ORIGINAL RESEARCH

A Comparison of ABO Blood Group Phenotypes in the Dambana Vedda and the Non Vedda Present Day Sri Lankans

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Abstract

Objective: This study aimed to determine the current distribution of ABO blood group phenotypes among the Dambana Vedda population of Sri Lanka, to compare these patterns with those of the contemporary Sri Lankan population, and to evaluate temporal changes in ABO distributions over several decades.

Methods: A cross-sectional comparative study was conducted involving 80 adult individuals identified as authentic Veddas from Dambana, verified through three-generation pedigree analysis. A comparison group of 160 adults representing all provinces of Sri Lanka was proportionally sampled. Capillary blood samples were collected aseptically by a qualified medical officer, and ABO phenotypes were determined using standard slide agglutination techniques with anti-A, anti-B, and anti-D antisera. Blood group distributions between populations were compared using appropriate statistical tests, and historical data from earlier studies were used for temporal assessment.

Results: Among present-day Veddas, blood group B was the most prevalent (48%), followed by A (24%), O (20%), and AB (8%). In contrast, the contemporary Sri Lankan population showed a predominance of blood group O (46%), followed by B (27%), A (22%), and AB (6%). The differences in the prevalence of blood groups B and O between the two populations were statistically significant ($p = 0.002$). Comparison with historical records revealed identifiable shifts in ABO phenotype frequencies within the Vedda population over time.

Conclusions: The ABO blood group distribution of the Dambana Vedda population remains genetically distinct from that of the wider Sri Lankan population. Despite temporal changes, the continued predominance of blood group B highlights the genetic continuity and anthropological significance of this indigenous community.

Keywords: ABO blood group system; Dambana Veddas; Blood group distribution; Population genetics

DOI: https://doi.org/10.4038/slaj.v10i2.349

Sri Lanka Anatomy Journal 2026; 10(II): 93–105

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Received 21/10/2026 *Revised version accepted 30/10/2026* *Published 11/11/2026*

Introduction

The ABO blood group system classifies human blood into four main types based on the presence or absence of specific antigens on the surface of red blood cells (1). In addition to their expression on red blood cells, ABO antigens are also highly expressed on the surface of various human cells and tissues, including the epithelium, sensory neurons, platelets, and vascular endothelium (2). The ABO blood type is an autosomal inherited trait, determined by variations in the ABO gene located at the 9q34.2 locus (3). Alleles A and B are codominant to allele O, which determines the expression of the corresponding antigens, allele O is recessive and does not influence the expression of any antigen (4). The A, B, and O blood types are determined early in life, with antibodies against A and B antigens typically developing in the bloodstream of immunocompetent individuals starting at around 6 months of age (5).

The Rh blood type is the most clinically significant after the ABO system because to its high immunogenicity (6). The Rhesus system includes the D, C, c, E, and e antigens. The Rh, genes are sequentially arranged on chromosome 1 and together form haplotypes. The presence of the D antigen is referred to as Rh positive, while the absence of the D antigen is referred to as Rh negative (7). Similar to the ABO system, anti-Rh antibodies are normally not present in the blood of individuals with D-negative red blood cells, unless they have been exposed to D-positive red blood cells. These immune antibodies are of the immunoglobulin G (IgG) type and, as such, can cross the placenta (8). Although the Rhesus genes and phenotype remain stable throughout life, their frequency varies across different races and geographical regions (9).

Both the ABO and Rh blood group systems play an essential role in ensuring the safety and efficacy of transfusion practices. Understanding these systems is also crucial in blood donor matching and organ transplant compatibility, as well as in predicting complications in pregnancy related to Rh incompatibility (10). The distribution of ABO and Rh (D) blood groups varies across different races, ethnicities, and socio-economic classes in various regions worldwide (11). Understanding the distribution of ABO blood groups is important, as certain diseases and cancers tend to be more common in individuals with specific blood groups (12).

In Sri Lanka, at present there is a considerable gap in the literature regarding the distribution of blood groups within the country's multi-ethnic and multi-socioeconomic society. This includes various ethnic groups, socio-economic classes, and indigenous populations, such as the Vedda community.

The 'Vedda,' Sri Lanka's indigenous inhabitants, have lived in the island's monsoon dry forests for more than 16,000 years. They have close roots in culture and history to people from Western Eurasia and South Asia (13). The Veddas are settled in various regions across Sri Lanka. Vedda communities reside in numerous villages spread across different provinces of the country. The majority of authentic Veddas now live in Dambana Vedda capital (14). Dambana which is a small village in a forested area in the Badulla District near Mahiyanganaya city, is the heartland of the Vedda people (Figure 1.). This village is located approximately 300 kilometers from Colombo, the capital city of Sri Lanka.

The Veddas are increasingly influenced by the dominant culture, leading to a gradual loss of

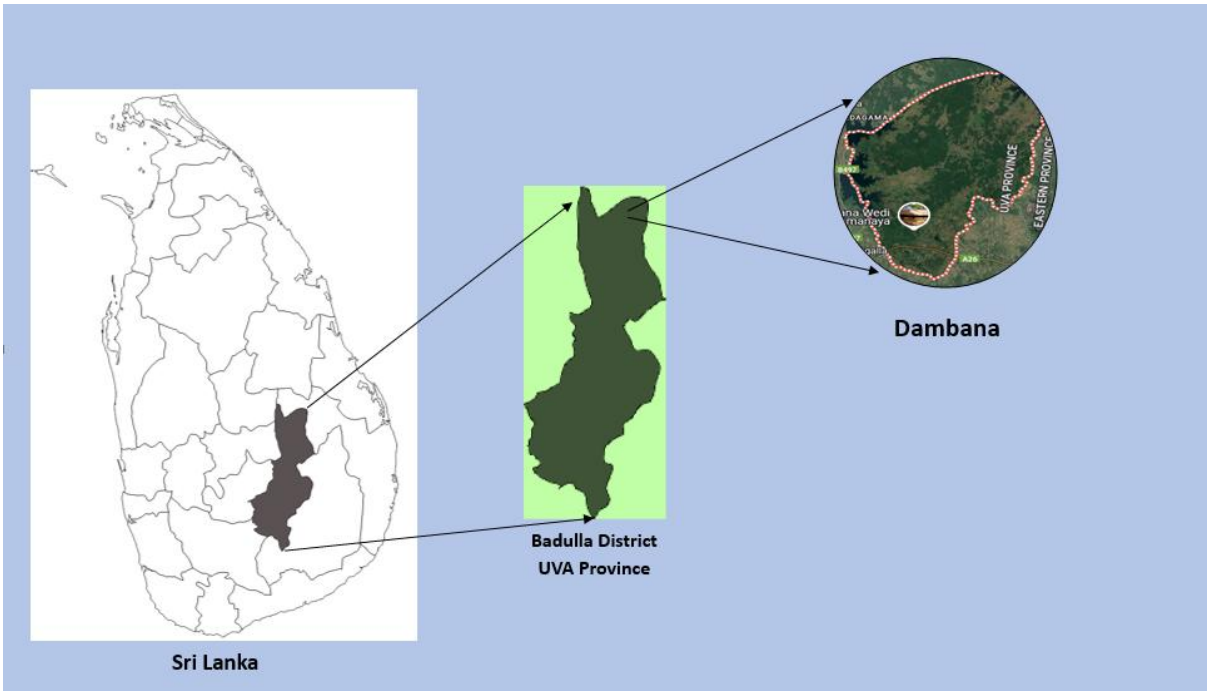


Figure 1: Satellite Map displaying the location of Dambana Vedda Capital, Sri Lanka

their traditional customs and way of life, as they shift away from the livelihood practices they have followed for centuries (13). Waruga' or 'Warige,' which refers to the clan, is a significant criterion used to classify and identify the Vedda community. These classifications are primarily based on factors such as familial lineage, geographic location, and distinct cultural practices. Today, the number of Vedda clans has been reduced to four. These clans are now identified as *Uru, Thala, Morana,* and *Unapana warige* (15) . In past, marriages among the Veddas predominantly occur within the same *warige*. However, with increasing interaction with Sinhala and Tamil communities, interethnic marriages have become more common. Despite this shift, unions within different Vedda *warige* are still preferred over marrying outside the community. Nevertheless, the trend of intermarriage with Sinhala and Tamil individuals continues to grow, reflecting evolving social dynamics (14). The Vedda community residing in Dambana, Sri Lanka, represents a genetically distinct and relatively isolated population may have potentially exhibiting unique distributions of ABO and Rh blood group frequencies.

From a population genetics perspective, the Vedda population provides a rare opportunity to examine the effects of long-term isolation, founder effects, genetic drift, and restricted gene flow, all features that can influence allele frequencies in small populations. The limited number of contemporary studies on Vedda blood groups, including the significant work of Ellepola and Wikramanayake (1986), underscores the need for updated data to understand temporal trends, genetic continuity, and potential admixture effects over recent decades (17).

Understanding the present-day distribution of ABO and Rh blood groups in the Dambana Vedda population contributes valuable insights into their genetic distinctiveness, the effects of cultural assimilation, and deviations from

broader Sri Lankan population patterns. This study was undertaken to analyze the prevalence of ABO and Rh blood group types and to compare these distributions with present-day non Vedda Sri Lankans as well as historical Vedda data to evaluate temporal changes and genetic continuity within the Dambana Vedda community.

Methods

Data collection was conducted after completing the ethical review process and obtaining necessary permissions from the relevant authorities including Vedda Chief *Uruwarige Wannila Atthho*. All adult authentic Vedda people who represented by *Warige* pedigree living in Dambana were recruited to study. The inclusion criteria required participants to be members of the Vedda community only, as confirmed by a verbal *Warige* Pedigree analysis, with ancestry traced back at least three generations. Total of 80 authentic Vedda individuals from the Vedda community residing in Dambana Vedda capital village, located in the Badulla District of Uva Province, Sri Lanka were included into the study.

Before collecting blood samples, all participants were fully informed about the research objectives, procedures, and potential implications by the support of well-educated individual living in same population, and informed consent was obtained from each individual. Individuals belonging to other pedigrees, those with psychiatric or cognitive disorders, individuals with severe language barriers, those who were extremely debilitated, pregnant or lactating mothers, and those who participated in the pre-test phase were excluded from the study.

Each participant's ABO and Rh blood phenotypes were determined using commercially available antisera, such as anti-A, anti-B, and anti-D antibodies, using slide agglutination. A medical officer obtained capillary blood samples from each subject piercing a finger using sterile lancets while adhering to strict aseptic procedures. For each blood sample, three drops of blood were deposited on a clean slide, followed by a drop of anti-A, anti-B, and anti-D antibodies. After few minutes of mixing, the samples were examined for agglutination. The ABO (A, B, O) and Rh blood groups were determined by the presence or absence of visible agglutination. To corroborate the findings, agglutination patterns were investigated under a light microscope.

For the comparison with present-day non Vedda Sri Lankans, 160 adult individuals were selected proportionate to the population residing in each province of the country using proportional case control sampling method. Altogether 80 males and 80 females for the total of 160 were included to the study. Written informed consent was obtained from each individual. Each participant's ABO and Rh blood phenotypes were determined using the same procedure described above.

SPSS software version 23.0 was used to manage and analyze the collected data. The mean percentage distribution of each ABO and Rh blood group was calculated separately for the Dambana Vedda population and present-day Sri Lankans. Differences in the prevalence of each blood group between the Vedda population and present-day non Vedda Sri Lankans were assessed using the Z-test for population proportions in SPSS version 23.0. For other comparisons, historical data reported in 1986 were utilized, including Vedda blood group data reported by Ellepola &

Wikramanayake (1986) and national blood group data from De Zoysa (1985) (17,18). A p-value of less than 0.05 was considered statistically significant, indicating meaningful differences in blood group distributions between the study populations.

Ethical clearance for the study was granted by the Ethics Review Committee (ERC) of the Faculty of Medical Sciences, Wayamba University, Sri Lanka (Ref No.PW/2024/01/30). Participants were provided with an information sheet prior to their invitation to join the survey, and written informed consent was obtained from all participants.

Results

The analysis of the present Vedda population (2024) revealed that blood group B was the most prevalent (48%), followed by A (24%), O (20%), and AB (8%) (Figure 2). The Rh-positive phenotype was highly predominant (96%), while Rh-negative individuals comprised only 4% of the population.

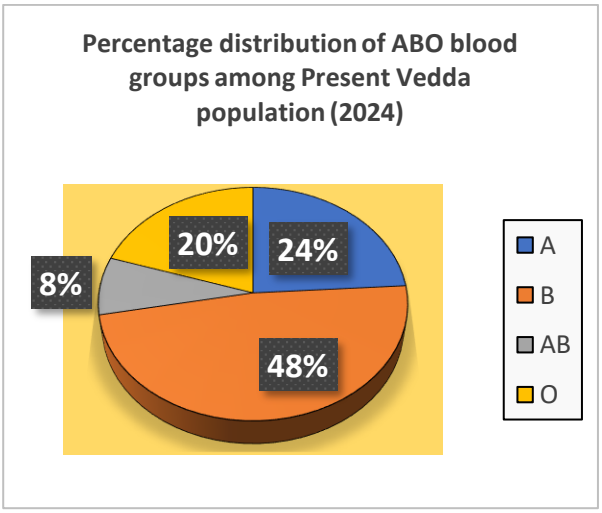


Figure 2: Percentage distribution of ABO blood groups among Present Vedda population (2024)

Comparison of the ABO blood group distribution between the Vedda populations of 1986 and 2024 showed an increase in the prevalence of blood group A (from 13% to 24%) and AB (from 3.7% to 8%), while blood group O declined markedly (from 40.7% to 20%). Blood group B showed a slight increase from 42.6% to 48% (Table 1). Statistical analysis using Z-tests indicated that the decrease in blood group O prevalence was significant ($P = 0.011$), whereas changes in blood groups A, B, AB, and Rh factors were not statistically significant ($P > 0.05$).

When the blood group distribution of Vedda population who lived in 1986 was compared with the past non Vedda Sri Lankan population in 1985, Statistically significant differences of prevalence of blood group distribution of among them between two population group were not observed ($P > 0.05$ for all groups). Blood group B showed a trend toward higher prevalence among the past Vedda population (42.6%) compared to the past non Vedda Sri Lankans (29%), although this difference was not statistically significant ($P = 0.066$) (Table 2). Other blood groups (A, AB, O) and Rh factor distributions were comparable between the two populations.

Comparison between prevalence of ABO blood groups between present-day Sri Lankans and the present-day Vedda population of 2024 revealed significant differences Table 3). Blood group B was significantly more prevalent in the Vedda population (48%) compared to present-day Sri Lankans (26.82%, $P = 0.002$), while blood group O was significantly lower in Vedda (20%) compared to Sri Lankans (45.83%, $P < 0.001$). The prevalence of blood groups A and AB, as well as Rh-positive and Rh-negative phenotypes, did not differ significantly between the two populations ($P > 0.005$).

Table 1: Percentage Distribution of ABO and Rh Blood Groups in the Present-Day Vedda Population (2024) Vs Past Vedda Population (1986)

Blood Group	Prevalence in Vedda Population (1986) (%)	Prevalence in Vedda Population (2024) (%)	P value	Significance
A	13	24	0.181	Not significant
B	42.6	48	0.596	Not significant
AB	3.7	8	0.474	Not significant
O	40.7	20	0.011	Significant
Rh+	96.2	96	1.00	Not significant
Rh−	3.8	4	1.00	Not significant

Table 2: Comparison of Prevenance of ABO and Rh Blood Groups in Past Vedda Population (1986) vs. Past non Vedda Sri Lankan Population (1985)

Blood Group	Prevalence in past Vedda Population (1986) (%)	Prevalence in past non Vedda Sri Lankan Population (1985) (%)	P value	Significance
A	13	23	0.123	Not significant
B	42.6	29	0.066	Not significant (trend toward significant)
AB	3.7	6	0.734	Not significant
O	40.7	43	0.874	Not significant
Rh+	96.2	94	0.734	Not significant
Rh−	3.8	6	0.734	Not significant

Table 3: Comparison of Prevenance of ABO and Rh Blood Groups in Present-day Vedda Population vs. Present-day non Vedda Sri Lankan Population

Blood Group	Prevalence in Present-Day Non Vedda Sri Lankans (%)	Prevalence in Vedda Population (2024) (%)	P value	Significance
A	21.88	24	0.733	Not significant
B	26.82	48	0.002	Significant
AB	5.47	8	0.469	Not significant
O	45.83	20	0.000	Significant
Rh+	95	96	0.933	Not significant
Rh−	5	4	0.985	Not significant

Table 4: ABO and Rh blood group distributions in selected Indigenous and primitive ethnic populations residing in different regions around world (20, 21, 22, 23, 24, 25)

Indigenous community (country)	A (%)	B (%)	AB (%)	O (%)	Rh+ Positive (%)	Rh- negative (%)	Citation
Aboriginal (Northern Territory, Australia)	39.7	3.0	0.7	56.6	97.6	2.4	McLean *et al.,* 2021
Eskimos (South-west Greenland)	49.5	6.45	2.62	41.40	100	0	Ahrengot and Eldon,1952
Eastern Native Americans	21.3	2.8	1.7	74.2	-	-	Halverson & Bolnick, 2008
Naga People (India)	23.9	17.9	12.0	46.2	99.5	0.5	Bupesh *et al.,* 2025
Chakma (Bangladesh)	27	37	23	12	99	0.4	Dewan, G. (2015).
Ga Adamgbe (Ghana)	22.9	23.1	3.8	50.2	91.9	8.1	Doku *et al.*, 2022

Discussion

The current study reflects that the distribution of ABO and Rh blood group phenotypes in the Dambana present day Vedda community differs significantly from that of contemporary non Vedda Sri Lankans. Blood group B was the most prevalent blood phenotype among the Vedda (48%), that is significantly greater than in modern Sri Lankans (26.82%, P = 0.002). Blood group O predominated in the overall non Vedda Sri Lankan population (45.83%), significantly above that reported in the Vedda (20%, P < 0.001). Blood types A and AB were distributed similarly in both populations, with no statistically significant differences (A: 24% vs. 21.88%; AB: 8% vs. 5.47%). Rh-positive people predominated in both populations

(Vedda 96%, Sri Lankans 95%), while Rh-negative individuals were uncommon (Vedda 4%, Sri Lankans 5%), demonstrating that Rh allele frequencies were consistent between populations. These findings confirm the present day Vedda community's different genetic composition when compared to present day non Vedda Sri Lankans.

A secular tendency throughout time can be seen by comparing the blood group distributions of the present-day Vedda population in Dambana with those of the Vedda population in the past. In 1986, the Vedda population had the highest proportion of blood group B (42.6%), followed by O (40.7%), A (13%), and AB (3.7%) (17). The present study shows a further increase in the B (48%) and A (24%) phenotypes, a doubling of AB (8%), and a significant decline in blood group O (20%). The drop-in blood group O prevalence was statistically significant ($P = 0.011$), while the changes in blood groups A, B, AB, and Rh factors were not significant ($P > 0.05$). These trends may suggest minimal genetic admixture due to historical isolation and the practice of endogamy within the group, such as marriages within the *Warige* pedigrees, which maintain genetic authenticity throughout generations. The preservation of blood type B dominance highlights the Vedda population's distinct genetic composition, which has been influenced by historical, social, and cultural behaviors.

The blood group distribution seen among the 1986 Vedda population, as contrasted to the 1985 non-Vedda Sri Lankan population, can be interpreted in the context of the Veddas' complicated genetic and anthropological background. Previous genomic and anthropometric investigations found a significant genetic identity between Veddas and Sinhalese, indicating long-term gene flow and shared ancestry. This close association explains why the 1986 Vedda and non-Vedda populations had broadly similar ABO and Rh blood group patterns, despite cultural differences (17).

Nonetheless, slight discrepancies in ABO frequencies, particularly the relatively higher incidence of blood group B in the 1986 Vedda population, could be attributed to genetic drift, founder effects, and historical endogamy in a small and semi-isolated population. Such demographic processes can alter allele frequencies without producing statistically significant divergence when compared with a larger, more heterogeneous non-Vedda population. These patterns are consistent with evidence suggesting that the Veddas retain genetic links to ancient Sri Lankan populations, including Homo sapiens balangodensis (Balangoda Man), while also showing admixture with Sinhalese populations (17).

When compared literature evidence of present-day primitive Sri Lankans with the present Vedda study findings, the Vedda blood group profile is distinct. The *Purana* population in Sigiriya Sri Lanka had a predominance of blood group O (46%) and a low AB frequency (4%) (19), in contrast to the significant prevalence of blood group B in the Vedda. Add similarities and differences of blood groups among them.

Vedda are more genetically closely related to other Asian primitive tribes than to Australo-Melanesian groups (17). The distribution of ABO and Rh blood groups among Indigenous and ethnic populations is highly distinct (Table 04), reflecting both genetic background and population history. Blood group O is the most common among Australian Aboriginals in the Northern Territory (56.6%), followed by A at

39.7% and B and AB at substantially lower numbers (3.0% and 0.7% respectively). The Rh-positive phenotype is highly prevalent at 97.6%, which is consistent with prior research showing a low prevalence of Rh-negative individuals among Indigenous Australian populations (20).

Similarly, the Eskimo population of South-west Greenland has a high frequency of groups A (49.5%) and O (41.4%), with extremely few occurrences of B and AB (21). Eastern Native Americans have a high prevalence of group O (74.2%), while A, B, and AB are less prevalent, mirroring the overall trend of high O-group frequency in Indigenous groups of the Americas (22).

In South Asia, the Naga people of India have a relatively balanced ABO distribution, with O (46.2%) and A (23.9%) dominating, but B and AB are greater than in Indigenous Australian and American groups (17.9% and 12.0%, respectively). The number of Rh-positive people remains high (99.5%), while Rh-negative individuals are extremely rare. The Chakma community of Bangladesh, in comparison, has a very high frequency of B (37%) and AB (23%), with O accounting for only 12% of the population, demonstrating significant regional heterogeneity within South Asia. Rh-negative individuals are extremely rare, accounting for only 0.4% (23, 24).

The current analysis of the Vedda population in Sri Lanka (2024) indicated that blood group B is the most common (48%), followed by A (24%), O (20%), and AB (8%). The Rh-positive phenotype is prevalent (96%), with Rh-negative individuals accounting for 4% of the population. This distribution differs significantly from that of other South Asian and global Indigenous populations, where blood group O is often dominant, such as Australian Aboriginals, Eastern Native Americans, and India's Naga people. The Chakma group in Bangladesh has a high incidence of B (37%) and AB (23%), with O accounting for only 12% of the population and Rh-negative individuals being exceedingly rare (0.4%) (24). While both Vedda and Chakma populations have elevated B-group frequencies, they are geographically separated and do not form a closed territory, implying that the similarities are accidental rather than the result of direct gene exchange. However, the Vedda community has a somewhat larger proportion of Rh-negative individuals and a lower AB frequency than the Chakma, highlighting its distinct phenotypic character. Overall, these findings identify the Dambana Vedda as a genetically distinct Indigenous community, with a blood group distribution pattern that differs significantly from other South Asian and global populations, most likely due to historical isolation, limited gene flow, and population-specific evolutionary factors.

The Rh phenotypic distribution reinforces worldwide patterns. The Vedda population's Rh-positive prevalence (96%) is consistent with patterns seen in South Asia, where Rh-negative individuals are uncommon, including India (2.7%) and Pakistan (7.5%) (26). Rh-negative prevalence is higher in Europe (Germany, Britain ~17%) and North America (~15%), but low in Africa and South Asia due to historical genetic difference.

Present study findings on Vedda ABO blood group phenotypes compared with present day nearer ethnic groups in the world. Similar finding was reported in South Indians, South Indian populations indicate O as the most prevalent blood group (38.75%) followed by B (32.69%) and A (18.85%), whereas in Bangladesh, B is most common (34.5%),

followed by O (33.4%) and A (22.9%) (27, 28). Chinese populations are dominated by O (34.2%) and A (28.72%), with B (28.17%) and AB (8.91%) being less common (29). African populations, especially Ethiopia, have greater O and A frequencies, but B is less prevalent (30). Collectively, these studies demonstrate that the Dambana Vedda community has a distinct ABO distribution pattern that varies both regionally and internationally, highlighting the influence of ethnic, geographic, and historical factors on blood type distribution.

The findings have multiple implications. First, the unique ABO and Rh distributions highlight the necessity for individualized blood donation procedures and public health planning in the Vedda population. Second, these data help us understand population genetics, migration, and genetic drift in isolated ethnic groups. Third, understanding these phenotypic patterns is useful in medico-legal settings, disease risk assessment, and personalized health care management. Finally, the observed temporal shifts in blood group distribution shed light on genetic stability and the impact of sociocultural variables on genetic diversity.

Furthermore, the study of indigenous population like the Veddas is significantly important. The Vedda community, which has endured for millennia in conditions similar to much of early human existence, is now at risk of cultural and genetic dilution due to rapid assimilation into non-Vedda communities. Began with relocation into Mahaweli development settlements and continues to the present, has promoted increasing cohabitation and genetic admixture, gradually diminishing distinct indigenous genetic markers. Consequently, opportunities to document and preserve the unique genetic characteristics of the Vedda population are rapidly disappearing, underscoring the need for focused research and conservation-oriented strategies to safeguard the biological and cultural heritage of this indigenous community.

In conclusion, the Dambana Vedda community has a distinct blood group profile, distinguished by a predominance of blood group B, a significant decline in blood group O, and near-universal Rh positive. These patterns differ dramatically from those observed in contemporary Sri Lankan and worldwide populations, indicating the impact of historical isolation, endogamy, and genetic drift. This research provides critical baseline data for population genetics, transfusion medicine, and public health planning in this indigenous society.

Acknowledgement

The authors extend their sincere gratitude to the Vedda Chief and the Dambana Vedda community for their invaluable cooperation and for facilitating the cultural access necessary to conduct this research. We are profoundly grateful to the study participants, whose voluntary contributions and commitment of time were fundamental to the completion of this work. Furthermore, the authors gratefully acknowledge AVON Pharma (Private) Limited for their generous financial sponsorship, which provided the necessary resources for the implementation of this study. Finally, we thank Mr Mufazir technical officer of the Department of Anatomy Wayamba University of Sri Lanka who provided logistical support throughout the data collection process.

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