

Full length Research Article

# ABO Blood Group Genotypes and Demographic Traits in Susceptibility to Type 1 Diabetes Mellitus in Lagos, Southwest, Nigeria

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**Summary:** Studies have shown that ABO blood groups and demographic traits influence susceptibility to type 1 diabetes mellitus (T1DM) and can be employed with insulin therapy to reduce the disease's burden. However, geographical variations exist in the influence of demographic traits and ABO blood groups on susceptibility to diseases and thus require establishing them in every locality. This study determined the influence of demographic traits and ABO blood groups on the prevalence of T1DM in Lagos, Nigeria. A structured checklist was used to collect data from the health records of 150 non-obese type 1 diabetic patients at Ayobo Health Center, Lagos. The results revealed that males, with 88 participants (58.7%), constituted the majority, while females had 62 (41.3%). The age group  $\geq 40$  years had the highest proportion of participants with 37 (24.7%), followed by 31–40 years with 32 (21.30%), 21–30 years with 30 (20%), 11–20 years with 27 (18%), and 1–10 years with 24 (16%). Eight (5.3%) of the participants were primary school graduates; 34 (22.7%) were secondary school graduates; and 108 (72%) were tertiary school graduates. The Yoruba ethnic group, with 77 participants (51.3%), was the most prevalent, followed by Igbo with 50 (33.3%), and Hausa with 3 (2.0%). ABO blood group A and B (positive and negative) individuals were the most diabetic and expressed the most severe cases, while group O positive and AB negative individuals were the least diabetic. T1DM prevention should be a priority for blood group A and B residents.

**Keywords:** ABO blood groups, Demographic characteristics, Type 1 diabetes mellitus

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## INTRODUCTION

Type 1 diabetes mellitus (T1DM) is an autoimmune disease in which immune cells (T cells) destroy insulin-producing pancreatic  $\beta$ -cells, resulting in hyperglycemia and a proclivity for ketoacidosis. In healthy humans, insulin carries glucose from the bloodstream into the cells where it is used, and thus insulin helps maintain blood glucose (Yahaya and Salisu, 2020). This homeostatic event is assisted by another hormone synthesized in the pancreatic  $\alpha$ -cells, called glucagon. However, in people suffering from T1DM, the immune system dysfunctionally destroys the  $\beta$ -cells along with foreign antigens, a phenomenon called autoimmunity. As a result, the pancreas fails to produce insulin, causing the retention of glucose in the blood, often referred to as hyperglycemia. T1DM symptoms include frequent thirst, hunger, and the desire to urinate; constant diapering; bedwetting in children; unexplained weight loss; weakness; poor vision; poor cut and sore healing; and yeast infections in the vaginal area (Syed, 2022). These symptoms

are often mild at first and get worse over days, weeks, or months because the pancreas of the affected person makes less and less insulin (Syed, 2022). If urgent intervention is not administered, insulin levels may fall so low that lipolysis begins and ketone bodies (caused by fat metabolism) accumulate in the blood (Kahanovitz *et al.*, 2017). Ketoacidosis may eventually lead to complications such as mental confusion, cerebral edema, unconsciousness, coma, and even death (Kahanovitz *et al.*, 2017). T1DM can affect people of all ages, but it most often develops in children or adolescents (IDF, 2020).

T1DM is the most common endocrinological abnormality in children, with an incident rate steadily increasing globally (Rachna and Satish, 2022). As of 2021, 1 in 10 people aged 20 to 79 have diabetes, resulting in a cumulative figure of 537 million. By 2030 and 2045, those numbers are expected to increase to 643 million and 783 million, respectively (IDF, 2021). About 10% of all people with diabetes have T1DM (IDF, 2021). Moreover, over 1 million children and adolescents between the ages of 0–19 years are living with T1DM (IDF, 2021). The incident rate

of T1DM in the sub-Saharan Africa region is 6%, and mortality could be as high as 7% (Damiens *et al.*, 2019; Patterson *et al.*, 2019). In Nigeria, a study has shown a T1DM hospital prevalence of 1.6/1000 in the southern region, while another study shows a prevalence of 2.3/1000 in the northern region (Umar *et al.*, 2016). The economic burden of T1DM is enormous. In a study that compared the life-time economic burden of 1,630,317 individuals with T1DM versus the same number of individuals without diabetes over the course of 100 years, as much as an \$813 billion difference was reported (Sussman *et al.*, 2020).

The particular etiology of T1DM is not known, but there is evidence of genetic susceptibility strongly associated with certain alleles of human leukocyte antigen (HLA) genes, especially DRB103-DQB10201 and DRB10401-DQB10302H (Yahaya and Salisu, 2020). Some other genes also influence susceptibility to the disease. T1DM heritability has been demonstrated by some studies. For instance, studies have shown that the probability of developing T1DM without a family history is about 0.4%, whereas children of a mother with the condition have a 1%-4% chance of developing the disease (Redondo *et al.*, 2018). Furthermore, the children of a type 1 diabetic father have a 3% to 8% chance, while the risk for children whose both parents are diabetic could be up to 30% (Redondo *et al.*, 2018). The chance of a monozygotic twin developing T1DM after the diagnosis of the other twin is 23-61%, while that of a dizygotic twin is 0-27% (Giwa *et al.*, 2020). Scientific evidence also suggests that epigenetic and environmental factors play a significant role in the etiology of T1DM (Yahaya *et al.*, 2017a; Yahaya and Shemishere, 2019).

There is no permanent cure for T1DM, and the available management procedure involves daily insulin injections, which are expensive, painful, and burdensome. But the mortality or burden of the disease can be lessened with adequate management, among which is early screening for the biomarkers of the disease. (Cousin *et al.*, 2022). Unfortunately, T1DM screenings are mainly genetic testing, which is expensive and not readily available, particularly in developing nations like Nigeria. As an alternative, some studies, including Oladele *et al.* (2020) and Yahaya *et al.* (2021a), suggested that demographic characteristics and ABO blood group antigens influence susceptibility to diabetes mellitus and can be used in preventive and management strategies. However, global variations exist in demographic traits and the distribution of ABO blood groups, even among people of the same ethnic group (Akinnuga *et al.*, 2011). This suggests that there is a need to determine the distribution of demographic characteristics and ABO blood group antigens among type 1 diabetics in each locality in order to develop effective preventive and management strategies. As a result, this study was aimed at determining the distribution of demographic characteristics and ABO blood group antigens among type 1 diabetic patients at Ayobo Primary Health Center in Lagos, Nigeria.

## MATERIALS AND METHODS

**Description of study location:** This study was carried out at the Ayobo Primary Health Center in Lagos, Nigeria. Lagos is located in the southwestern region of the country at

latitude 6° 27' 14.65" N and longitude 3° 23' 40.81" E (LatitudeLongitude.org, 2015). Lagos is densely populated and hosts most of the industries in Nigeria, which has resulted in high anthropogenic activity in the state. Lagos has grown to become an economic hub in Africa and one of the most rapidly growing cities in the world. The city has many bodies of water, including the Atlantic Ocean, lagoons, creeks, rivers, estuaries, and streams. The vegetation of the state is tropical, with a long rainy season and a short dry season. Various ethnic groups in Nigeria, mainly Yoruba, Hausa, and Igbo, reside in the city.

The Ayobo Primary Health Center is located on 18 Durojaye Apasha Street, Ipaja, Lagos, in the Alimosho Local Government Area at latitude 6°36'22.4"N and longitude 3°14'06.1"E (VYMaps.com, 2022). Alimosho is one of the most densely populated areas and the largest local government area in Lagos, and so the health center is visited by diverse groups of people. Because of high urbanization, the majority of Lagos residents spend most of their time in their workplaces and depend on energy-laden fast foods, which are diabetogenic. The incident rate of DM in the state is 11%, compared with a 2.2% national prevalence (Shittu *et al.*, 2017). The aforementioned diet, coupled with lifestyles and some other factors, could be responsible for the state's high prevalence of DM. The high DM incident rate in the city necessitated the current study to find preventive measures.

**Study population and data collection:** A backdated and random-sample study of non-obese type 1 diabetic patients who attended the Ayobo Primary Health Center between May 2021 and May 2022 was carried out. Relevant medical information about the patients was collected using a standardized checklist. The checklist consists of 2 sections (Sections I and II). Section I contains socio-demographic variables, including the age, gender, religion, educational status, and ethnicity of each patient. Section II contains medical/health information, namely the ABO blood group, the rhesus status, and the severity of T1DM.

**Determination of sample size:** The sample size for the study was calculated using equation 1 (Yamane, 1973).

$$n = \left( \frac{N}{1+Ne^2} \right) \quad (1)$$

where  $N$  = number of individuals with T1DM that attended the Ayobo Primary Health Center between May 2020 and May 2022 while  $e$  is the level of precision, which is usually between 0.10 and 0.01 (i.e., 10% to 1%).

Using a level of precision ( $e$ ) of 5% and a population size ( $N$ ) of 207,

$$n = \frac{207}{1+207(0.05)^2}$$

$n = 150.09$ , resulting in  $\sim 150$ .

Therefore, the sample size used was 150.

**Eligibility criteria:** Criteria for inclusion were eligible medical records of all patients diagnosed with T1DM between May 2021 and May 2022. Criteria for exclusion include individuals outside the stated duration, those with incomplete records, and obese or overweight individuals.

**Ethics approval and consent to participate:** This study was approved by the Office of the Study Center, National

Open University of Nigeria, Lagos. The guidelines for conducting research on humans as outlined by the Center were strictly followed. Moreover, written consent was obtained before accessing the medical records of the patients.

### Data analysis

The Statistical Package for the Social Sciences (SPSS) version 24 was used to analyze the data, and the results were shown in percentages and frequency distribution tables.

## RESULTS

**Influence of gender on the prevalence of T1DM:** Table 1 shows the gender distribution of T1DM at Ayobo Primary Health Center, Lagos. Males were 88 in number, representing 58.7%, while females were 62, representing 41.3%.

**Table 1:**

Gender distribution among type 1 diabetic patients at Ayobo Primary Health Center, Lagos

Gender	Frequency	Percentages (%)
Male	88	58.7
Female	62	41.3
<b>Total</b>	<b>150</b>	<b>100</b>

**Influence of age on the prevalence of T1DM:** The age distribution among the type 1 diabetic participants at Ayo Primary Health Center is revealed in Table 2. The age groups 1-10 years had 24 (16%) participants, 11-20 years had 27 (18%), 21-30 years had 30 (20%), 31-40 years had 32 (21.30%), and 40 years and older had 37 (24.7%).

**Table 2:**

Age distribution among type 1 diabetic patients at Ayobo Primary Health Center, Lagos

Age (year)	Frequency	Percentage (%)
<b>1-10</b>	24	16.0
<b>11-20</b>	27	18.0
<b>21-30</b>	30	20.0
<b>31-40</b>	32	21.3
<b>&gt;40</b>	37	24.7
<b>Total</b>	<b>150</b>	<b>100</b>

**Influence of religion on the prevalence of T1DM:** Table 3 reveals the proportion of each religion among type 1 diabetic patients at Ayobo Primary Health Center. Christianity had the highest with 74 participants, representing 49.3%, followed by Islam with 71 participants (47.3%), and traditional religion with 5 participants (3.3%).

**Table 3:**

Religion distribution among type 1 diabetic patients at Ayobo Primary Health Center, Lagos

Religion	Frequency	Percentage (%)
Christian	74	49.3
Islam	71	47.3
Traditional	5	3.3
<b>Total</b>	<b>150</b>	<b>100</b>

**Influence of education on the prevalence of T1DM:** The level of education among type 1 diabetic participants at Ayobo Primary Health Center is shown in Table 4. Participants with a primary education made up 8 (5.3%) of the total, while those with a secondary education made up 34 (22.7%) and those with a tertiary education made up 108 (72%).

**Table 4:**

Education qualifications among type 1 diabetic patients at Ayobo Primary Health Center, Lagos

Education qualification	Frequency	Percentage (%)
No formal education	0	0.0
Primary education	8	5.3
Secondary education	34	22.7
Tertiary education	108	72.0
<b>Total</b>	<b>150</b>	<b>100</b>

**Influence of ethnicity on the prevalence of T1DM:** Table 5 displays the prevalence of T1DM among ethnic groups at Ayobo Primary Health Center. The Yoruba ethnic group, with 77 participants (51.3%), was the most prevalent, followed by Igbo with 50 (33.3%), Benin with 13 (8.7%), Idoma with 7 (4.7%), and Hausa with 3 (2.0%) in that order.

**Table 5:**

Ethnic distribution among type 1 diabetic patients at Ayobo Primary Health Center, Lagos

Tribe/ethnic	Frequency	Percentage (%)
Yoruba	77	51.3
Igbo	50	33.3
Benin	13	8.7
Idoma	7	4.7
Hausa	3	2.0
<b>Total</b>	<b>150</b>	<b>100</b>

**ABO Blood types and the prevalence of T1DM:** Table 6 reveals the distribution of ABO blood genotypes among type 1 diabetic patients at Ayobo Primary Health Center. With 49 (32.7%) participants, A+ was the most diabetic, followed by A- with 27 (18.0%), AB+ with 20 (13.3%) participants, B+ with 18 (12.0%) participants, and O+ with 7 (4.7%) participants. In terms of severity, A+ was the most severe with 22 (31.4%) participants, followed by A- with 15 (21.4%) participants, B+ with 10 (14.3%) participants, and the least severe was AB- with 2 (2.9%) participants.

**Table 6:**

Distribution of ABO blood groups among type 1 diabetic patients at Ayobo Primary Health Center, Lagos

Blood group types	Frequency n (%)	Severe cases n (%)
A positive (A <sup>+</sup> )	49 (32.7%)	22 (31.4%)
A Negative (A <sup>-</sup> )	27 (18.0%)	15 (21.4%)
B Positive (B <sup>+</sup> )	18 (12.0%)	10 (14.3%)
B Negative (B <sup>-</sup> )	12 (8.0%)	7 (10.0%)
AB Positive (AB <sup>+</sup> )	20 (13.3%)	6 (8.6%)
AB Negative (AB <sup>-</sup> )	7 (4.7%)	2 (2.9%)
O Negative (O <sup>-</sup> )	7 (4.7%)	4 (5.7%)
O Positive (O <sup>+</sup> )	10 (6.7%)	4 (5.7%)
<b>Total</b>	<b>150 (100%)</b>	<b>70 (100%)</b>

## DISCUSSION

The current study was carried out at Ayobo Primary Health Center in Lagos and determined the influence of demographic characteristics and ABO blood group genotypes on the prevalence of type 1 diabetes mellitus (T1DM). Retrospective demographic data collected from the hospital indicated that T1DM was more common among males than females. This result supports the findings of a systematic review by Diaz-Valencia *et al.* (2015), comprising 70 published articles from 35 countries around the world. In addition, Ostman *et al.* (2008) also reported a higher incidence of T1DM among males than females in the 8012 cases investigated in Sweden. Furthermore, Kyvik *et al.* (2004) reported a higher incidence of T1DM among males than females in a prospective study carried out in Europe. The male preponderance of T1DM could be due to the high secretion of testosterone among young adults and younger middle-aged men, predisposing to insulin resistance (Wändell and Carlsson, 2013). Meanwhile, Amadi *et al.* (2020) observed more females among diabetic patients in Uyo, Nigeria, though they expressed mainly adult-onset T1DM. Umar *et al.* (2016) also reported a female preponderance of T1DM in Kano, Nigeria. Ogundele *et al.* (2016) reported more females than males among diabetic patients (types 1 and 2) in Lagos. Lean muscle mass for glucose uptake; higher estrogen/progesterone, which influence insulin sensitivity; and a higher predisposition to autoimmune disorders are some of the factors that increase the risk of T1DM among females (Kim *et al.*, 2018; Desai and Brinton, 2019).

Demographic data collected further showed that T1DM was more common among adults aged 30 years and older. Unfortunately, there was not enough information to ascertain if the diabetic adults had adult-onset T1DM or childhood-onset T1DM and survived to adulthood. However, some studies carried out in Africa, including Padoa (2011), Amadi *et al.* (2020), and Balcha *et al.* (2020), have reported the preponderance of adult-onset T1DM on the continent. Adewumi *et al.* (2022) also found that the majority of individuals with either type 1 or type 2 diabetes mellitus in Lagos were between the ages of 41 and 60. Furthermore, a systematic review of T1DM in 32 countries and regions across the world by Harding *et al.* (2022) reported a high prevalence of adults expressing T1DM. According to Padoa (2011), the high prevalence of adult onset of T1DM in Africa could be attributed to the prolonged breastfeeding practices on the continent. Prolonged breastfeeding delays and lowers the introduction of bovine albumin, a protein found in cow's milk that is known to cause beta cell autoimmunity, thus delaying the start of T1DM in genetically predisposed individuals (Padoa, 2011). Moreover, adequate breastfeeding boosts the immune system of infants with bioactive molecules, beneficial bacteria, as well as minerals and vitamins (Yahaya and Shemishere, 2020). Meanwhile, a review by Distiller (2014) noted that some childhood type 1 diabetics can live to old age with adequate glycemic control, particularly with insulin therapy. According to Distiller, type 1 diabetics with a family history of longevity and the absence of metabolic and cardiovascular disorders may live to an old age. This implies that genetic factors play a role in the progression to old age of some individuals expressing

childhood T1DM, and that some of the adults expressing diabetes in the current study could have developed it from infancy.

Higher educational status was another demographic characteristic associated with T1DM at Ayobo Primary Health Center. This finding is consistent with the findings of Amadi *et al.* (2020) in Uyo, Nigeria, and Olssen *et al.* (2011) in the Nord-Trøndelag Health Study. Ogundele *et al.* (2016) also reported the preponderance of individuals with higher education among diabetics in Lagos. In addition, a survey of 39 low-and middle-income countries by Seiglie *et al.* (2020) advanced education was linked to increased susceptibility to diabetes mellitus. Olssen and colleagues opined that a high level of education was associated with an increased risk of autoimmunity in adult-onset T1DM through increased exposure to environmental triggers of the disease (Olssen *et al.*, 2011). Besides, parental higher education might cause insufficient exposure to early infections, which should have trained the immune system of an infant, predisposing it to an autoimmune-inducing microbial attack at an advanced age (Maahs *et al.*, 2010; Yahaya *et al.*, 2017b).

Moreover, from the demographic data, Christians were the most diabetic, followed closely by Muslims, while traditionalists were the least diabetic. The higher diabetic populations of Christians and Muslims compared to traditionalists could be due to their high populations in the study area. The slight difference between the Christian and Muslim diabetic populations could stem from differences in religious practices. Fasting has been shown to boost glycemic control, and more Muslims than Christians engage in lengthy fasts, particularly during the Ramadan fast. Salti *et al.* (2004) conducted a systematic review during Ramadan fasting in 13 countries, and both participating type 1 and type 2 diabetic Christians and Moslems experienced a significant drop in blood glucose. The results of the current study are consistent with the findings of a study by Yahaya *et al.* (2021a) conducted on type 2 diabetic patients across selected hospitals in Lagos. Adewumi *et al.* (2022) also reported the preponderance of Christians among type 1 and type 2 diabetics in Lagos.

Further investigation showed that the Yoruba ethnic group was the most diabetic among all the ethnic groups in the study population, followed by the Igbo, while the Hausa were the least. The Yoruba and Igbo ethnic groups, in that order, are the two most dominant ethnic groups in the study area, so the result might have reflected ethnic population sizes. This result is in line with that of Yahaya *et al.* (2021a), who reported Yoruba and Igbo ethnic groups (respectively) as the most diabetic in a study of type 2 diabetes prevalence in Lagos. There is a dearth of documented information on the prevalence of T1DM among ethnic groups in Nigeria, from which the results of the current study can be further elucidated. This information is crucial because studies, including Khanolkar *et al.* (2017) and Tosur *et al.* (2018), have shown that there is a differential ethnic predisposition to T1DM.

Regarding the ABO blood group genotype distribution in the collected data, type A positive and negative individuals were the most diabetic, followed by B positive and negative individuals, while O positive and AB negative individuals were the least diabetic. This result is closely in line with the findings of Okon *et al.* (2008), who reported

that blood groups A positive and O negative were predominant, while O positive was significantly lower among diabetic patients in Calabar and Uyo, both in Nigeria. Unfortunately, there is a dearth of documented studies with similar objectives in Nigeria to compare with the current study. Meanwhile, outside Nigeria, the relationship of ABO blood groups with diseases, particularly T1DM, seems to be controversial, with the majority reporting increased susceptibility of type B to T1DM. In a study of an Iranian population by Ordooei *et al.* (2022), type B positives were the most diabetic, while type O positives were the least. In a study by Bener and Yousafzai (2014) in Qatar, B positive was dominant among diabetics, followed by O negative and A positive, while O positive was less dominant. Ghafar *et al.* (2021) also reported an increased susceptibility of B-positive individuals to all forms of diabetes in Pakistan. However, in Arar, Saudi Arabia, no relationship was established between ABO blood groups and diabetes mellitus (Alanazi *et al.*, 2018). In a study carried out in Istanbul, Turkey, the frequency of the AB blood group was significantly higher in T1DM (Oner *et al.*, 2016). According to Ordooei *et al.* (2022), these inconsistencies could have stemmed from variations in the study designs and sample sizes of the studies. The inconsistencies also suggest that racial and geographical variations influence the distribution of ABO blood group phenotypes and disease susceptibility. Generally, type O blood is more resistant to diseases than non-O blood types (Abegaz, 2021). This is probably because type O blood is the richest in antibodies, possessing both antibodies A and B, and thus is more protective against microbial infections, some of which may cause autoimmunity, a hallmark of autoimmune disorders, including T1DM (Yahaya *et al.*, 2021b).

It is noteworthy to add that the findings of the current study would have been more convincing with more participants. However, we encountered constraints in getting access to more information. Additionally, the findings of this study do not in any way replace T1DM diagnostic tests but could be used in the prevention and management of the disease.

In conclusion, the results revealed that, of the type 1 diabetic patients that visited Ayobo Primary Health Center, males and those aged 30 and above constituted the majority. Higher education was also linked with an increased susceptibility to the disease. Furthermore, the diabetic population contained mainly Christians and Muslims, in that order, and these were predominantly Yoruba and Igbo ethnic groups. ABO blood group A and B (positive and negative) individuals were the most diabetic and expressed the most severe cases of the disease, while group O positive and AB negative individuals were the least diabetic.

It is strongly recommended that the ABO blood genotypes of newborns be tested so as to predict their susceptibility to diseases, including diabetes mellitus. Newborns with type A and B (positive and negative) blood groups should be breastfed well and long before the introduction of cow's milk, so as to reduce their chances of developing autoimmunity from bovine protein. Infants that are at increased risk of T1DM, as mentioned above, should be monitored closely to prevent environmental triggers of the disease, such as certain diets, chemical exposure, and bacterial and viral infections, among others. More studies should be conducted to ascertain the findings of this study

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