Frequency Distribution of ABO and Rhesus (D) Blood Groups in Tacloban City, Philippines (2014-2015)

Carlito C. Cabo, Jr., Leni G. Yap-Dejeto*
Division of Natural Sciences and Mathematics, University of the Philippines Visayas Tacloban College, Tacloban City 6500 Leyte, Philippines

ABSTRACT

Information on blood frequency distribution is important as it is used in genetic research, modern medicine, counseling, anthropology, and health care planning. For example, studies show individuals with Blood Group A are more susceptible to infections and severe COVID-19. This study intended to determine the phenotype ABO and Rh (D) blood groups' frequencies in Tacloban City and compare this with the national distribution. Blood records from three health service centers were judiciously collected from March 2014 to March 2015; the frequency distributions of two blood group systems, ABO and Rhesus (D), were then determined. A total of 5,953 entries, ranging from infants to adults, within the city were collected. The distribution of the phenotypic frequency for ABO blood groups were 45.4%, 24.0%, 24.9%, and 5.7%, for groups O, A, B, and AB, respectively; while the frequency distribution for the Rhesus (D) blood groups were 98.9% and 1.1% for Rh (D)+ and Rh (D)-, respectively. Chi-square tests on the frequency distributions revealed a distinction between Tacloban and the national population. Allelic frequencies were calculated and yielded these results: 0.6720 for O allele, 0.1613 for A allele, and 0.1667 for B allele. This study provides the first record on phenotypic and genotypic frequencies of these blood groups in the city. The phenotypic frequencies of Tacloban population from the most to the least frequent is O>B>A>AB.

KEYWORDS:

ABO, Rhesus (Rh) D blood groups, genotype and phenotypic frequencies, Philippines

INTRODUCTION

There are several blood groups known to medicine, among these known blood groups, the ABO and Rh (D)- blood groups are the most important. The ABO blood group is considered the main blood group (Adeyemo & Soboyejo 2006). Knowledge of these blood groups is crucial in blood transfusion. Blood transfusions, albeit necessary in modern medicine, could potentially pose grave danger to the recipients if the donor and recipients are incompatible. In addition, the different types of blood groups have certain susceptibility to some diseases. For example, studies show that individuals with Blood Group A are more susceptible to pancreatic and stomach cancers; and more notably severe COVID-19 infection than people with other blood groups (Lee et al 1990; Greer et al. 2010; Ray et al. 2021). This medical system saves the lives of many people due to blood-based pathologies humanity is experiencing at present, such as blood malignancies, sickle cell disease, dengue, and this recent COVID-19 pandemic, among others.

Aside from medicine, knowledge of blood frequency distribution also shows importance to several other fields; database of blood frequency distribution is essential to the analyses in forensics, paternity suits, anthropology, and also human relation tracing (Tekade et al. 2011). This can also help in genetic counseling and medical diagnosis (Adeyemo & Soboyejo 2006).

These defining characteristics in the individual's blood is expressed by the genes of the person. The ABO expressing genes can be found in chromosome 9 that contains 7 exons, being most of the coding sequence in the 7 exons (Nagariya 2013; Narahara et al. 1986). It is in chromosome 1 that the Rhesus locus can be found (Chérif-Zahar et al. 1991). With these characteristics of the blood groups, they can also be used in Hardy-Weinberg Equilibrium to assess the

*Corresponding Author:
Natural Sciences and Mathematics, University of the Philippines Visayas Tacloban College, Tacloban City 6500 Leyte, Philippines;
Email address: lgyapdejeto@up.edu.ph

state of population (Klug et al. 2012). Certain blood groups, for example the MN blood group, have unique modes of inheritance. The MN system is inherited as codominant alleles. It means that each allele expressing the MN antigens of the blood is expressed equally, there is no total dominance over the other expressing gene.

There have been several studies on ABO Blood Frequency Distribution in the world. Most studies yielded results having blood type O as most dominant followed by blood type A, blood type B, and blood type AB (O>A>B>AB) (Ghobadian et al. 2013; Adeyemo & Soboyejo 2006; Akinnuga et al. 2011). There are also studies on ABO blood groups in the Philippines. A study of Fraser et al. (1964) showed the ABO frequency distribution in Manila was, type O, 45.4%; type A, 25.8%; type B, 22.8%; and type AB, 0.6%. The most recent is by Guzman et al. (2010) which showed the first different pattern of frequency distribution of ABO blood groups in the Philippines, type O, 43.51%; type B, 25.69%; type A, 25%; and type AB, 5.8%.

Although there is a national data established recently (Guzman et al. 2010), it is important to consider that the Philippines is an archipelago; migration and mixing of populations of different region occurs at a lower rate compared to other countries. This means that there is a possible difference of the frequency distribution in Tacloban City compared to the National data established, as their data is a composite of different regions. Also, by setting the blood frequency distribution in Tacloban City, hospitals and blood drives can have better basis on how to prevent blood shortages during the peak of transfusion incidences caused by a dengue epidemic, for example, in the city.

This study is done particularly in Tacloban City to produce baseline data on population genetics based on blood (ABO and Rh-D) frequency distributions. The city suffered great casualties from super typhoon Haiyan/Yolanda (2013), which could have potentially altered the state of the population and this event could be assessed by further research of the topic using this data as basis. This study specifically aimed to determine the phenotype ABO and Rh (D) blood groups frequency distribution of the population in Tacloban City in 2014-2015; establish the ABO and Rh (D) blood group genotypic/allelic frequencies data using the Hardy-Weinberg equation in the city; and compare these with the national data, and selected cities around the world in terms of blood frequency distributions.

MATERIALS AND METHODS

Site Description

The study was carried out in Tacloban City, a highly urbanized city (HUC) situated in the northeastern part of the island of Leyte, Philippines. Tacloban City is the capital of the island of Leyte, and it is one of the major commercial nerves in eastern Visayas. The city is characterized by two weather seasons, the rainy/wet and dry seasons and is frequently visited by typhoons all throughout the year.

Three health care facilities were included in this study, 1) Mother of Mercy Hospital, a private hospital that operated just after the super typhoon Haiyan and had a surge of patients when the largest public hospital, Eastern Visayas Medical Center became non-operational, 2) Divine Word Hospital, the largest private hospital that served as the main receiver of the surge of patients, and 3) Red Cross Tacloban Chapter which was the biggest blood bank in the region. These were the facilities that had the biggest blood hub or used transfusion and the ones that had their records and data still intact and available, other health facilities were damaged from the super typhoon and their records lost or damaged.

The inclusion criteria for the blood records were people who had their address in Tacloban City; those records that were addressed outside of the city and had missing address entry were excluded from the study. The data were checked to prevent double entry.

Data Collection

Blood typing records of people of varying ages (7 days old – 89 years old) were retrospectively collected from three health service centers in Tacloban City. A whole year data of the health service centers from March 2014 – March 2015 were used. Only a whole year data was retrieved because acquisition of data from 2013 was impossible as most records got wet from the super typhoon Haiyan on November 2013. The health service centers included Divine World Hospital (DWH), Mother of Mercy Hospital (MMH), and Red Cross Tacloban Chapter (RCTC). The records obtained in this study was with the approval of the administrators in the said health service centers.

Allelic Frequency Calculations

The allelic frequencies for the ABO blood group were calculated using the following equations (Klug et al. 2012):

$$PA = \frac{2NAA + NAO + NAB}{2n}$$

$$PB = \frac{2NBB + NBO + NAB}{2n}$$

$$PO = \frac{NAO + NBO + 2NO}{2n}$$

Where:

PA = A allelic frequency

PB = B allelic frequency

PO = O allelic frequency

NAA = Number of AA individuals

NAO = Number of AO individuals

NBB = Number of BB individuals

NBO = Number of BO individuals

NOO = Number of OO individuals

n = total number of samples

For the Rhesus (D) blood group, the allelic frequencies were computed using the Hardy-Weinberg equation (Klug et al. 2012):

Hardy-Weinberg Equations:

$p^2 + 2pq + q^2 = 1$ — p = frequency of the dominant allele in a population

$p + q = 1$ — q = frequency of the recessive allele in a population

The allelic frequencies were calculated under the Hardy-Weinberg assumption.

Statistical Analysis

The results were subjected to chi-square tests to determine if the frequency distributions of the two blood groups are significantly different to the national data established by Guzman et al. (2010).

RESULTS

Frequencies of the ABO and Rh (D) Blood groups and their allelic/genotypic frequencies in Tacloban City

As presented in table 1, the occurrence of ABO blood group frequencies was shown to follow in the order O > B > A > AB (45.4% > 24.9% > 24% > 5.7%), respectively, among the individuals in the studied population. Blood type O had the predominant overall percentage frequency (45.4%), while the AB blood type had the least overall percentage frequency observed. The table also shows that there was a marginal difference between the frequencies of blood types A and B (24% and 24.9%, respectively). The pattern of the overall percentage frequencies of the ABO blood group system is consistent with the prevalence in the three health facilities. The table also describes the frequencies of the Rhesus (D) blood group system; it reveals that 98.9% of the studied population were Rh (D)+, while there was a near negligible frequency of Rh (D)- phenotypes. This trend was consistent with the three health facilities in the study.

Table 1. Distribution of phenotypic frequency of ABO and Rh (D) blood group systems of the sample population in Tacloban City.

Health Facilities	ABO System					Rhesus (D) System		
	O	A	B	AB	Total	Rh+	Rh-	Total
MMH	50(42.4)	32(27.1)	32(27.1)	4(3.4)	118	118(100)	0(0)	118
DWH	1790(45.0)	956(24.1)	999(25.1)	229(5.8)	3974	3966(99.8)	8(0.2)	3974
RCLC	863(46.4)	440(23.6)	452(24.3)	106(5.7)	1861	1801(96.8)	60(3.2)	1861
Gross Total	**2703(45.4)**	**1428(24.0)**	**1483(24.9)**	**339(5.7)**	5953	**5885 (98.9)**	**68 (1.1)**	5953

*values in parenthesis represent percentages of occurrence

Allele frequencies in this studied population is also presented. Table 2 shows the overall allelic frequencies for the ABO and the Rhesus (D) blood group systems. For the ABO blood group, allele frequency is shown to be highest for the O allele (0.6720), followed by B allele (0.1667), and lastly A allele (0.1613). The Phenotype frequencies relative to the calculated alleles were O = 45.2%, B = 24.3%, A = 25.2%, and AB = 5.4%. For the Rhesus (D) blood group, the calculated genotypic frequencies were DD = 0.798, Dd = 0.191, and dd = 0.011. Whereas the allelic frequencies were D= 0.8932 and d = 0.1068. Note that calculations for the allelic frequencies were carried out under the Hardy-Weinberg assumption.

Table 2 also shows that the frequency of the AA genotype is the least of all the genotypes expressed, while OO genotype is the prevalent genotype in the population. There is a marginal difference between the AA and BB genotype.

Comparison of Frequencies of the ABO and Rh (D) Blood groups and their allelic/genotypic frequencies between Tacloban City and the National Data

There is a significant difference between the distributions of the ABO frequencies in Tacloban population and that of the national population, from a previous study (Guzman et al. 2010) in the country. There is a significant difference (P<0.05) between the two frequencies (df = 3, $x^2_{0.05} = 7.815$). There is greater distribution of O phenotypes in the Tacloban population (f=45.4) compared to that in the national population (f=43.51), as seen in figure 1. However, the two data do share a similar trend, wherein the O is the most prevalent blood type while the AB is the least in both populations. Figure 1 also shows that both populations present marginal differences in A and B occurrence.

Both populations share the same trend for the Rhesus (D) blood type occurrence, as shown in figure 2. The figure shows that there is 98.86% and 99.83% occurrence of people with Rh (D)+, in Tacloban and the national populations, respectively. Although similar trend has been shown in figure 2 for the Rhesus (D) distributions, these two populations are actually very different. The two studied populations have a very significant difference (P<<0.005) with the calculated value $x^2 = 331.6$ (df = 1).

Table 2. Gene frequencies of ABO and Rh (D) blood group alleles of the sample population in Tacloban City, Philippines.

Blood group system	Gene(allele)	Frequency	Genotype	Frequency	Phenotype	Frequency
ABO	O	0.6720	OO	0.4516	O	0.4516
	A	0.1613	AA	0.0260	A	0.2428
			AO	0.2168	A	
	B	0.1667	BB	0.0278	B	0.2518
			BO	0.2240	B	
			AB	0.0538	AB	0.0538
Rhesus	D	0.8932	DD	0.7978	Rh+	0.9886
			Dd	0.1908	Rh+	
	d	0.1068	dd	0.0114	Rh-	0.0114

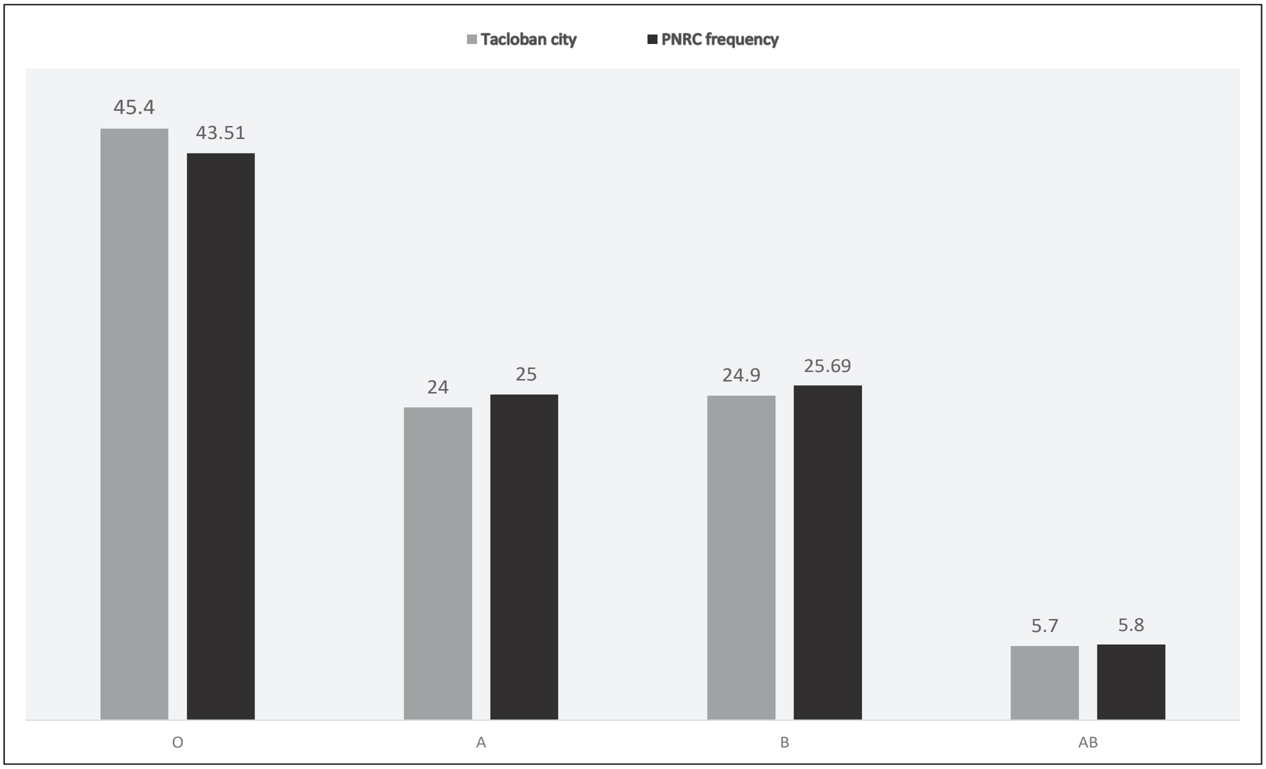

Figure 1. Percentage distribution of ABO blood group from two populations. Tacloban City population and national population from PNRC (Philippine National Red Cross) data. The general trend in the two populations consist of blood type O with the highest frequency, followed by type B, type A, and with the least frequency, type AB.

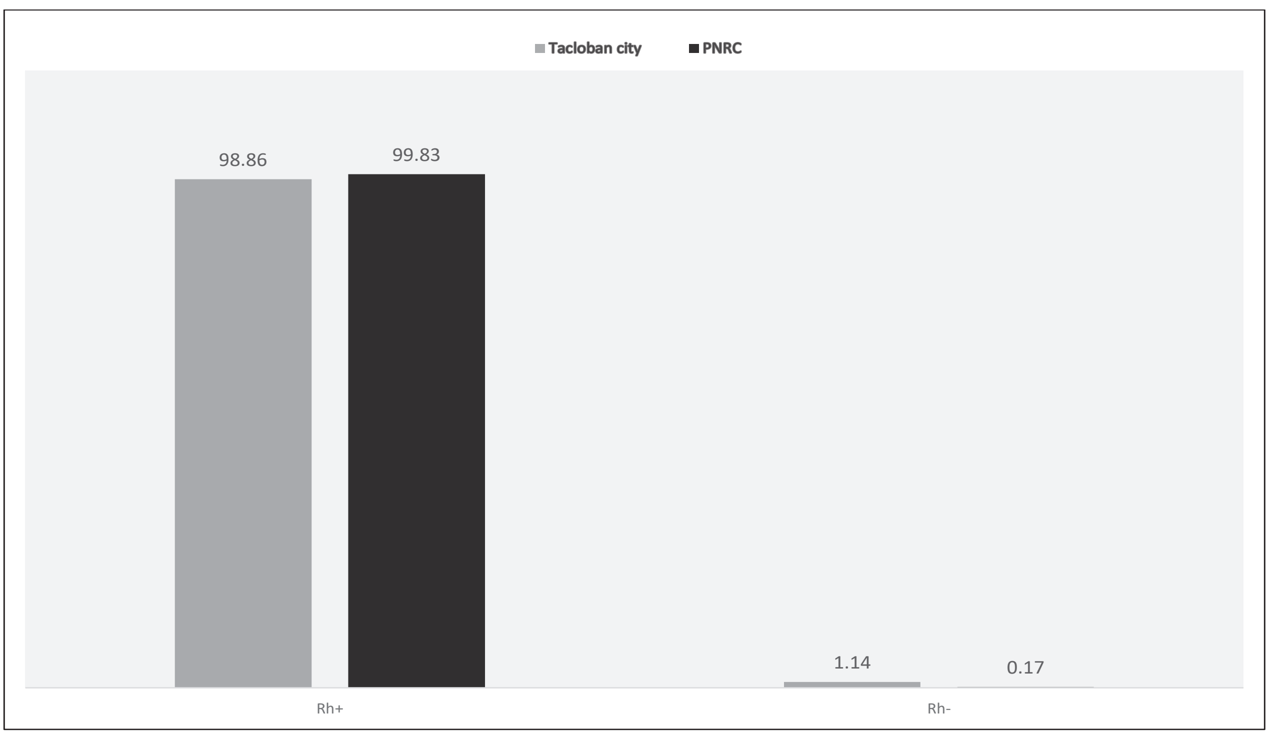

Figure 2. Percentage distribution of Rhesus (D) factor blood group in two populations; Tacloban population, and national population (taken from PNRC data; Philippine National Red Cross). Both populations showed bare minimum frequency of Rh (D)- and overwhelming frequency of Rh (D)+.

Comparison of Frequencies of the ABO and Rh (D) Blood groups and their Allelic/Genotypic Frequencies between Tacloban City and Selected Cities Around the Globe

From the different reports on ABO distributions around the world, table 3 describes that Tacloban populace follows the trend of the studied populations in Asia, including Philippines. Different Asian populations (Pakistan - Mandi bahauddin, Gujrat, Sahiwal, Swabi, Hazara; India; Philippines) have ABO frequency distribution following O>B>A>AB, while most of the Caucasian and African populations show a different trend, O>A>B>AB.

Table 3. Comparison of frequency of ABO blood groups in different populations across the world.

Population	O	A	B	AB	Reference
Europe					
Britain	0.4670	0.4170	0.0860	0.0300	*Khattak, 2008*
Hungary	0.5593	0.2766	0.1218	0.0423	*Tuaszik, 1995*
Turkey	0.7398	0.1220	0.1213	0.0085	*Akbas, 2003*
America					
USA	0.4600	0.4100	0.0900	0.0400	*Mollison, 1993*
Africa					
Nairobi (Kenya)	0.6900	0.1580	0.1261	0.0239	*Lyko, 1992*
Sudan	0.6683	0.1814	0.1235	0.0268	*Khalil, 1989*
Guinea	0.4888	0.2254	0.2386	0.0472	*Loua, 2007*
Nigeria	0.4894	0.2443	0.2388	0.0275	*Falusi, 2000*
Ogbomoso (Nigeria)	0.5000	0.2290	0.2130	0.0590	*Bakare, 2006*
Benin (Nigeria)	0.5322	0.2372	0.2009	0.0297	*Enosolease, 2008*
Ibadan (Nigeria)	0.5420	0.2160	0.2140	0.0280	*Omotade, 1999*
Port-Harcourt (Nigeria)	0.5516	0.2290	0.1710	0.0484	*Jeremiah, 2006*
Adamawa (Nigeria)	0.5060	0.1650	0.2130	0.1170	*Abdulazeez, 2008*
Northern Nigeria	0.4660	0.2305	0.2995	0.0440	*Kulkarni, 1985*
Ilorin (Nigeria)	0.5810	0.1870	0.1760	0.0560	*Iyiola, 2011*
Lagos (Nigeria)	0.5290	0.2310	0.2130	0.0270	*Iyiola, 2012*

Table 3 continued

Middle East					
Kuwait	0.6678	0.1608	0.1406	0.0265	*Al-Bustan, 2002*
Saudi Arabia	0.5200	0.2400	0.1700	0.0400	*Khattak, 2008*
Asia					
Mandi Bahauddin (Pakistan)	0.5522	0.1583	0.2832	0.0448	*Anees, 2007*
Swat (Pakistan)	0.2910	0.2792	0.3240	0.1058	*Khattak, 2008*
Sahiwal (Pakistan)	0.5419	0.1744	0.2837	0.0494	*Anees, 2011*
Gujrat (Pakistan)	0.5596	0.1740	0.2229	0.0435	*Anees, 2005*
Hazara (Pakistan)	0.3300	0.2400	0.3200	0.1100	*Khaliq, 1984*
India	0.3875	0.1885	0.3250	0.0990	*Khattak, 2008*
Swabi (Pakistan)	0.3220	0.2760	0.3040	0.0880	*Khurshid, 1992*
Philippines	0.4351	0.2500	0.2569	0.0580	*Guzman, 2010*
Tacloban (Philippines)	**0.4540**	**0.2400**	**0.2490**	**0.0570**	**Present study**

In table 4, a comparison between studied populations around the world with regards to the O phenotype ratio, presents that the gathered data in Tacloban is similar to the studied populations in USA, Northern Nigeria and Britain. These populations have small marginal difference of observed O phenotypes compared to the other populations. This table shows that the Tacloban population belongs to the population with relatively lower O blood typed individuals by ratio.

The relative proportion of individuals with A and B phenotypes are above average in the Tacloban population. Tables 5 and 6 show the data of this study to be relatively higher or is on the upper league of the studied populations in the world. This explains why in table 4, comparing blood group O to the rest of the world, the Philippines is on the lower part of the list. Relative to the other populations, there is a significant proportion of people that have A and B blood types in Tacloban.

Table 4. World populations in comparison with the proportion of O blood typed individuals..

Population	O blood type	Reference
Turkey	0.7398	*Akbas, 2003*
Nairobi (Kenya)	0.6900	*Lyko, 1992*
Sudan	0.6683	*Khalil, 1989*
Kuwait	0.6678	*Al-Bustan, 2002*

Table 4 continued

Ilorin (Nigeria)	0.5810	*Iyiola, 2011*
Gujrat (Pakistan)	0.5596	*Anees, 2005*
Hungary	0.5593	*Tuaszik, 1995*
Mandi Bahauddin (Pakistan)	0.5522	*Anees, 2007*
Port-Harcourt (Nigeria)	0.5516	*Jeremiah, 2006*
Ibadan (Nigeria)	0.5420	*Omotade, 1999*
Sahiwal (Pakistan)	0.5419	*Anees, 2011*
Benin (Nigeria)	0.5322	*Enosolease, 2008*
Lagos (Nigeria)	0.5290	*Iyiola, 2012*
Saudi Arabia	0.5200	*Khattak, 2008*
Adamawa (Nigeria)	0.5060	*Abdulazeez, 2008*
Ogbomoso (Nigeria)	0.5000	*Bakare, 2006*
Nigeria	0.4894	*Falusi, 2000*
Guinea	0.4888	*Loua, 2007*
Britain	0.4670	*Khattak, 2008*
Northern Nigeria	0.4660	*Kulkarni, 1985*
USA	0.4600	*Mollison, 1993*
Tacloban (Philippines)	**0.4540**	**Present study**
Philippines	0.4351	*Guzman, 2010*
India	0.3875	*Khattak, 2008*
Hazara (Pakistan)	0.3300	*Khaliq, 1984*
Swabi (Pakistan)	0.3220	*Khurshid, 1992*
Swat (Pakistan)	0.2910	*Khattak, 2008*

Table 5. World populations in comparison with the proportion of A blood typed individuals.

Population	A blood type	Reference
Britain	0.4170	*Khattak, 2008*
USA	0.4100	*Mollison, 1993*
Japan	0.3865	*Yoshiko, 1978*
Swat (Pakistan)	0.2792	*Khattak, 2008*
Hungary	0.2766	*Tuaszik, 1995*
Swabi (Pakistan)	0.2760	*Khurshid, 1992*
Philippines	0.2500	*Guzman, 2010*
Nigeria	0.2443	*Falusi, 2000*
Saudi Arabia	0.2400	*Khattak, 2008*
Tacloban (Philippines)	**0.2400**	**Present study**
Hazara (Pakistan)	0.2400	*Khaliq, 1984*
Benin (Nigeria)	0.2372	*Enosolease, 2008*
Lagos (Nigeria)	0.2310	*Iyiola, 2012*
Northern Nigeria	0.2305	*Kulkarni, 1985*
Port-Harcourt (Nigeria)	0.2290	*Jeremiah, 2006*
Ogbomoso (Nigeria)	0.2290	*Bakare, 2006*
Guinea	0.2254	*Loua, 2007*
Ibadan (Nigeria)	0.2160	*Omotade, 1999*
India	0.1885	*Khattak, 2008*
Ilorin (Nigeria)	0.1870	*Iyiola, 2011*
Sudan	0.1814	*Khalil, 1989*
Sahiwal (Pakistan)	0.1744	*Anees, 2011*
Gujrat (Pakistan)	0.1740	*Anees, 2005*
Adamawa (Nigeria)	0.1650	*Abdulazeez, 2008*
Kuwait	0.1608	*Al-Bustan, 2002*
Mandi Bahauddin (Pakistan)	0.1583	*Anees, 2007*
Nairobi (Kenya)	0.1580	*Lyko, 1992*
Turkey	0.1220	*Akbas, 2003*

Table 6. World populations in comparison with the proportion of B blood typed individuals.

Population	B blood type	Reference
India	0.3250	*Khattak, 2008*
Swat (Pakistan)	0.3240	*Khattak, 2008*
Hazara (Pakistan)	0.3200	*Khaliq, 1984*
Swabi (Pakistan)	0.3040	*Khurshid, 1992*
Northern Nigeria	0.2995	*Kulkarni, 1985*
Sahiwal (Pakistan)	0.2837	*Anees, 2011*
Mandi Bahauddin (Pakistan)	0.2832	*Anees, 2007*
Philippines	0.2569	*Guzman, 2010*
Tacloban (Philippines)	**0.2490**	**Present study**
Nigeria	0.2388	*Falusi, 2000*
Guinea	0.2386	*Loua, 2007*
Gujrat (Pakistan)	0.2229	*Anees, 2005*
Ibadan (Nigeria)	0.2140	*Omotade, 1999*
Lagos (Nigeria)	0.2130	*Iyiola, 2012*
Ogbomoso (Nigeria)	0.2130	*Bakare, 2006*
Adamawa (Nigeria)	0.2130	*Abdulazeez, 2008*
Benin (Nigeria)	0.2009	*Enosolease, 2008*
Ilorin (Nigeria)	0.1760	*Iyiola, 2011*
Port-Harcourt (Nigeria)	0.1710	*Jeremiah, 2006*
Saudi Arabia	0.1700	*Khattak, 2008*
Kuwait	0.1406	*Al-Bustan, 2002*
Nairobi (Kenya)	0.1261	*Lyko, 1992*
Sudan	0.1235	*Khalil, 1989*
Hungary	0.1218	*Tuaszik, 1995*
Turkey	0.1213	*Akbas, 2003*
USA	0.0900	*Mollison, 1993*
Britain	0.0860	*Khattak, 2008*

The data in table 7 shows that Tacloban residents belong to the upper proportion of populations that have comparatively higher occurrence of AB blood typed individuals. In table 7 it is presented that there is higher distribution of A and B genes in the gene pool of Tacloban inhabitants relative to the average in the studied populations.

Table 8 shows the frequencies of Rh (D) Blood Group in selected cities and countries around the world. The Rh (D) frequencies ranged from 0.9983-0.83, with the Philippine data being the highest (Guzman et al. 2010), followed by the frequency from Tacloban City, while the lowest is from Britain (Khattak, et al. 2008). See table 8.

Table 7. World populations in comparison with the proportion of AB blood typed individuals.

Population	AB blood type	Reference
Adamawa (Nigeria)	0.1170	*Abdulazeez, 2008*
Hazara (Pakistan)	0.1100	*Khaliq, 1984*
Swat (Pakistan)	0.1058	*Khattak, 2008*
India	0.0990	*Khattak, 2008*
Swabi (Pakistan)	0.0880	*Khurshid, 1992*
Ogbomoso (Nigeria)	0.0590	*Bakare, 2006*
Philippines	0.0580	*Guzman, 2010*
Tacloban (Philippines)	**0.0570**	**Present study**
Ilorin (Nigeria)	0.0560	*Iyiola, 2011*
Sahiwal (Pakistan)	0.0494	*Anees, 2011*
Port-Harcourt (Nigeria)	0.0484	*Jeremiah, 2006*
Guinea	0.0472	*Loua, 2007*
Mandi Bahauddin (Pakistan)	0.0448	*Anees, 2007*
Northern Nigeria	0.0440	*Kulkarni, 1985*
Gujrat (Pakistan)	0.0435	*Anees, 2005*
Hungary	0.0423	*Tuaszik, 1995*
USA	0.0400	*Mollison, 1993*
Saudi Arabia	0.0400	*Khattak, 2008*
Britain	0.0300	*Khattak, 2008*
Benin (Nigeria)	0.0297	*Enosolease, 2008*

Table 7 continued

Ibadan (Nigeria)	0.0280	*Omotade, 1999*
Nigeria	0.0275	*Falusi, 2000*
Lagos (Nigeria)	0.0270	*Iyiola, 2012*
Sudan	0.0268	*Khalil, 1989*
Kuwait	0.0265	*Al-Bustan, 2002*
Nairobi (Kenya)	0.0239	*Lyko, 1992*
Turkey	0.0085	*Akbas, 2003*

Table 8. Comparison of Rhesus (D) blood type frequency to different populations around the world.

Population	Rh +	Rh –	Reference
Europe			
Germany	0.9500	0.0500	*Akbas, 2003*
Britain	0.8300	0.1700	*Khattak, 2008*
North America			
USA	0.8500	0.1500	*Khattak, 2008*
Middle East			
Saudi Arabia	0.9300	0.0700	*Khattak, 2008*
Africa			
Adamawa (Nigeria)	0.9740	0.0260	*Omotade, 1999*
Port Harcourt (Nigeria)	0.9677	0.0323	*Jeremiah, 2006*
Ogbomoso (Nigeria)	0.9670	0.0330	*Bakare, 2006*
Ilorin (Nigeria)	0.9550	0.0450	*Iyiola, 2011*

Table 8 continued

Ibadan (Nigeria)	0.9500	0.0480	*Omotade, 1999*
Nigeria	0.9430	0.0570	*Falusi, 2000*
Lagos (Nigeria)	0.9400	0.0600	*Adeyemo, 2006*
Benin (Nigeria)	0.9388	0.0603	*Enosolease, 2008*
Asia			
Tacloban (Philippines)	**0.9886**	**0.0114**	**Present Study**
Philippines	0.9983	0.0017	*Guzman, 2010*
India	0.9445	0.0550	*Khattak, 2008*
Mandi Bahauddin (Pakistan)	0.9140	0.0860	*Anees, 2007*

DISCUSSION

For the population covered by the period 2014-2015, and a total of 5,953 individuals within Tacloban City, the phenotypic order of occurrence for the ABO blood type was O>B>A>AB. The records from different health service centers were compared and it showed consistent order of occurrence. This study confirmed that there is a significant difference between the distributions of the ABO frequencies in Tacloban population than that of the national population, from a previous study (Guzman et al. 2010) in the country. The significant difference could be due to the big difference in the O distribution from the two populations. There is greater distribution of O phenotypes in the Tacloban population (f=45.4) compared to that in the national population (f=43.51). This suggests that the most readily available blood in a Filipino population is blood type O.

The gene frequency of the ABO blood group was calculated in this study, based on the assumptions of the Hardy-Weinberg Equilibrium. Unfortunately, the national data from Guzman et al. (2010) did not present gene frequencies. Thus, search for similar data led to previous works in the Philippines. A study by Atienza (1955) yielded these gene frequencies A = 0.168, B = 0.160, and O = 0.672; Fraser and his colleagues (1964) also did a similar study and reported these gene frequencies A = 0.17, B = 0.15, and O = 0.58. The two previous studies were in good agreement with each other, showing marginal differences with other gene frequencies and showing the O>A>B pattern. However, the results of this study diverge from the trend of the previous researches, with gene frequencies A = 0.1613, B = 0.1667, and O = 0.6720, with O>B>A pattern. Although there is no gene frequency presented by Guzman et al. (2010) for the national data, we could deduce that the pattern is the same as the data in this study, of O>B>A, since there were also more blood group B individuals in the national data. The studied population, in Tacloban and the national data of Guzman et al. (2010), differs from both studies of Atienza (1955) and Fraser's (1964). There were relatively more B alleles than A alleles in the gene pool in the more recent data. We can only surmise whether it is genetic drift or gene flow that would be the cause of the differences in allelic frequencies of the data that is about two generations ago from this study's data and Guzman et al.'s data. These observations need to be investigated further as this is beyond the scope of this study.

The data presented in this study are consistent with other findings similar to this research in other populations. Such as a similar study in Guinea that reported the ABO frequencies were 48.88%, 22.54%, 23.86%, and 4.72% for O, A, B, and AB blood groups, respectively (Loua et al. 2007). However, this data deviates from the ABO trend in most African populations wherein most of the studied populations follow the order O>A>B>AB (Tiruneh et al. 2020). The Caucasian populations follow this trend too (Tuaszik 1995; Akbas 2003; Khattak 2008). But Asians have ABO frequency distribution following O>B>A>AB (Khurshid 1992; Akbas 2003; Anees 2007; Khattak 2008; Anees 2011). This indicates that there are more people with blood types A than B in Europeans, Americans, and Africans; and there are relatively more people with blood type B than A in an Asian populace. The lower blood group A in Africa could probable be explained by the susceptibility of people with blood group A to malarial parasitemia (Akhigbe et al. 2011). While that lower blood group A in the Caucasian population has been the subject of evolution studies and theories (Candela 1942; Farhud & Zarif Yeganeh 2013). However, the most comparable populations in terms of ABO frequency to the Tacloban population are Guinea, Nigeria, Ogbomoso (Nigeria), and Philippines (Loua et al. 2007; Falusi et al. 2000; Bakare et al. 2006; Guzman et al. 2010; Akhigbe et al. 2009).

Throughout several works in the past decades, there have been several implications on the population this study has suggested. Higher frequency of O blood type has health implications suggesting that the population is less likely to be affected by severe malaria cases. This is because studies have unveiled that O blood type individuals are less susceptible to severe malaria due to the mechanism of reduced rosetting (Rowe et al. 2007). This is an advantage to the population of Tacloban City; however, higher frequency of O blood type could bring about higher occurrence of peptic and duodenal ulcer to the population as studies have reported that persons with blood type O are more vulnerable to this disease compared to the rest of the blood groups (Reid et al. 2012; Edgren et al. 2010; Buseri & Okonkwo 2014; Akhtar et al. 2003). There are also other reports that associate blood types with other diseases; the relatively low frequency of A blood type in the population hints that there is a lower possible incidence of cases of pancreatic cancers. This is because recent studies have reported positive correlation of occurrence of pancreatic and stomach cancers with blood type A patients (Greer et al. 2010; Lee et al 1990). Other malignancies are also described to be associated with blood group populations, like the cases of esophageal carcinomas which is higher in blood type B males (Min et al. 2001). And recently, the susceptibility of Blood Group A to severe COVID-19 infection (Ray et al. 2021).

These results suggest that the blood banks in the area should stock up on O blood type with regards to the higher need for blood group O, for transfusion purposes. Knowledge of this study can greatly aid in transfusion cases, health care planning, and counseling.

The similar trend for the Rhesus (D) blood type occurrence in the national data and the Tacloban City data illustrates that Filipino population is dominated by individuals with Rhesus (D) positive blood type and that there is little or negligible occurrence of people with Rhesus (D) negative blood type. The figure shows that there is 98.86% and 99.83% occurrence of people with Rh (D)+, in Tacloban and the national populations, respectively. As per Chi square calculations, the two studied populations have a very significant difference ($P<<0.005$). This was because the national population has an insignificant percentage of rhesus (D) negative, which is less than one percent, while Tacloban population has 1.14% of Rhesus (D) negative. This difference could be attributed to occurrence of Super Typhoon Haiyan/ Yolanda the year before (2013). There is a possibility that Rh (D)- individuals might have been displaced, perished or migrated out of the city. This is just a hypothesis, and should be further verified in future studies.

The Rhesus (D) positive frequency in this study is revealed to be predominant in Tacloban population. There are few Rhesus (D) negative individuals in the studied population consisting to a minute proportion of the people, this infers that the recessive rhesus (D) phenotype is very rare to Filipinos (Guzman et al. 2010). The findings of this study are consistent with all the reports from other similar researches across the world where Rhesus (D) positive phenotype is very dominant, or that there are no populations having significant percentage of Rhesus (D) negative phenotype occurrence. The reason could be that Rh

(D) negative homozygotes were not as physically and mentally healthy as the Rh (D) positive phenotype (Flegr et al. 2021).

The Philippines showed the highest ratio for Rhesus (D) positive incidence. Interestingly, both studies in the Philippines presented consistent results that show that the Filipinos have incredibly high ratio of Rhesus (D) positive individuals. This might be due to the archipelagic nature of the Philippines. As the Philippines is archipelago, transportation is not as easy as in countries with continuous land masses, there is lesser instance of amalgamations between locals and foreigners. This hypothesis needs to be verified. Nevertheless, the population of Tacloban City (Philippines) and Philippine national data provided the scenario for the lowest occurrence of the hemolytic newborn syndrome (erythroblastosis fetalis). It can also be stated that the Philippine populations is distinct from the rest of the world in terms of its Rhesus (D) negative incidence.

In summary, recent data showed that the Philippines is found to have the highest proportion of Rhesus (D) positive individuals which is distinct from the rest of the studied populations in the world. It is determined in this study that the population in Tacloban is distinct ($P<0.05$) compared to the Philippine national population. This confirms that this population is prevalent with Rhesus (D) positive individuals, with 98.9% of the population being Rh(D)+ while only 1.1% were Rh (D)-.

The ABO frequency distribution in Tacloban is dominated by blood type O (45.4%), followed by blood types B (24.9%) then A (24%), and the least occurring is blood type AB (5.7%). Data on the gene frequencies of ABO and Rhesus (D) blood groups in Tacloban City have shown that there is gene variability for A and B alleles between the gene pools of Tacloban population (O = 0.672, A = 0.1613, B = 0.1667) and other studied populations in the Philippines.

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Appendix A

Chi square table for comparison between Tacloban ABO frequencies and National frequencies, taken from PNRC (Guzman et al, 201).

	Observed *Tacloban* frequency(o)	Expected based on National frequency(e)	$(o-e)^2/e$
O	2703	2590.15	4.917
A	1428	1488.25	2.439
B	1483	1529.33	1.404
AB	339	345.27	0.1139
Total	5,953		$\chi2 = 8.8739$
Conclusion	P<0.05; The frequency distributions between the two population is significantly different.		

Chi square table comparing the difference of Rhesus frequencies between Tacloban population and national population, PNRC data (Guzman et al, 2010). Appendix B

	Observed *Tacloban* Frequency(o)	Expected based on National frequency(e)	$(o-e)^2/e$
Rh+	5885	5942.88	0.5637
Rh-	68	10.12	331.04
Total	5,953		$\chi2 = 331.6037$
Conclusion	P<<0.005; There is a very significant difference between the frequency distributions of the two populations.		

Appendix B

Blood Typing

The ABO and Rh (D) blood typing starts with pricking the fingers with sterile lancets and obtaining droTps of blood. These are then placed on a spot plate containing blood typing anti-serum. Monoclonal antibodies such as Eryclone TM Anti-A and Anti-B of Tulip Diagnostics Ltd. (India) for the ABO blood type; and Epiclone-2 Anti-D of CSL-Australia for the Rh (D) blood group are used for agglutination. Blood drops that agglutinated are positive for that particular blood grouping reagent.

(This procedure follows in principle blood typing as discussed in Stroup MT, Treacy M. 1982. Blood group antigens and Antibodies. Raritan, NJ: Ortho Diagnostic Systems. 255 p.)

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Authors: Carlito C. Cabo, Jr., *Division of Natural Sciences and Mathematics,*
University of the Philippines Visayas, Tacloban College, Tacloban City (6500), Leyte
e-mail: cccabo@up.edu.ph

Leni G. Yap-Dejeto, *Division of Natural Sciences and Mathematics,*
University of the Philippines Visayas, Tacloban College, Tacloban City (6500), Leyte
e-mail: lgyapdejeto@up.edu.ph