influence in predisposing to several human disorders and its vital significance in transfusion medicine.[17,18] The relationship between blood types and various diseases, including cancers, peptic ulcers, gastric carcinoma, infections, diabetes mellitus, dermatologic conditions, heart disease, dental caries, periodontal diseases, pregnancy complications, and other diseases, has been studied with varying degrees of success, with some studies showing an increased risk of some diseases with the ABO blood types before the study.[16] Those with blood type O may have a decreased risk of thromboembolic illness and pancreatic cancer compared to people with other blood types.[19] According to a study, those with blood types A and O are more likely to have stomach cancer and peptic ulcers, respectively.[20] According to further research, people with blood type A had a lower chance of developing isolated congenital heart disease (CHD) than those with other blood types.[21] Epidemiology research has shown that some chronic inflammation-related disorders, such as cancer and cardiovascular disease, are linked to certain ABO blood types.[22] According to research, people with blood type O are more likely to get denture stomatitis. One of the most recent instances of a disease statistically connected to an ABO blood type is the Chikungunya virus infection.[23,24]

The ABO blood types and the risk of coronary heart disease, atherosclerosis, and venous thrombosis have been linked in several studies. According to research by Hilde and colleagues, blood types A and B were linked to a higher probability of thromboembolic events and lower odds of hypertension than those with blood type O.[25] ABO blood types have been linked to many disease phenotypes, notably cardiovascular illnesses, which are the leading cause of mortality in industrialized nations and are becoming increasingly prevalent. Recent genetics research reveals that a person's genes and blood type may influence their likelihood of contracting a more dangerous variant of COVID-19 should they get infected with the new coronavirus.[26]

A genetic analysis of COVID-19 patients in recent research revealed that blood type might affect whether someone gets a serious condition. According to a genetic study of the patients, people with blood type A had a higher risk of contracting COVID-19 than people with other blood types. In contrast, people with blood type O had a lower risk of infection than people with different blood types, marking the first report of a link between the ABO blood type and SARS-CoV-2.[19] Those with blood type A had a much greater chance of contracting SARS-CoV-2 infection, but those with blood type O had a significantly reduced risk, according to the results of a second research on the subject. Age and gender also showed a significant relationship with the infection. According to the research, male patients over 60 were similar to the infected individuals.[27] While many different clans and tribes inhabit the area, genetic studies and health research linked to blood type on individuals in North-east Indian tribal communities have been conducted less often than in other regions of India. The goal of the current study, which is being conducted among the general population of the Chakhesang Naga tribe, is to observe the distribution patterns of the ABO and Rh blood type systems among them, to monitor the rising prevalence of diseases within the tribe, and to comprehend the people's health status.

2. Materials and methods

2.1. Sampling location

The research is carried out in Nagaland's Kohima district. The state capital of Nagaland, Kohima, has an area of 6401 square miles (16,579 km^2), a population of 267,988, and 45 % of its residents live in urban areas. It is situated in the southern section of the state. After Dimapur district, it is the second most populated district in Nagaland. To determine the distributional pattern of the ABO and Rh blood type systems and to assess the prevalence of emerging illnesses in the tribe, a non-experimental prospective observational research on Chakhesang Naga people residing in several areas of Kohima was carried out.

2.2. Study population

One hundred volunteers, including men and women from the Chakhesang tribal tribe, served as research respondents. The sample comprised 100 participants from the Chakhesang Naga tribe, with a 50:50 gender ratio, and included individuals from all age groups within the 18–70 age range. The experimental group consisted of individuals with conditions such as hypertension and diabetes, whereas the control group included clients without these conditions. In other research, including Indian communities, the prevalence of hypertension and diabetes was lower, often ranging from 20 % to 30 % and 10 %–15 %, respectively.[28] Hypertension prevalence was significantly elevated among the Chakhhesang tribe at 36 %, whereas diabetes was observed at 18 %, indicating potential hereditary or environmental influences within this society. The current study identified a greater incidence of blood type B in the Chakhesang tribe compared to other regions of India, where blood type O is typically reported as frequent, alongside blood types A and O. They advocate for more targeted health intervention strategies and additional genetic research to identify the origins of these varying trends. The distinction is preserved throughout the publication to provide clarity and prevent confusion, with the author guaranteeing that the comparisons made in the study are accurately represented. When studying the complete population is not feasible, a smaller sample is collected using a random descriptive sampling methodology. The survey method was used on the respondents to obtain their details, such as name, type of illness, and blood type.

2.3. Data collection

Since the study was descriptive, the researchers thought the survey technique would be a good choice for gathering data. Based on the 5-point Likert scale approach, the researchers have created 2 sets of questionnaires for the treatment and control groups, respectively. Also, pilot research with 50 respondents verified the designed questionnaire. The pilot research revealed that another 50 respondents employed certain fixed corrections and similar blood typing procedures. Using Microsoft Excel, the obtained data were coded and evaluated in terms of percentage and mean score.

2.4. Laboratory analysis

After sample collection, ABO and Rh blood type testing was carried out in the lab using the established ABD antisera typing Kit procedure. ABO typing is the identification for the blood typing test. Antibodies against type A and type B blood are combined with a sample of your blood. The sample is next examined to determine whether or not the blood cells adhere to one another. Blood reacting with one of the antibodies results in blood cells adhering to one another. Visit www.anamollabs.com for more information on ordering and the ABD antisera typing Kit method. This methodology used in this investigation is schematically depicted (Fig. 1). A total of 100 participants, including both men and women from the Chakhesang tribal region, donated blood samples. Participants were categorized into control and patient groups using structured questionnaires, and the responses were recorded using Microsoft Excel for subsequent analysis. Blood typing was performed using the ABD antisera typing Kit. Appropriate statistical analyses were conducted to interpret the data. To ensure the accuracy of the disease survey, all participants were explicitly instructed to report only conditions that a licensed physician had diagnosed. This approach was employed to minimize the potential for self-reported inaccuracies and to ensure the reliability of the data collected.

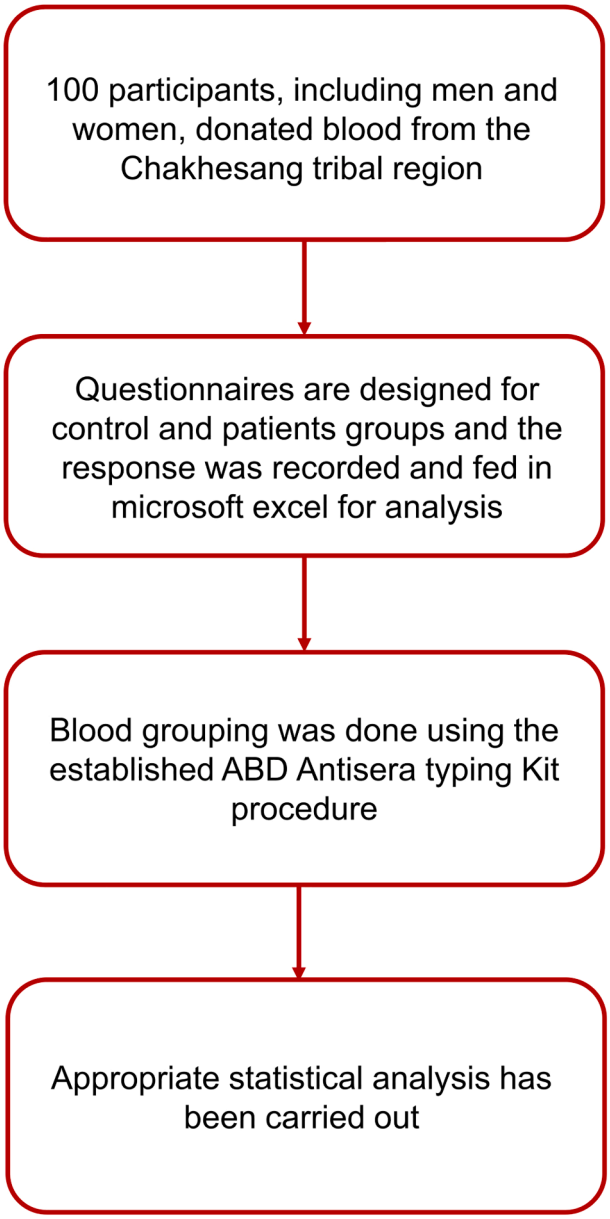

Fig. 1. The schematic representation of the methodology used in the study.

2.5. Statistical analysis

The Hardy-Weinberg model, which uses the S2 ABO estimator software, determines blood type gene and allele frequencies. On the presumption of Hardy-Weinberg equilibrium (Table 1), 10 allele frequencies are computed and given as percentages. The reported genotypic and allelic frequency distributions of the blood type and Rh antigens are compared to those under the Hardy-Weinberg model using the Chi-square test.

3. Results

Several studies have reported the frequency of blood types among people in India. Still, till now, only a few have been carried out among people living in the northeastern region of the Indian subcontinent.[9] Allele frequencies for the ABO and Rh factor loci were estimated using the software after 100 members of the Chakhesang Naga tribe in Nagaland had their blood typed for the ABO blood loci. Table 2 shows the gene frequencies, *HW-EML*, and genotypic frequency of ABO blood types among the Chakhesang Naga tribe. The observed allele frequencies of *P*[A], *Q*[B], and *R*[O] were 0.19, 0.084, and 0.73, with a log-likelihood of −106.13. These results are in concordance with expectations for this population, as the genotypic distribution is O>A>B. The χ^2 value obtained was 0.63 while the *P* was 0.42, a fact that implies no significant departure from Hardy-Weinberg equilibrium. Further, the Rh factor has a 100 percent prevalence of the *Rh-positive* gene, and no *Rh-negative* gene was detected. The distribution of ABO blood type phenotypes in hypertension cases and control subjects of Chakhesang tribe is presented in Table 3. Phenotype *A* was more frequent in cases (43 %) compared to controls (20 %), with a statistically significant χ^2 value of 16.3 ($P = 0.00$) and an odds ratio (*OR*) of 4.4 (95 % confidence interval (*CI*): 2.09–9.99). Conversely, phenotype *B* was less frequent in cases (37 %) compared to controls (53 %), also showing a significant association ($\chi^2 = 18.0$, $OR = 0.27$, 95 % *CI*: 0.17–0.57, $P = 0.00$). Phenotype *AB* was not found in either group. Phenotype *O* mean values in cases were 67 % and in controls 56 % with $\chi^2 = 0.085$, $P = 0.87$. The results provided here indicate possible links between phenotypes *A* and *B* and hypertension in this sample population.

3.1. Neighbor-joining (NJ) tree analysis for population relationships

The population's genetic affinities and neighbor-joining trees are determined in this study using phylogenetic tree construction. Neighbor-joining (NJ) trees were built utilizing several published research studies in the tribes of India and the globe, utilizing the same loci/alleles to explore the genomic affiliations of the ten tribal communities of Nagaland under examination. The ABO blood type allele frequency data from eleven study tribal communities were utilized in the first analysis. The study suggests a strong connection between each of the Naga tribes. This tree demonstrated the kinship between the Chakhesang and Sumi Naga

Table 1
Hardy-Weinberg model for ABO blood type.

Phenotype (blood type)	Genotype	Phenotype frequency	Genotype frequency	Expected (blood type frequency)
A	*AA + AO*	*nA*	*nAA + nAO*	$P^2 + 2PR$
B	*BB + BO*	*nB*	*nBB + nBO*	$Q^2 + 2QR$
O	*AB*	*nAB*	*nAB*	*2PQ*
AB	*OO*	*nO*	*nOO*	R^2

Table 2
ABO blood types and allele frequencies among the Chakhesang Naga tribe.

Naga tribe	Gene frequency			Hardy- Weinberg log likelihood	Genotypic frequency	$\chi 2$	*P*-value	Rh+(D)	Rh-(D)
	P[*A*]	*Q*[*B*]	*R*[*O*]						
Chekhesang	0.19	0.084	0.73	−106.13	*O* > *A* > *B*	0.63	0.42	100	0

χ^2: Chi-square with 1 degree of freedom.

Table 3
Distribution of ABO phenotype frequency for hypertension and control subjects of Chakhesang tribal populations.

ABO type	Case	Control	χ^2	*OR*	*CI*	*P*-value
A	43	20	16.3	4.4	2.09–9.99	0.00*
B	37	53	18.0	0.27	0.17–0.57	0.00*
AB	0	0	–	–	–	–
O	67	56	0.085	0.915	0.60–1.65	0.87

χ^2: Chi-square with 1 degree of freedom; *OR*: odds ratio; *CI*: Confidence interval; *: Statistically significant.

tribes (Fig. 2). The tree illustrates the clustering patterns of various Naga tribes, including the Chakhesang (Kohima and Dimapur), Sumi, Angami, Lotha, Zeliang, Mao, Ao, Sangtam, Phom, and Konyak populations. Bootstrap values are indicated at branch points to represent the confidence level of each cluster.

Using the ABO blood data common to the current study, data from previous reports were computed to construct an NJ tree.[29–37] The same was depicted to determine the genomic affinities of the study populations with other Indian populations and the World.[31–34,38–42] According to this tree, the Chakhesang Naga are more closely related to other War Khasi, Adikomtan, and Khasi tribal communities than to their Indian tribe neighbors.

3.2. Principal coordinates analysis (PCoA)

Principal coordinates analysis (PCoA) investigates and depicts data similarities and differences as 2D or 3D images. This research showed that the Naga tribe populations are spirited from other Indian populations. It was based on ABO polymorphic loci of the current study, which were used to determine their proximity to other Indian groups. The Naga tribe is distinct from other world groups, according to a second PCoA analysis of the current research based on ABO polymorphic loci to assess their affinity with other Indian and global populations (Fig. 3). The plot displays the relative positioning of 11 Naga tribes based on pairwise distances derived from genetic or phenotypic data. Coordinate 1 and Coordinate 2 represent the 2 principal dimensions capturing the variation among the populations. Closer clustering of groups suggests genetic or trait similarity, while distant positioning indicates greater divergence. The ABO polymorphic loci data made publicly available were employed for both analyses.

3.3. ABO blood genetic impact on the health of Chakhesang tribal populations

Limited research has been done on the genetics and epidemiology of illness in different Indian tribal cultures. This research looked at the prevalence of ailments, including hypertension, diabetes, ulcers, asthma, anemia, skin allergies, typhoid fever, nerve difficulties, tuberculosis, cancer, heart problems, and genetic abnormalities, among 4 South Indian tribal tribes being studied.

The proportion of illness distribution in the Chakhesang ethnic groups is shown in Table 4. The Chakhesang tribe of Nagaland has the highest rate of hypertension. Chakhesang ethnic groups were found to have the highest percentage of hypertension (36 %). Significant percentages of the study population also had diabetes, nerve disorders, and heart problems (Fig. 3).

The hallmarks for identifying the genetic basis of complex disorders include association studies between genetic variations and diseases. Understanding the genetic etiology of complex human features and the link between allelic and genotype frequencies of candidate genes among afflicted and healthy participants is an effective way to shed light on the disease pathogenesis of these traits. We then attempted to clarify if there may be a connection between the Chakhesang ethnic groups of Nagaland's hypertension and diabetes and the ABO blood polymorphisms

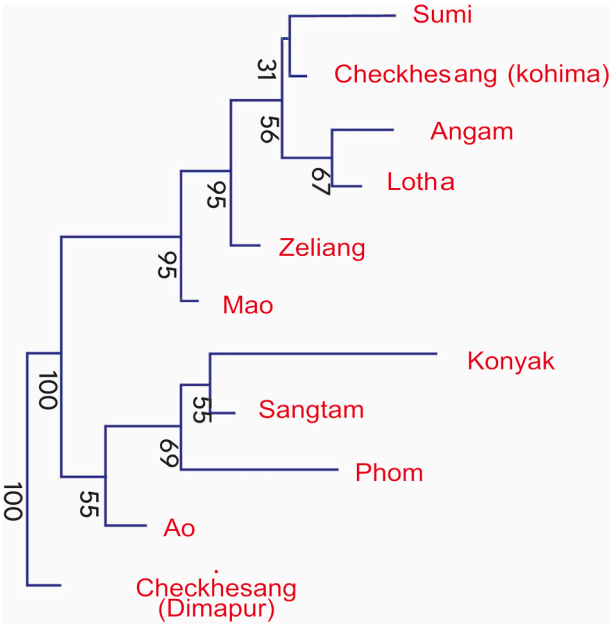

Fig. 2. Neighbor-joining tree depicting genomic affinity among the 10 tribal populations of Nagaland.

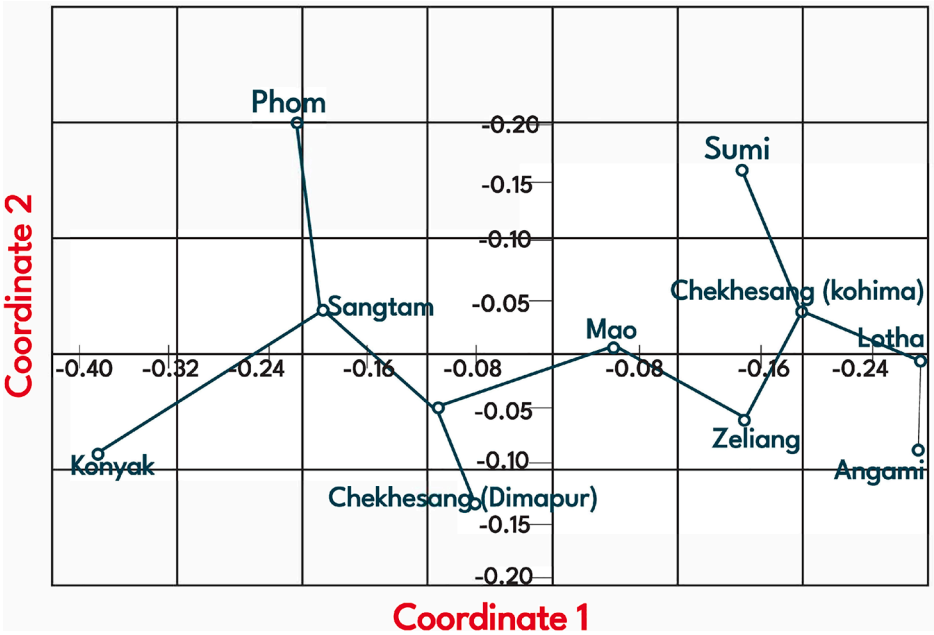

Fig. 3. Principal coordinates analysis based on allele frequencies of ABO polymorphic loci for the Naga tribe.

Table 4
Distribution of ABO phenotype frequency in percentage for diabetes and control subjects of Chakhesang tribal populations.

ABO blood	Case	Control	χ^2	*OR*	*CI*	*P*-value
A	58	18	29.9	4.6	2.06–9.97	0.00*
B	29	49	9.81	0.39	0.20–0.70	0.02*
AB	0	0	–	–	–	–
O	39	457	3.9	0.59	0.31–0.98	0.06

χ^2: Chi-square with 1 degree of freedom; *OR*: odds ratio; *CI*: Confidence interval; *: Statistically significant.

(Fig. 4). Hypertension accounts for the highest in the Chakhesang tribal populations of Nagaland. Hypertension accounts for more portions of Chakhesang tribal populations found to be maximum. Diabetes, nerve problem, and heart problems were also present at notable percentages in the study populations.

3.4. Hypertension

Many studies have investigated the prevalence of ABO and Rh blood types in different populations and ethnic groups. These studies have been undertaken for several reasons: their importance in blood transfusion and organ transplantation, their application in genetic research, forensic pathology, and anthropology, and studying the ancestral relationships of humans.[22] Blood type prevalence studies are also important in managing blood product resources in the community and assessing different disorders related to blood types.[19] The Chakhesang ethnic people's ABO blood and type of hypertension relationships were examined. The *blood type O* allele was more common in hypertension patients than controls, as indicated in Table 3. Phenotype distributions, allelic frequencies, and the associated *OR* were determined for each mutation. The phenotype combination of the population (*blood type A and B* allele) was statistically significant respectively ($P = 0.00$).

3.5. Diabetics mellitus

The ABO system comprises four groups, A, B, AB, and O, determined genetically by 3 allelic genes on chromosome 9.[3] The distribution of blood types varies regionally and ethnically, and there have been several studies on the distribution of ABO and Rh blood types in different geographical, ethnic, and socioeconomic groups.[39] Among the Chakhesang tribal communities, the association between ABO blood type and type 2 diabetes mellitus (T2DM) was examined. As stated in Table 4 and it was discovered that T2DM sufferers were more likely to have the *Blood type O* allele than controls. Phenotype distributions, allelic frequencies, and the associated *OR* were determined for each mutation. The phenotype combination (*blood type A and B* allele) was statistically significant ($P = 0.00$ and $P = 0.02$).

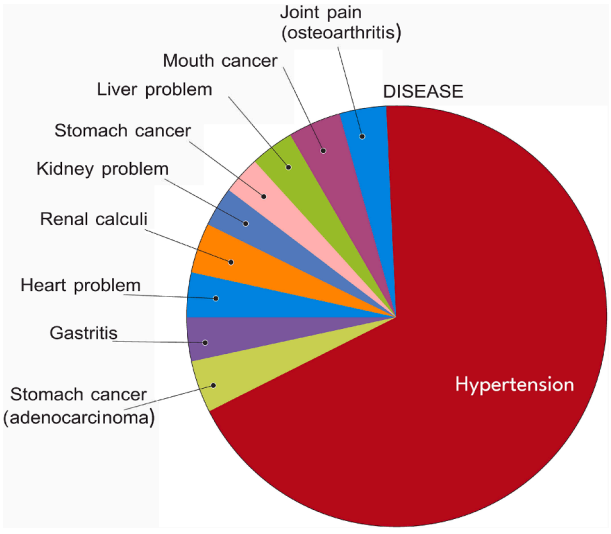

Fig. 4. The percentage of distribution of diseases in the Chakhesang ethnic populations.

4. Discussions

Life is impossible without blood. It is the most significant bodily fluid in that it circulates and transports the most vital chemicals, including oxygen and other crucial nutrients, enzymes, and hormones, throughout the body's cells.[40] An Australian physician named Landsteiner discovered the ABO blood types in 1901.[41] Subsequently, in 1940, Landsteiner and Weiner discovered the Rh blood type. Although the second most significant blood type in terms of transfusion, the Rh blood type system was the fourth to be identified.[42] The 2 most important clinically relevant blood type antigens are known to be ABO and Rh.[43] Based on the presence or absence of a hereditary antigenic component that certain antibodies can detect on the surface of red blood cells, the 4 primary ABO blood type systems or blood types, A, B, O, and AB, are divided.[44]

A and B are highly antigenic, and anti-A and anti-R antibodies are naturally occurring antibodies found in the serum of a person missing the matching antigen.[45] These antibodies are capable of causing intravascular hemolysis in the event of incompatible transfusion.[46] Antigen A is present in blood type A red blood cells, while anti-B antibodies are in the serum. Anti-B and anti-A antibodies are present in blood type B as well. A and B antigens are present in blood type AB. However, there are no antibodies.[47] Blood type O contains both anti-A and anti-B antibodies but no antigens. Anti-A and anti-B antibodies typically belong to the IgM subclass (Immunoglobulin M), and they initially develop in the first year of life. The finding of blood types is crucial for the transfusion of blood amongst diverse populations, regardless of their ethnic origin, for organ transplantation, for the advancement of legal medicine, genetic research, anthropology, and training about human ancestry.[48]

Race, religion, and caste are all quite diverse in India. Even within the same nation, regional variations exist in the ABO blood type and the Rh system. The current research results indicated that blood type O was most prevalent among the Chakhesang tribe's common folk, followed by blood types A and B. A, B, and O each had a frequency distribution pattern of 0.19, 0.084, and 0.73, respectively. According to this research, blood types should be in the same sequence as they were in Pojar's 2,000 reports on the Chakhesang Naga tribe, where blood type O was shown to have the greatest frequency, followed by blood types A, B, and AB (O>A>B>AB).[49] Blood type O is most frequent in studies of various northeastern Indian tribes, followed by other blood types, in contrast to the research on Regmas, which found that blood type B was more abundant than other blood types.[50] Blood type A was found to be most prevalent among Brahmins (35 %), and blood type O was most prevalent among Muslims (49.50 %) in separate research on Manipur tribes.[51] According to a study on Bangladesh's tribal population, blood type A is most prevalent among the Meitei tribes, whereas blood type O is most prevalent among the Khaisias.[29] While studies have shown that blood type O is more frequent in South India[52,53] and blood type B is more prevalent in Northern India, it has been claimed that blood type O was found to be more common in India.[11,24,54] The sole difference between the blood type systems of all human cultures is the frequency of certain kinds. ABO, Rh, and MN group prevalence vary globally and among racial groups.[55] ABO blood types are crucial for understanding racial migration and inherited diseases. Understanding how various blood types and illnesses interact is vital since certain diseases are more likely to develop in particular blood types.[56] In addition, we observed some differences from the previous study,[6] especially in the frequency of occurrence in some blood types and other diseases. These differences may flow from size, population, or other factors assignable to the Chakhesang tribe's environment. Furthermore, there are differences in methods, including diagnostic criteria or data collection techniques, which may have predisposed the differences. Studying these factors underscores the need to conduct research confined to certain regions to include the improving res of genetic and environmental certainties of various populations. The leading cause of mortality in humans is an illness, notably cardiovascular disease,[57] and their prevalence rate is rising quickly. One of the most prevalent risk factors for heart disease is hypertension. Because it participates in the etiology of CHD and its substantial correlation with modifiable risk factors such as adiposities, age, stress, and excessive salt intake,[58] it is a chronic condition of concern. This study identifies a substantial difference in blood type concerning hypertension and diabetes ($P<0.05$), suggesting a hereditary predisposition within the Chakhesang tribal people. However, it must be acknowledged that these findings are not statistically significant alone. The heightened occurrence of serious disease in individuals with blood type A may be attributed to biological variations in the expression of glycoproteins or inflammatory pathways linked to the ABO blood type. These discoveries underscore the necessity of integrating blood type data into public health strategies to enhance the well-being of populations most susceptible to chronic diseases.

According to the current research results, diabetes (18 %) and hypertension (36 %) are the 2 aconditions that affect the Chakhesang Naga tribe's common folk the most often. We found that the blood type A positive was more often impacted and sensitive to hypertension and diabetes and that the blood type B exhibited the highest prevalence of the illness in both the male and female populations of the tribe. This would imply that people with the A blood type are genetically predisposed to hypertension and diabetes. Nevertheless, a study of a tribal tribe in Rajasthan reveals that those with high blood pressure are more likely to have blood type B.[59] Another research revealed that most of those with blood type AB had greater systolic blood pressure (SBP), which was an outstanding result. Several studies have also shown a similar relationship between blood pressure and ABO blood types.[60] According to further research, those with the ABO blood type antigens A, B, and O are more likely to develop hypertension.[61,62]

NJ trees make it simple to understand population linkages. NJ trees were built utilizing several published studies in the tribes of India and internationally using the same set of loci/alleles to examine the genetic affiliations of the native population of Nagaland. ABO blood polymorphism loci alleles are utilized to build the tree in the NJ tree to determine the genetic affinities among the Naga tribal tribes under investigation. Surprisingly, this tree revealed that compared to the other 10 Naga tribes of Nagaland, the Chakhesang tribe is most similar to the Sumi tribe.

The current study reveals that the Chakhesang tribal people with blood type A exhibit a greater prevalence of hypertension and diabetes compared to other blood types. Nonetheless, these findings must be regarded with skepticism and should be rigorously assessed in the context of previous studies.[3,63] Previous studies have presented somewhat contradictory information concerning the relationship between ABO blood types and susceptibility to disease.[64] Research indicates that individuals with blood type A may have an elevated risk of some chronic conditions, such as cardiovascular illnesses and diabetes, potentially due to genetic or immunological factors.[65] Nevertheless, alternative studies have not identified any significant associations, suggesting that fluctuations in illness incidence may be attributed to environmental factors or lifestyle choices rather than blood type genetics. The trends identified in this study may result from factors beyond genetic risk, such as dietary modifications, physical activity, and access to healthcare, which have not been accounted for in this analysis. Moreover, the sample size is quite limited, rendering the study's results difficult to generalize, and robust inferences cannot be drawn. Differences may also arise due to genetic variation within the population, cultural behaviors, or geographical conditions of the Chakhesang tribe.

4.1. Study limitations

The reported low prevalence of the AB blood type in our study warrants caution since a sample size of one hundred Chakhesang individuals may not accurately reflect the true prevalence of the AB blood type within the broader Chakhesang tribal population. This constraint undermines the validity of statistical inferences and the ability to demonstrate the biological feasibility or relevance of observations about

this blood type. Sampling constraints may ultimately lead to the inadequate representation of particular populations, a common issue in studies with tiny, stationary, or culturally uniform groups. Additionally, other factors, such as cultural or environmental influences, may have impacted the observed distribution of participation rates. Future studies must address these constraints by utilizing sufficiently large and representative samples for statistical analysis. An expanded dataset would enhance the analysis, rendering the observed patterns less unclear and allowing for a more accurate determination of the distribution and implications of rarer blood phenotypes, such as *AB*, within this group.

5. Conclusions

Our research highlights that, compared to healthy individuals, the prevalence of hypertension and diabetes was much higher in the general population (non-tribal). The Chakhesang Naga tribe has the highest prevalence of blood type B, while those with blood type A are the most afflicted and sensitive to hypertension and diabetes. In this research, we discovered that blood type A had a higher risk of developing hypertension and diabetes than blood types B and O. This might imply that blood type A may be genetically predisposed to diabetes and hypertension more than other blood types. According to research on blood type genetics, blood type O was shown to be the most prevalent in the population, followed by blood types A and B. Understanding how ABO blood types are determined and how they relate to blood pressure and other disorders is crucial and helpful for blood type-specific methods to maintaining health and preventing diseases in society. The distribution of blood types varies significantly worldwide, so this relationship between disease and blood type may partly explain regional differences in disease occurrence. The findings of this research hold significant significance for healthcare practices and genetic counseling for tribal populations. Upon establishing this understanding of the Chakhesang Naga tribe's genotype concerning hypertension and diabetes, physicians will be equipped to initiate a campaign and implement screening measures for the associated illness risks. Furthermore, genetic counseling within other community health promotion initiatives can enhance public understanding of inherited health risk factors and empower individuals to make informed decisions on preventive health measures. These methods can help mitigate disparities in health access and enhance health equity for aboriginal populations.

CRediT authorship contribution statement

Giridharan Bupesh: Writing – original draft, Visualization, Validation, Supervision, Methodology, Investigation, Formal analysis, Conceptualization. **Jogeswar Panigrahi:** Writing – review & editing, Visualization, Validation, Supervision, Formal analysis, Conceptualization. **Rangasamy Nandakumar:** Writing – review & editing, Validation, Methodology, Conceptualization. **Razoukhrulu Nienu:** Writing – review & editing, Visualization, Methodology. **Renganathan Senthil:** Writing – review & editing, Visualization, Validation. **Konda Mani Saravanan:** Writing – review & editing, Validation. **Kuldeep Singh Panwar:** Writing – review & editing, Visualization, Validation.

Ethical approval

The study protocol was approved by the Institutional Review Board (or Ethics Committee) of St Joseph's University, Nagaland, India (No. SJU/ZOO/IHEC/2021/1 and November 27, 2021). Written informed consent has been obtained from the patient(s) to publish this paper.

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Data availability

The data generated and analyzed during the current study are available from the corresponding author on reasonable request.

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