

Blood types of minorities in Bangkok: A study in Thai Sikhs and the Burmese blood donors

Kallaya Kerdkaewngam* Issarang Nuchprayoon**

Phuraya Ovataga* Dussadee Pooreekul*

Nootchanat Premprayoon* Udom Tingtoy*

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Background : *Blood types are unique to each ethnic groups. In Thailand, Sikhs are one of established ethnic minorities. They are known to have certain rare blood types which have not been systematically studied. Therefore, we studied nine blood group systems of the Sikh and Burmese blood donors in Bangkok, Thailand.*

Objectives : *To assess the proportion of alleles of nine blood group antigens among Thai Sikhs and Burmese blood donors.*

Materials and Methods : *A total of 122 samples of Thai Sikhs blood donors at Sri Guru Singh Association Mobile Unit and 189 samples of the Burmese and Mons blood donors at Jia Hong Garment Factory Mobile Unit were tested for nine blood groups of antigen system including Rh (C, E, c, e), MNS (M, N, S, s), P (P1 and P2), Lewis (Le^a and Le^b), Kidd (JK^a and JK^b), Duffy (Fy^a and Fy^b), Kell (K and k) and Diego (Di^a and Di^b). For ABO and Rh(D) blood group system, data of 1,597 Thai Sikhs and 189 the Burmese blood donors were taken from the National Blood Centre, Thai Red Cross Society's database.*

* Antiserum and Standard cell Preparation Section, National Blood Centre, Thai Red Cross Society, Bangkok, Thailand.

** Department of Pediatrics, Faculty of Medicine, Chulalongkorn University

Results : *Thai Sikhs blood donors have a higher proportion of Rh(D) negative (3.7%) than the Burmese ones (1.0%). Almost all Thai Sikhs blood donors are Rh(C) positive and Rh(e) positive. Similarly, most the Burmese blood donors are commonly Rh(C) positive (93.6%) and Rh(e) positive (97.4%). As for the MNS system, most the Burmese (96.3%) and all Thai Sikhs blood donors are M^{ρ} (-) and also both groups were predominantly M (+) and s (+). As for the P blood group system, the predominant allele is P1 (63.1%) in Thai Sikhs, and P2 (74.1%) in the Burmese blood donors. As for the Duffy system, $Fy(a+b+)$ is the most common allele among the Thai Sikhs blood donors (43.4%), while $Fy(a+b-)$ is the most common allele among the Burmese blood donors (77.2%). Allele $Fy(a-b+)$ is common in the Thai Sikhs blood donors (21.3%) but rare in the Burmese (2.6%). The Kell antigen K (+) and Diego antigen Di^{ρ} (+), both are very rare in the Thai Sikhs and the Burmese blood donors.*

Conclusion : *The red cell antigen profiles of the Thai Sikhs blood donors are different from the Burmese, Mons and Thais blood donors. In additional, Thai Sikhs blood donors have distinctively higher proportion of Rh negative, $Fy^{\rho}(-)$, S(+), and K(+) but they are absence of M^{ρ} (+) and Di^{ρ} (+).*

Keywords : *Blood type, Thai Sikhs, Burmese.*

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National Blood Centre, Thai Red Cross Society, Bangkok 10330, Thailand.

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- เหตุผลของการทำวิจัย** : หมู่โลหิตชนิดต่าง ๆ มีความจำเพาะในแต่ละเชื้อชาติ ชาวไทยซิกซ์เป็นชนกลุ่มน้อยในสังคมไทย พูดภาษาไทย และพบว่าหมู่เลือดหายาก แต่ยังมีใครรวบรวมนำเสนอข้อมูลอย่างเป็นระบบ สำหรับงานวิจัยนี้ได้ศึกษาหมู่เลือดเกาะระบบ ในผู้บริจาคโลหิตชาวไทยซิกซ์ ชาวพม่าและมอญ ซึ่งอยู่ในกรุงเทพมหานคร
- วัตถุประสงค์** : เพื่อหาสัดส่วนของอัลลีลแอนติเจนหมู่เลือดเกาะระบบ ในผู้บริจาคโลหิตชาวไทยซิกซ์และชาวพม่า
- วัสดุและวิธีการ** : ตัวอย่างเลือดจากผู้บริจาคโลหิตชาวไทยซิกซ์จำนวน 122 ราย จากหน่วยเคลื่อนที่สมาคมศรัทธาสิงห์ และตัวอย่างเลือดจากผู้บริจาคโลหิตชาวพม่าและมอญ จำนวน 189 ราย จากหน่วยเคลื่อนที่บริษัทเจียบสงการเม้นท์นำมาทดสอบแอนติเจนหมู่เลือดระบบ Rh ระบบ MNS ระบบ P ระบบ Lewis ระบบ Kidd ระบบ Duffy ระบบ Kell และ ระบบ Diego สำหรับหมู่เลือดระบบ ABO และ Rh(D) ของผู้บริจาคโลหิตชาวไทยซิกซ์จำนวน 1,597 ราย และผู้บริจาคโลหิตชาวพม่าจำนวน 189 ราย นำข้อมูลมาจากรฐานข้อมูลของศูนย์บริการโลหิตแห่งชาติ สภากาชาดไทย
- ผลการศึกษา** : ผู้บริจาคโลหิตชาวไทยซิกซ์มีสัดส่วนของกลุ่มเลือด Rh ลบ (ร้อยละ 3.7) สูงกว่าชาวพม่า (ร้อยละ 1.0) ชาวไทยซิกซ์ส่วนใหญ่มี Rh (C) บวก และ Rh (e) บวก คล้าย คลึงกับชาวพม่าส่วนใหญ่เป็น Rh (C) บวก (ร้อยละ 93.6) และ Rh (e) บวก (ร้อยละ 97.4) สำหรับหมู่เลือดระบบ MNS นั้น ผู้บริจาคชาวพม่าส่วนใหญ่ (ร้อยละ 90.3) และชาวไทยซิกซ์ทุกรายเป็น M^i ลบ ทั้งสองเชื้อชาติส่วนใหญ่มี M และ s บวก สำหรับหมู่เลือดระบบ P นั้น P1 เป็นอัลลีลเด่นในชาวไทยซิกซ์ (ร้อยละ 63.1) ส่วน P2 เป็นอัลลีลเด่นในชาวพม่า (ร้อยละ 74.1) สำหรับหมู่เลือดระบบ Duffy อัลลีล $Fy(a+b+)$ พบได้บ่อยในชาวไทยซิกซ์ (ร้อยละ 43.3) และอัลลีล $Fy(a+b-)$ พบได้บ่อยในชาวพม่า (ร้อยละ 77.2) อัลลีล $Fy(a-b+)$ พบได้บ่อยในชาวไทยซิกซ์ (ร้อยละ 21.3) แต่หาได้ยากในชาวพม่า (ร้อยละ 2.6) หมู่เลือดระบบ Kell แอนติเจน K บวก และหมู่เลือดระบบ Diego แอนติเจน D^i บวก หาได้ยากทั้งในชาวไทยซิกซ์และชาวพม่า
- สรุป** : หมู่เลือดต่าง ๆ ของชาวไทยซิกซ์แตกต่างจากชาวพม่า ชาวมอญและชาวไทย โดยชาวไทยซิกซ์มีสัดส่วนของ Rh ลบ, Fy^b บวก, S บวกและ K บวกสูงกว่า และไม่พบ M^i บวก และ D^i บวก
- คำสำคัญ** : หมู่เลือด, ไทยซิกซ์, พม่า.

Thai Sikhs are ethnic minority of Indian and Pakistani origins whose ancestors migrated to Siam during the reign of King Rama V (1868 - 1910 A.D.). They settled in certain areas in Bangkok, Chiang Mai and other provinces. Usually, they earn their living as tailors who follow rigorous religious practices, and have Panjabi language as their mother tongue. ⁽¹⁾

The National Blood Centre regularly sends a Mobile Blood Donation Unit to Guru Singh Associations which most donors are Thai Sikhs. Donated blood samples from these donors have unique blood group systems but they have never been in systematically studied.

In the past two decades, there were a large number of migrant workers from Myanmar into Thailand. Many of them worked as laborers in factories, construction field, rice mills, farms, fisheries, etc. The National Blood Centre regularly sends mobile blood donation units to several factories, where donors are of the Burmese and Mons origin. ⁽²⁾

We are going to study on nine blood group systems of Thai Sikhs and people from Myanmar, which found the unique blood group characteristics of Thai Sikhs. This study is useful for Antiserum and Standard Cells Production Section, National Blood Centre, Thai Red Cross Society (NBC) as our section produces standard cells for antibody screening and identification that uses rare blood groups as raw materials. Thai Sikhs blood donors who have certain rare blood group would be useful for standard cells production.

Materials and Methods

Inclusion criteria

Volunteer blood donors at the Sri Guru Singh

Association Mobile Units of the NBC between January 2 and December 30, 2010 had a 7-mL blood sample remaining from routine that collected in 10% citrate-phosphate dextrose (CPD) solution (manufactured by NBC) at the time of blood donation as standard operating procedure. ⁽³⁾ the Thai Sikhs blood samples were identified by their popular last name "Singh", including but not limited to Taginder Singh, Ranjit Singh, Ravinder Singh, Talwinder Singh, and Surjit Singh Madan. The sample whose last name without Singh or questionable were excluded from this study.

Volunteer blood donors at the Jia Hong Garment Factory Mobile Units of the NBC who self-identify as the Burmese or Mons blood donors between January 2 and December 30, 2010 also had 7-mL blood sample remaining from routine that preserved in CPD. Samples from the Burmese and Mons blood donors who were identified from the time of registration "foreign laborer identification number" added next to their last names that identify they came from Myanmar. Thais and other blood donors were excluded from this study.

Red cell antigen typing

Each CPD-preserved blood samples from the Thai Sikhs and the Burmese donors that were identified in this study were assayed for nine blood group systems, including ABO, Rh (D, C, E, c, e), MNS (M, N, S, s), P (P1 and P2), Lewis (Le^a and Le^b), Kidd (Jk^a and Jk^b), Duffy (Fy^a and Fy^b), Kell (K and k) and Diego (Di^a and Di^b) using the standard tube technique. ⁽⁴⁾ Anti-D, anti-E, and anti-c monoclonal antibodies, anti-M, anti-N rabbit polyclonal antibodies, and anti-Mi^a human polyclonal antibodies were manufactured by the NBC, Bangkok, Thailand. Anti-

C, anti-e, anti-S, anti-s, anti-P1, anti-Le^a, anti-Le^b and Anti-K monoclonal antibodies, Anti-Jk^a, Anti-Jk^b, Anti-Fy^a, and Anti-k (cellano) human polyclonal antibodies were manufactured by Bio-Rad Laboratories Limited Switzerland, and CSL Bioplasma Immunohaematology Limited, Australia. Anti-Fy^b, anti-Di^a and anti-Di^b monoclonal antibodies were manufactured by Blood Group Section, Kanto-Koshinetsu Blood Centre, Japanese Red Cross, Tokyo, Japan.

In addition, data on ABO and Rh (D) antigens from the NBC donor database for 1,597 Thai Sikhs donors and 189 the Burmese donors were included in this report to improve the accuracy of the prevalence of these major blood groups.

Data analysis

Data were recorded as personal history of each donor, and were analyzed by using descriptive statistics, including percentage. Gene frequencies were calculated for each blood group system using Hardy-Weinberg equation in which a binomial distribution $p^2+2pq+q^2 = 1$ for biallelic blood group systems where p and q are each allele frequency and $p+q = 1$. As for the tri-allelic blood group system (p, q and r; $p+q+r = 1$), each allele frequency was calculated using the equation: $p^2+q^2+r^2+2pq+2pr+2qr = 1$.^(5,6)

Results

The most common ABO alleles among 1,597 Thai Sikhs blood donors is group B (46.0%), followed by O (31.0%), A (15.7%), and AB (7.3%). On the contrary, the predominant ABO blood group among 189 the Burmese blood donors, is O (39.2%) followed

by B (31.7%), A (21.2%), and AB (7.9%). Rh(D) negative blood donors are much more prevalent in the Thai Sikhs (3.69%) than the Burmese (1.0%) (Table 1).

Minor blood group alleles among 122 Thai Sikhs and 189 the Burmese blood donors show unique distributions. Almost all Thai Sikhs blood donors have Rh(C) and none are Rh(e) negative. In other words, all the Thai Sikhs blood donors have Rh(e). The proportion of Rh(c) positivity is 58%; and Rh(E) positivity is 28%. The majority of the Burmese blood donors also have Rh(C) (93.6%) and Rh(e) (97.4%) while fewer have Rh(c) (43.4%), and Rh(E) (27.5%). The predominant CDE phenotype cluster among Thai Sikhs and the Burmese blood donors are R₁R₁ (CCDee), at 43%, and 53% respectively (Table 2). The least common CDE phenotype clusters in both the Thai Sikhs and the Burmese blood donors are R₂R₂ (ccDEE) and R₂R₂ (CcDEE).

As for the MNS blood group system, both populations show predominant by M (+) 97.9% of the Burmese, and 86.9% of Thai Sikhs blood donors; s (+) is 98.9% of the Burmese and 87.7% in Thai Sikhs blood donors. Antigen Mi^a is negative in most the Burmese (96.3%) and all of the Thai Sikhs blood donors. With regards to P blood group system, P1 antigen is the predominant allele in the Thai Sikhs (63.1%), while P2 predominates in the Burmese blood donors (74.1%).

On the part of the Duffy blood group system, phenotype Fy (a+b+) is the most common among Thai Sikhs blood donors (43.4%). In contrast, phenotype Fy (a+b-) is the most common in the Burmese blood donors (77.2%). Phenotype Fy (a-b+) is common in the Thai Sikhs blood donors (21.3%) but rare in the

Burmese (2.6%). K (+) antigen of Kell blood group system is rare in the Thai Sikhs blood donors and absent in the Burmese. Similarly, the Di^a (+) antigen of Diego system is rare in the Burmese but absent in the Thai Sikhs blood donors. The predominant phenotype of the Lewis system in both populations is Le (a-b+) (Table 2).

Gene frequencies are calculated based on Hardy-Weinberg equilibrium principle (Table 3). Each allele frequency in the Burmese and the Thai Sikhs blood donors is compared to previously published frequencies in Thais blood donors.⁽⁵⁾ The population patterns of blood groups profiles in the Burmese are closer to that of the Thais than the Thai Sikhs blood donors.

Table 1. Major blood group phenotypes frequency in Thai Sikhs and the Burmese compared Thais blood donors of National Blood Centre, Thai Red Cross Society⁽³⁾

Blood Types	Thai Sikhs (1,597 donors)		Burmese (189 donors)		Thais (National Blood Centre) (1,382,980 donors)	
	Donors	Phenotype Frequency (%)	Donors	Phenotype Frequency (%)	Phenotype Frequency (%)	
A	250	15.7	40	21.2	21.4	
B	736	46.0	60	31.7	33.6	
O	495	31.0	74	39.2	37.7	
AB	116	7.3	15	7.9	7.3	
Rh negative (D-)	59	3.69	2	1.0	0.3	

Table 2. Minor blood group phenotypes frequency in Thai Sikhs and the Burmese compared Thais blood donors of National Blood Centre, Thai Red Cross Society⁽³⁾

System	Minor Blood Group Phenotypes	Thai Sikhs (122 donors)		Burmese (189 donors)		Thais blood donors (National Blood Centre) (1,381,221 donors)	
		Donors	Phenotype Frequency (%)	Donors	Phenotype Frequency (%)	Donors	Phenotype Frequency (%)
Rh	R ₁ R ₁ (CCDee)	52	42.6	101	53.4	5,122	49.38
	R ₂ R ₂ (ccDEE)	Not found	-	3	1.6		11.21
	R ₁ R ₂ (CcDEe)	33	27.0	44	23.3		19.91
	R ₁ r (CcDee)	36	29.5	30	15.9		10.89
	R ₂ r (ccDEe)	1	0.82	3	1.6		3.90
	R ₂ R _z (CcDEE)	Not found	-	2	1.0		1.21

Table 2. Minor blood group phenotypes frequency in Thai Sikhs and the Burmese compared Thais blood donors of National Blood Centre, Thai Red Cross Society⁽³⁾ (Continuous)

System	Minor Blood Group Phenotypes	Thai Sikhs (122 donors)		Burmese (189 donors)		Thais blood donors (National Blood Centre) (1,381,221 donors)	
		Donors	Phenotype Frequency (%)	Donors	Phenotype Frequency (%)	Donors	Phenotype Frequency (%)
MNS	M(-)	16	13.1	4	2.1	985	16.4
	M(+)	106	86.9	185	97.9		83.6
	N(-)	58	47.5	84	44.4		37.9
	N(+)	64	52.5	105	55.5		62.1
	S(-)	57	46.7	148	78.3		82.9
	S(+)	65	53.3	41	21.7		17.1
	s(-)	15	12.3	2	1.0		1.9
	s(+)	107	87.7	187	98.9		98.1
	Mi ^a (-)	122	100	182	96.3	20,569	90.9
	Mi ^a (+)	Not found	-	7	3.7		9.1
P	P1	77	63.1	49	25.9	21,950	31.0
	P2	45	36.9	140	74.1		69.0
Lewis	Le(a+b-)	16	13.1	46	24.3	-	No Data
	Le(a-b+)	71	58.2	87	46.0		No Data
	Le(a-b-)	36	29.5	56	29.6		No Data
Kidd	JK(a+b-)	59	48.4	68	35.9	2,461	26.5
	JK(a-b+)	25	20.5	37	19.6		23.2
	JK(a+b+)	38	31.1	83	43.9		50.3
Duffy	Fy(a+b-)	43	35.2	147	77.2	1,658	76.7
	Fy(a-b+)	26	21.3	5	2.6		3.7
	Fy(a+b+)	53	43.4	37	19.6		19.5
Kell	K(+)	5	4.1	Not found	-	1,522	1.85
	K(-)	117	95.9	189	100		98.16
Diego	Di(a+b+)	Not found	-	3	1.59	3,950	2.99
	Di(a-b+)	122	100	186	98.41		97.01

Table 3. Gene Frequency of Thai Sikhs, the Burmese compared Thais blood donors of National Blood Centre, Thai Red Cross Society⁽³⁾

Alleles	Gene Frequency		
	Thai Sikhs (122 donors)	Burmese (189 donors)	Thais blood donors (National Blood Centre) (1,382,980 donors)
A	0.126	0.151	0.155
B	0.317	0.223	0.230
O	0.557	0.626	0.615
Rh negative D (-)	0.188	0.098	0.049
Rh positive D (+)	0.847	0.881	0.951
C	0.709	0.735	0.626
c	0.291	0.233	0.375
E	0.139	0.151	0.315
e	0.860	0.817	0.685
M	0.672	0.712	0.596
N	0.328	0.288	0.404
S	0.328	0.113	0.139
s	0.672	0.886	0.861
Mi ^a	not calculated	not calculated	No Data
P1	0.631	0.259	No Data
P2	0.369	0.741	No Data
Le ^a	0.131	0.243	No Data
Le ^b	0.582	0.460	No Data
Le ^(a-b-)	0.295	0.296	No Data
Jk ^a	0.640	0.579	0.510
Jk ^b	0.360	0.416	0.490
Fy ^{a(-)}	0.213	0.026	0.038
Fy ^a	0.569	0.870	0.870
Fy ^b	0.430	0.124	0.130
K	0.020	not calculated	0.010
k	0.980	1.000	0.990
Di ^a	not calculated	0.008	No Data
Di ^b	1.000	0.992	No Data

Discussions

This is so far the first ever report in details of minor blood groups among ethnic minorities in Thailand. This study identified that Thai Sikhs blood donors distinctively have higher frequencies of Rh negative, Fy^a (-), S (+), and K (+) blood group compared to the Thais, the Burmese, and Mons blood donors. In addition, Mi^a (+) and Di^a (+) were absent in the Thai Sikhs.

Sikhs are mostly in fabric trade business, and adheres to their religious and traditional values. They can be identified by "5-K" symbols, notably wearing a turban. The Gurdwara Guru Singh Sabha, established in 1932, was central to the religion and Sikhs activities located in Pahurat area in Bangkok.⁽⁷⁾ It is estimated that there are around 30,000 Sikhs in Thailand.^(7, 8) This Gurdwara serves approximately 12,000 Sikhs families.⁽⁹⁾ Sri Singh Sabha Association was established by Thai Sikhs and registered with the National Council of Cultural Affairs in 1963. Mission of the Association is to conserve Sikhs culture, educate young Thai Sikhs, and also take care of the activities in the Gurdwara.⁽⁷⁾ The study of blood donors at the mobile unit is therefore highly representative of the Sikhs community in Thailand. Sikhs have Panjabi as their *lingua franca*, and also in their daily lives. The family name of Thai Sikhs is highly unique, with Singh is the common last or middle name of male Sikhs and it is a compulsory last name for male Khalsa Sikhs; who has taken the Amrit Ceremony.⁽¹⁰⁾ Although not all with the family name Singh are the Sikhs, the chance of non-Sikhs Indians who donated their blood at the mobile unit was extremely rare.

Our findings that group B is the most common ABO blood group is similar to that of the Sikhs in Calcutta, India.⁽¹¹⁾ In whom group B (38%) is more

common than O (29%), A (23%), and AB (10%), as well as two large studies of Jat Sikhs in Panjab (B 35%, O 33%, A 23%, AB 9%).^(12, 13) Similarly to our study, the gene frequency of B allele (0.24 - 0.36) is more frequent in Jat Sikhs than A allele (0.12 - 0.23).^(12, 13) This pattern is different from smaller studies of the Sikhs in Panjab,⁽¹⁴⁾ and Assam,⁽¹⁵⁾ who have group O (36 - 37%) as the most common, followed by A (26 - 30%) or B (24 - 32%) and AB (6 - 9%). In comparison with Thai Sikhs, people in Maharashtra district⁽¹⁶⁾ and north Pakistan (Swat district)⁽¹⁷⁾ also were predominantly group B (31.9% and 32.4%), followed by O (31.0% and 29.1%), A (28.4% and 27.9%), and AB (8.7% and 10.6% respectively). These is finding correlate with the history of Sikh migration as being displaced from Northern Pakistan to Punjab, then to different parts of India. Of approximately 300 founders Sikh who migrated to Thailand, most were born in Punjab or West Pakistan.⁽⁹⁾

The Rh negativity is also consistently high among Sikhs in Panjab (10 - 11%), Calcutta (7.6%),⁽¹¹⁾ as well as in Assam (6.7%),⁽¹⁵⁾ is comparable to Indian (4.64%)⁽¹⁶⁾ and Pakistani (10.72%),⁽¹⁷⁾ but the Rh negative is not as prevalent as the Caucasians (15%). Also, similar to our study (Table 2), the most common CDE phenotype cluster among Sikhs in Calcutta are R_1R_1 (CCDee, 38%), followed by R_1r (CcDee, 29%), and R_1R_2 (CcDEe, 16%), while R_2R_2 (ccDEE) is rare (<1%) and R_2R_z (CcDEE) not found.⁽¹¹⁾

People in Myanmar consist of several ethnic groups. Our study of the Burmese migrant workers who were blood donors did not ascertain a specific ethnic group. Nevertheless, the preponderance of group O over group B, and A in our study is similar to that of the Mons and the Karen in Myanmar, but differ from the Burmese.^(18, 19)

Our finding of very low prevalence of Rh-negative blood group is consistent with a previous report of 0.83% among all the Burmese ethnic groups except the Kachins.⁽¹⁸⁾ The prevalence of Rh negativity in the Burmese and Thais (0.3%) are in group of the lowest in the world.⁽⁵⁾ Similar to the previous reports, the most common CDE phenotype cluster among Mons, the Burmese, Kachins, the Arakanese, Paduangs, and Shans in Myanmar also R_1R_1 (CCDee) 47 - 64%, followed by R_1R_2 (CcDEe) 14 - 28%, and R_1r (CcDee) 4 - 18%.^(18, 19)

As for the MNS system, our finding of predominance of allele M over N, and S over s, confirmed the previous findings among Sikhs in Calcutta, where frequencies of M (0.67), N (0.33), S (0.30), and s (0.70) were quite similar to that of the Thai Sikhs.⁽¹¹⁾ In contrasts, the Thais and the Burmese share much higher frequency alleles of s (0.86 - 0.89, Table 3), and therefore much lower proportion of antigen S (17 - 22%). The s allele frequencies are highly consistent with result from all the Burmese ethnic groups, and are common among the Mongoloids.^(18, 19)

The low-incidence variant antigen Mi^a (+) is not present or has never been previously reported in Sikhs, but detected in 9.1% of Thais, and 3.7% of the Burmese in this study.⁽⁵⁾ We did not calculate the gene frequency as we have not explored other classes of variant MNS subsystem. The phenotypes of other minor blood groups are novel findings among Sikhs as there are no other reports of P, Lewis, Kidd, Duffy, Kell and Diego.

We found that a proportion of Thai Sikhs have Fy (a-b+), a common allele among the Caucasians but rare in Thais, and Burmese. (Table 3)^(5, 18, 20) The

K (+) antigen of Kell blood group system is rare in the Thai Sikh and is absent in the Burmese blood donors. Similarly, the Di^a (+) antigen of Diego system is rare in the Burmese and is absent in the Thai Sikhs blood donors. The predominant phenotype of Lewis system in both populations is Le (a-b+).

Conclusion

The red cell antigen profiles of Thai Sikhs are different from the Burmese, Mons and Thais blood donors but resemble that of Caucasians as shown by higher proportion of Rh negative, Fy^a (-), S(+), and K(+), but is absent of Mi^a (+), and Di^a (+).

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