Relationship Between ABO, Rhesus D Blood Groups And Diabetes Mellitus In Patients Attending Kandara Sub-County Hospital In Murang'a County, Kenya

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Abstract

Background: Blood is categorized into types depending on the presence or absence of antigens on red blood cell surfaces. Currently, there are four blood groups: A, B, AB, and O. In addition to blood grouping, blood can be classified as rhesus negative or positive based on the lack or presence of a protein on the surface of red blood cells known as the rhesus D antigen. Diabetes is one of the four most common non-communicable diseases, accounting for around 4 million deaths globally. Diabetes is classified into three types: T1DM, T2DM, and GDM. DM is a group of disorders that impact how the body processes blood glucose. Gestational diabetes is described as varying degrees of glucose intolerance that develops during pregnancy. To yet, there is insufficient evidence linking the ABO and rhesus D blood groups to diabetes mellitus. The link between ABO blood type distribution and diabetes mellitus is always ambiguous because no diseases have been linked to a lack of ABO blood group antigen expression. The link between ABO, rhesus D blood types, and diabetes mellitus was investigated at Kandara Sub-County Hospital in Murang'a County.

Methods: Participants in the study were recruited at random from individuals with high blood sugar levels. The subjects' blood groups and sugar levels were determined using Anti A, Anti B, and Anti D sera and a Ceracheck glucometer, respectively. The data from this study was documented on an Excel Spread Sheet. The data was analyzed with SPSS version 20. The frequency, mean, median, and standard deviation of blood groups as well as blood sugar levels were calculated. A correlation analysis was performed to investigate the association between blood types, the rhesus factor, and diabetes. The majority of diabetic patients were female (69.4%), with 30.6% being male. The age range was 2 to 85 years, with a mean of 30.97.

Results: Blood group O+ had the highest occurrence in both male and female diabetic patients, at 47% and 51% respectively. However, the prevalence of blood groups did not differ substantially between male and female diabetes patients ($F(1, 14) = 1.20$, $p=0.29$). The study individuals' glucose concentrations ranged from 7 mmol/L to 17 mmol/L. The mean glucose levels ranged from 7.5 to 12.95 mmol/L among diabetes individuals of diverse ages. Females aged 61-65 years had the highest mean glucose levels (14.9mmol/l). Males aged 26-30 had the highest mean glucose levels (13.3 mmol/l). However, there was no significant difference in glucose concentrations between male and female diabetes patients throughout age groups ($t15=1.10$, $p=0.287$). Diabetic patients with blood group AB+ had the highest blood sugar level, 11.21 mmol/L. However, blood sugar concentrations in male and female diabetic patients did not change substantially among age groups ($t6=0.27$, $p=0.79$). The Pearson correlation coefficient was $R=0.24$, $SE=0.45$, 95% CI, $p>0.05$. This implies that there is no link between blood groups and blood sugar levels, with the blood group effect accounting for 5% of the variation in blood sugar level. It is established that there is no link between diabetes and ABO blood groups, and persons with Group-AB+ are more likely to develop the condition.

Conclusion: The current study had several limitations, including the prevalence of blood groups being affected by geographical distribution, race, and ethnicity, as well as underage children whose parents did not consent for them to participate in the study, resulting in a low number of children participants: However, these findings are insufficient to draw a strong conclusion. Other genetic factors may be involved, necessitating more broad and thorough analysis. This study's findings were valuable to stakeholders involved in diabetes management. The Ministry of Health and non-governmental organizations working on diabetes used the gathered data to develop strategies for effective diabetes management.

Key words: ABO Blood group, Rhesus D, Diabetes Mellitus

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Introduction

The ABO blood group classification usually identifies blood types according to the diverse kinds of antigens in the RBC's and antibodies in the plasma (Li, 2020). (A, B, AB, O) are the four types of blood groups which are classified according to availability or lack of antibodies and antigens on red blood cells surfaces (Nazario, 2020). In addition, rhesus D antigen which is a protein can be present on surface of RBC (WHO, 2012). Individuals with this protein are referred to as Rhesus D positive. This makes an individual to have either of the following blood groups: A rhesus D positive (A+), A rhesus D negative (A-), B rhesus D positive (B+), B rhesus D negative (B-), O rhesus D positive (O+), O rhesus D negative (O-), AB rhesus D positive (AB+) and AB rhesus D negative (AB-) (Davis, 2008).

Rhesus D antigen system together with ABO blood group system are used to investigate which blood type will be suitable for a safe red blood cell transfusion (Khan, 2010). O negative blood type (universal blood donor type) has the lowest risk of producing serious reactions for most people who

obtain it in any immune deficient infants and emergency transfusions (Rajiv, 2020). O negative red blood cells may be given to anybody, if the condition is dangerous or the identical blood type is in insufficient amount during emergency cases. Blood donors with type AB positive blood group are termed as universal recipients because they accept red blood cells from any blood type and only give blood to a person with the same blood type. Blood donors with type AB negative blood type are universal plasma donors and can donate plasma to any other blood types (Berkley, 2021).

In terms of prevalence a Study by Jun, (2020) stated that the worldwide prevalence of blood groups A, B, AB and O were 31.90%, 24.14%, 8.42% and 35.54% respectively. About 85% of the United Kingdom populace is Rhesus D positive (36% of the populace has O+, the most prevalent group). Around the continent the distribution in Belgium was A, B, AB and 0 blood groups was 37%,9%,3.0% and 6.0% respectively (Croix, 2010), Australia as 32.0%,12.0%,4.0% and 38.0% (Roteskreuz, 2011), Brazil as 34.0%,8%,25% and 36% (Sanguineos, 2013) and Russia as 25.2%,21.28%,4.2% and 45.6% respectively (Krasnoyarsk regional blood center, 2021).

In Africa, the prevalence of blood groups stands as: blood group A (24.6%); blood group B (20.7%); blood group AB (4.5%) and blood group O (50.3%) (Edgar, 2016). In Kenya the prevalence of blood groups stands as A-26.2, B-22.0, AB-4.4 and O-47.4 with Rhesus D positive blood group accounting up to 96.1% (Githiomi, 2017). In Murang'a County the prevalence of blood groups stands at D(positive)-0.75% and D (negative)-3.9% (Kaviti, 2018).

Blood sugar is an important component and it determines the healthy condition of the blood. Diabetes is one of the blood sugar related illnesses. Diabetes is a condition that arises when your blood sugar, is too high. Insulin is a hormone that ensures proper functioning of sugar in the blood. Categories of diabetes mellitus include: i) type 1 diabetes mellitus which occurs when your pancrease doesn't make insulin or makes very little, ii) type 2 diabetes mellitus which results when the body doesn't use insulin properly and iii) GDM occurs during pregnancy in women without diabetes, (CDC, 2017).

A study in African region, reported the average prevalence of diabetes to be at 4.9% in 2013 (Orchard, 2015). Higher Prevalence rates were reported in of diabetes in Reunion (15.4%), Seychelles (12.1%) and Gabon (10.7%) (WHO, 2014). In Ethiopia the prevalence of diabetes mellitus stands at 6.5% (Makinen,2016). Previous studies by Kimanzi, (2014) in both rural and urban Kenya found diabetes frequency was at 3.5–5%, with higher magnitudes amongst those in the urban areas. In Murang'a County the prevalence of diabetes stands at 8% (Kamau, 2018).

Diabetes is one of the four main non-communicable illnesses causing about 4 million deaths worldwide (June, 2017). Low-income countries are likely to experience 92% rise in death rate due to diabetes by 2040 (WHO, 2014). Undiagnosed diabetes usually poses a public health concern with expensive community wellbeing consequences specifically in Africa (Gagliardino, 2017). Thus, it is very important to scrutinize the burden and danger implications of diabetes at national level to develop policies and national programs (MOH, 2015). Despite achievements to regulate communicable diseases, health status has deteriorated partly due to the rise of non-communicable diseases (NCDs) leading to 28% of deaths in 2010 with 2% of this in Africa (WHO, 2018).

Diabetes prevalence in Kenya stands at 3.3% and expects to rise to 4.5% by 2025 as estimated by the World Health Organization (WHO, 2020). The WHO Report 2002 estimates globally deaths of 7.1 million people due to blood pressure, 4.4 million deaths due to high cholesterol and 2.6 million deaths due to extreme body mass (IDF, 2007). Diabetes was the 9th principal reason of demise internationally with an estimate of 1.5 million cessation of life and before 70 years of age 48% of losses occurred in 2019(WHO, 2020). There was a 5% rise in premature death rates (i.e. before 70 years of age) in diabetes between 2000 to 2016. A drop in premature mortality rates was observed due to diabetes in high-income countries from 2000 to 2010 but then increased in 2010-2016 (NIDDK, 2017).

Blood group antigens are genetical alleles and they usually play an important role to understand heredity and pre-disposition to illness (Atum, 2017). There has been necessity to find out any probable relation between ABO and rhesus blood groups and different diseases, since the discovery of blood groups; For example, diabetes has been highly linked with blood group A and B (Waseem, 2012). In addition, association between T1DM, T2DM and GDM with blood groups, especially with A, AB and Rhesus positive blood groups have been reported (Sidhu, 2015).

ABO antigens usually appear on the surface of numerous human cells and tissues, including the epithelium, sensory nerves, platelets, and vascular endothelium together with their appearance on RBCs (WHO, 2014). During the development of different diseases there has been a vital involvement of the ABO and Rh blood group antigens as shown by the ABO and Rh blood group system (Rodgers, 2022). Thus, this study, will figure out the association between ABO and rhesus D blood groups with diabetes mellitus in Murang'a County, Kenya.

2. Materials and Methods

2.1 Study Area

Research was done at Kandara Subcounty Hospital Diabetic Clinic located in Murang'a County. The hospital provides good medical services and serves as a level 4 center

2.2 Study design

A descriptive cross-sectional study was used. This design was appropriate for this study because of the active screening and monitoring of blood sugar levels and determination of blood groups of the study participants.

2.3 Sampling Technique

Purposive random sampling was utilized to pick study participants in Kandara sub-county hospital in order to obtain more thorough information about my study participants as the

number of diabetes mellitus problems grew. A simple random selection approach with an interval of five (5) clients was used to pick consenting participants who satisfied the inclusion criteria until the needed sample size was achieved. The probability proportionate to size (PPS) technique was also employed to determine the number of responses from the hospital. Participants were separated into fifteen (15) groups, each of which was scheduled to visit the hospital for a weekly review.

2.4 Study Design

This was a descriptive cross-sectional study with a total of 385 participants.

2.5 Inclusion criteria and Exclusion Criteria

All consenting diabetic patients who visited the diabetic clinic at Kandara sub-county hospital above 18 years of age, long-term diabetes patients who have been following up with diabetic clinics for at least six (6) months and consenting parents who allowed their children below 18 years of age to participate. While non-consenting patients above 18 years of age and below were excluded from the study.

2.6 Laboratory Procedures and Quality Assurance

a) Blood grouping procedure.

The Blood Grouping test was done by a slide method.

i) Slide Method.

The patient hand was dangled downwards to increase blood flow in the fingers, 70% alcohol was used to clean the fingertip to be pierced, then pierced with a sterile lancet and a drop of blood was placed in three cavities followed by a drop of anti-seras (anti-A, anti-B and anti-D) were added to every cavity. They were mixed together with a clean stick and waited for agglutination to occur in the form of fine red granules within 30 seconds.

The DU test procedure was done only to those rhesus factor that are not satisfactory under the slide method.

ii) DU Test.

Helped to differentiate between true rhesus D negative from rhesus D positive. 5% cell suspension of red blood cells was prepared by-mixing 5 drops of sedimented RBCs with 2 ml of normal saline, then centrifuged at 1500 RPM for 1 minute and the supernatant was discarded. 4 ml of normal saline was added into the sedimented RBCs and mixed well. Tubes were labelled as T (where the anti-D will be added), C (where a drop of 22% bovine albumin will be added), a drop of the 5% cell suspension was added to each tube by a Pasteur pipette and mixed well, then both incubated at 37°C for 15 minutes. After incubation was complete cells in each tube were washed three times with fresh normal saline, after the last wash all normal saline was removed completely and two drops of Coombs reagent was added. The contents of the tube were gently mixed before centrifugation at 1500 RPM for 1 minute. Gentle agitation was used to re-suspend the cells, which were then inspected macroscopically for agglutination. If any confusion arose, the results were validated microscopically.

b) Blood glucose analysis.

A test strip was inserted into the glucometer, a side of the fingertip of the patient was pricked with the needle and a droplet of blood added to the test strip edge. The blood sugar level was displayed on the screen of the meter after a few seconds.

3.0 RESULTS

Prevalence of ABO and rhesus D blood groups in male and female diabetic patients

Whole blood was drawn from three hundred and eight five study subjects and the blood group for each study subjects was determined qualitatively. The distribution of the blood groups for the study subjects were as follows: Seventy-seven (77(20%) study subjects were blood group A RHESUS D positive while twenty seven (27(7.01%) study subjects were blood group A RHESUS D negative. Twenty six (26(6.75%) study subjects were blood group B RHESUS D positive while thirteen (13(3.4%) study subjects were blood group B RHESUS D negative. Fourteen (14(3.6%) study subjects were of blood group AB rhesus D positive while six (6(1.6%) study subjects were blood group AB rhesus D negative. It was noted from the study that there were no male subject whose blood group was AB rhesus D positive. On the other hand blood group AB rhesus D negative was found to be the blood group with least number (6 (1.6%) of the study subjects. Study subjects who had blood group O rhesus D positive were one hundred and ninety one (191(49.6%). Blood group O rhesus D positive was found to be the blood group with the highest number of the study subjects. Study subjects whose blood group was O rhesus D negative were thirty one (31(8%). The prevalence of ABO and rhesus D blood groups in male and female diabetic patients is as shown in table 1 and figure 1.

Blood sugars levels of diabetic patients in different age groups attending

The blood glucose concentration of each study subject was analyzed quantitatively. The minimum glucose concentration of the study subjects was 7 mmol/Lwhile the maximum glucose concentration of the study subjects was 17 mmol/Las shown in table 2. The mean glucose concentration for the whole study population irrespective of gender was 10.52 mmol/L. The mean glucose concentration for the males and females study subjects was 10.54 mmol/Land 10.19 mmol/Lrespectively. The glucose concentration difference between male and female study population was not statistically significant with t=1.738 and p value 0.085 as shown in table 2.

Table 1: The prevalence of ABO and rhesus D blood groups in male and female diabetic patients

Blood group	BGA +VE	BGA -VE	BGB +VE	BGB -VE	BGAB +VE	BGAB -VE	BGO+VE	BGO-VE
Number of study subjects	77(20%)	27(7.01%)	26(6.75%)	13(3.4%)	14(3.6%)	6(1.6%)	191(49.6%)	31(8%)

NB- BG= Blood group, +VE= Positive, -VE= Negative

Figure 1: Shows prevalence of ABO blood groups in male and female

The total number of male and female diabetic patients were 267 and 118 respectively. Blood group O+ had the highest prevalence in both male and female diabetic patients at 47% and 51% respectively. There was no male diabetic patient with blood group AB+. However, the prevalence of the blood groups were not significantly different among male and female diabetic patients (F (1, 14) =1.20, p=0.29).

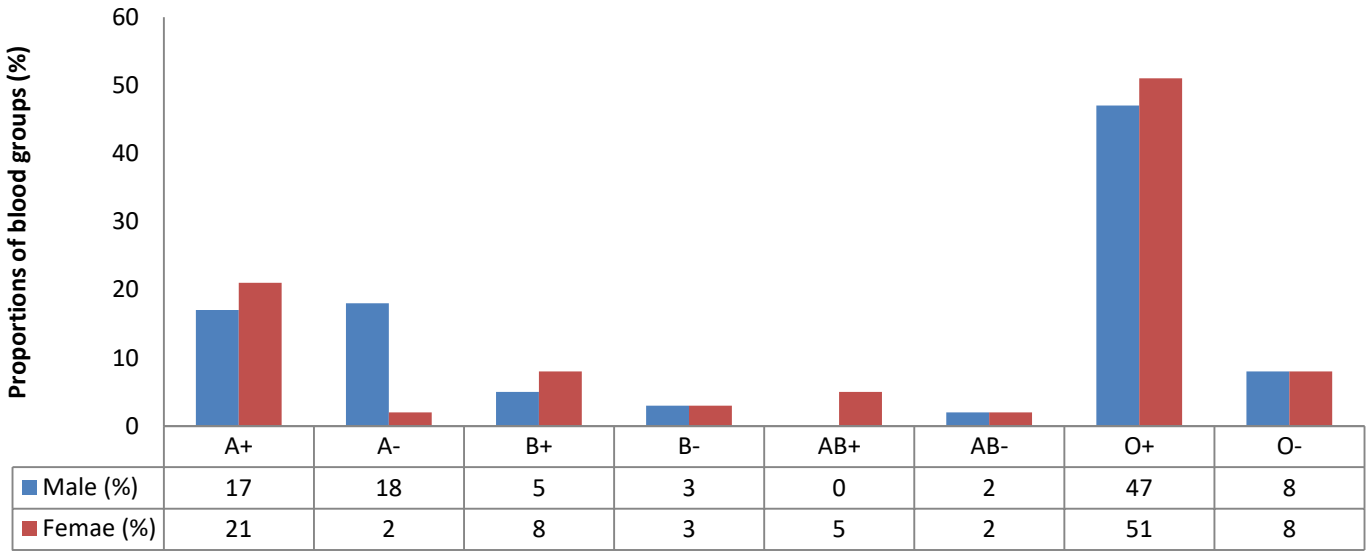


Figure 1: Shows prevalence of ABO blood groups in male and female.

Table 2: Comparison between male and female glucose concentration among the studied population

Gender	Number	Mean	Mean difference	Std. Deviation	Std error mean	95% Confidence Interval of the Difference		t	df	Sig. (2-tailed
Male	119	10.554	.362		.2084	Lower	Upper	1.738	118	.085
female	119	10.192		2.2730		-.0504	.7748			

Age group glucose concentration across the study population

The study subjects were arranged in groups of 10 years giving the following age groups: 0-10years,11-21 years,22-32 years,33-43 years, 44-54 years, 55-65 years, 66-76 years, 77-87 years and finally 88-98 years. Age group 0-10 years had 30 study subjects with the study subject with lowest glucose concentration of 7.5 mmol/Land the subject with the highest glucose concentration of 14 mmol/L. The mean glucose concentration of the study subjects in this age group was 10.36 mmol/L. Age group 11-21 years had 121 study subjects with the study subject with lowest glucose concentration of 7.8

mmol/Land the subject with the highest glucose concentration of 17 mmol/L. The mean glucose concentration of the study subjects in this age group was 10.39 mmol/L. Age group 22-32 years had 101 study subjects with the study subject with lowest glucose concentration of 7.6 mmol/Land the subject with the highest glucose concentration of 14 mmol/L. The mean glucose concentration of the study subjects in this age group was 10.37 mmol/L. Age group 33-43 years had 8 study subjects with the study subject with lowest glucose concentration of 7.8 mmol/Land the subject with the highest glucose concentration of 14 mmol/L. The mean glucose concentration of the study subjects in this age group was 9.84 mmol/L. Age group 44-54 years had 77 study subjects with the study subject with lowest glucose concentration of 7.5 mmol/Land the subject with the highest glucose concentration of 14.5 mmol/L. The mean glucose concentration of the study subjects in this age group was 10.22 mmol/L. Age group 55-65 years had 34 study subjects with the study subject with lowest glucose concentration of 7.8 mmol/Land the subject with the highest glucose concentration of 15.9 mmol/l. The mean glucose concentration of the study subjects in this age group was 11.6 mmol/L. Age group 66-76 years had 28 study subjects with the study subject with lowest glucose concentration of 7.8 mmol/Land the subject with the highest glucose concentration of 14 mmol/L. The mean glucose concentration of the study subjects in this age group was 10.89 mmol/L. Age group 77-87 years had 13 study subjects with the study subject with lowest glucose concentration of 7 mmol/Land the subject with the highest glucose concentration of 14 mmol/L. The mean glucose concentration of the study subjects in this age group was 11.35 mmol/L. Age group 88-98 years had 3 study subjects with the study subject with lowest glucose concentration of 11.7 mmol/Land the subject with the highest glucose concentration of 13 mmol/L. The mean glucose concentration of the study subjects in this age group was 12.17 mmol/Las shown in table 3 below.

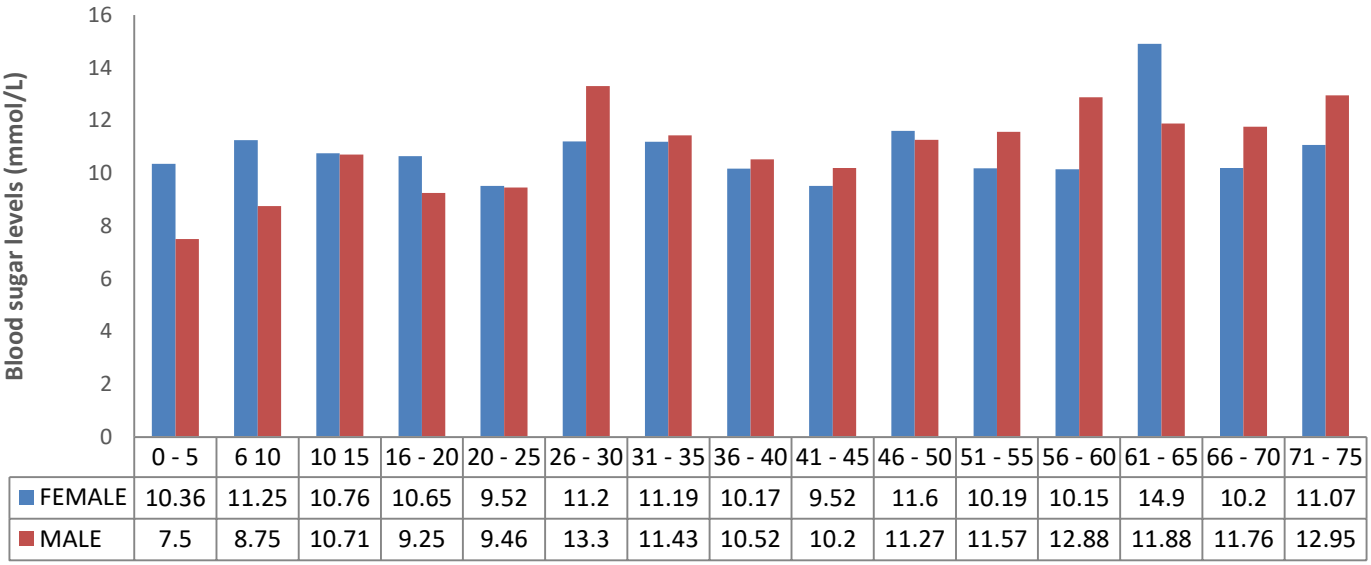
Table 3: Glucose concentrations among the various study group population

AGE GROUP	Number	Minimum [Glu]	Maximum [Glu]	Group mean [Glu]
A0-10YRS	30	7.5	14.0	10.357
A11-21YRS	112	7.8	17.0	10.388
A22-32YRS	101	7.6	14.0	10.374
A33-43YR	8	7.8	14.0	9.837
A44-54YR	77	7.5	14.5	10.223
A55-65YR	34	7.8	15.9	11.600
A66-76YR	28	7.8	14.0	10.889
A77-87YR	13	7.0	14.0	11.354
A88-98YR	3	11.7	13.0	12.167

NB/ A=Age group, YRS= Years, [Glu] = glucose concentration in mmol/l

Blood sugar levels in different age groups.

The mean glucose concentration ranged from 7.5 to 12.95 mmol/Lfor different diabetic patients in various age groups. The mean glucose concentration in different age groups were shown in figure 2. Age group 61-65 years had females with the highest mean glucose concentration of 14.9mmol/l. Age group of 26-30 years had males with highest mean glucose concentration of 13.3 mmol/L. However, the glucose concentrations did not vary significantly between male and female diabetic patients in different age groups (t_{15}=1.10, p=0.287).



	0 - 5	6 10	10 15	16 - 20	20 - 25	26 - 30	31 - 35	36 - 40	41 - 45	46 - 50	51 - 55	56 - 60	61 - 65	66 - 70	71 - 75
FEMALE	10.36	11.25	10.76	10.65	9.52	11.2	11.19	10.17	9.52	11.6	10.19	10.15	14.9	10.2	11.07
MALE	7.5	8.75	10.71	9.25	9.46	13.3	11.43	10.52	10.2	11.27	11.57	12.88	11.88	11.76	12.95

Figure 2: Shows blood sugar levels in different age groups.

Relationship between age groups and blood sugar levels.
The blood sugar levels are off the predicted levels thus non-linear relationship. The Pearson correlation coefficient between the age and blood sugar level was, R=0.67, SE=17.25, CI=95%, $p<0.05$. This therefore means a positive relationship between age and blood sugar levels, with 45% change in blood sugar level accounted for by an increase in age group as shown in figure 3.

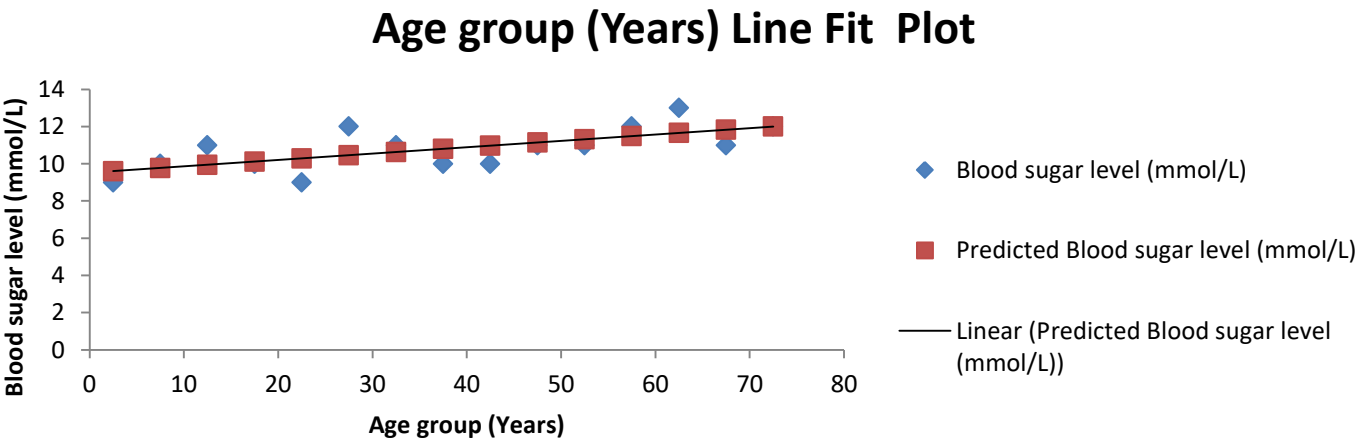


Figure 3: Shows relationship between age groups and blood sugar levels.

Relationship between glucose concentration and blood groups of the study subjects
Since there was no gender differences between the blood glucose concentrations, the blood groups were therefore considered without any gender reference. In blood group A +VE the study subject with the lowest glucose concentration had 7 mmol/L while the study subject with the highest having blood glucose concentration of 17 mmol/l. The mean glucose concentration of study subjects with blood group A+VE was 10.16 mmol/L. In blood group A -VE the study subject with the lowest glucose concentration had 7.8 mmol/L while the study subject with the highest having blood glucose concentration of 13 mmol/l. The mean glucose concentration of study subjects with blood group A-VE was 10.13 mmol/L. In blood group B +VE the study subject with the lowest glucose concentration had 7.5 mmol/Lwhile the study subject with the highest having blood glucose concentration of 14 mmol/l. The mean glucose concentration of study subjects with blood group B+VE was 10.54 mmol/L. In blood group B -VE the study subject with the lowest glucose concentration had 7.9 mmol/L while the study subject with the highest having blood glucose concentration of 13.8 mmol/l. The mean

glucose concentration of study subjects with blood group B-VE was 10.59 mmol/L. In blood group AB+VE the study subject with the lowest glucose concentration had 8.5 mmol/L while the study subject with the highest having blood glucose concentration of 13.9 mmol/l. The mean glucose concentration of study subjects with blood group AB+VE was 11.43 mmol/L. In blood group AB -VE the study subject with the lowest glucose concentration had 8.5 mmol/L while the study subject with the highest having blood glucose concentration of 13 mmol/l. The mean glucose concentration of study subjects with blood group AB-VE was 10.57 mmol/L. Similarly, in blood group O +VE the study subject with the lowest glucose concentration had 7.6 mmol/L while the study subject with the highest having blood glucose concentration of 15.9 mmol/l. The mean glucose concentration of study subjects with blood group O+VE was 10.6 mmol/L. Likewise, the study subject in blood group O –VE had a low glucose concentration of 8.0 mmol/Land the subject with the highest glucose concentration had 14.5 mmol/L, with an overall mean glucose concentration of blood group O-VE having 10.8 mmol/L. The status of blood glucose concentration in all the blood groups is as shown in table 4 below.

Table 4: The status of blood glucose concentration in all the blood groups.

	N	Minimum	Maximum	Mean
Bld Grp A +VE	77	7.0	17.0	10.160
Bld Grp A -VE	28	7.8	13.0	10.132
Bld Grp B +VE	25	7.5	14.0	10.540
Bld Grp B -VE	13	7.9	13.8	10.585
Bld Grp AB +VE	14	8.5	13.9	11.429
Bld Grp AB -VE	6	8.5	13.0	10.567
Bld Grp O+VE	191	7.6	15.9	10.598
Bld Grp O-VE	31	8.0	14.5	10.803

NB/Bld Grp= Blood group, +VE= Positive, -VE= Negative, N= number of study subjects

The effect of blood group rhesus factor on the glucose concentration of the study subjects

Blood glucose concentration of the study subjects with blood group A rhesus +VE was statistically compared with those with blood group A rhesus –VE and it was established that the difference was not statistically significant i.e. t=0.000, p=1.000. Blood glucose concentration of the study subjects with blood group B rhesus +VE was statistically compared with those with blood group B rhesus –VE and it was established that the difference was not statistically significant i.e. t= -0.104, p=919. Likewise, blood glucose concentration of the study subjects with blood group AB rhesus +VE was statistically compared with those with blood group AB rhesus –VE and it was established that the difference was not statistically significant i.e. t=0.567, p=0.595. Similarly, blood glucose concentration of the study subjects with blood group O rhesus +VE was statistically compared with those with blood group O rhesus –VE and it was established that the difference was not statistically significant i.e. t= 1.629., p= 0.114. It can be concluded that the rhesus factor of any blood group of individuals has no effect of the blood glucose concentration. The above information is expressed in table 5 below.

Table 5: Blood group Rhesus factor effect on blood glucose concentration of the study subjects.

		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference		t	df	Sig. (2-tailed)
					Lower	Upper			
Pair 1	BGA +VE - BGA -VE	.0000	2.7062	.5114	-1.0494	1.0494	.000	27	1.000
Pair 2	BGB +VE - BGB -VE	-.0615	2.1419	.5940	-1.3559	1.2328	-.104	12	.919
Pair 3	BGAB +VE - BGAB -VE	.6667	2.8780	1.1749	-2.3536	3.6869	.567	5	.595
Pair 4	BGO+VE - BGO-VE	.8839	3.0218	.5427	-.2245	1.9923	1.629	30	.114

Blood sugar levels in different blood groups

Diabetic patients with blood group AB+ had the highest blood sugar concentration of 11.21 mmol/L. Blood sugar levels in different blood groups are shown in Figure 4. However, the levels of blood sugar concentrations in male and female diabetic patients did not vary significantly among the blood groups in different age groups, (t_6=0.27, p=0.79).

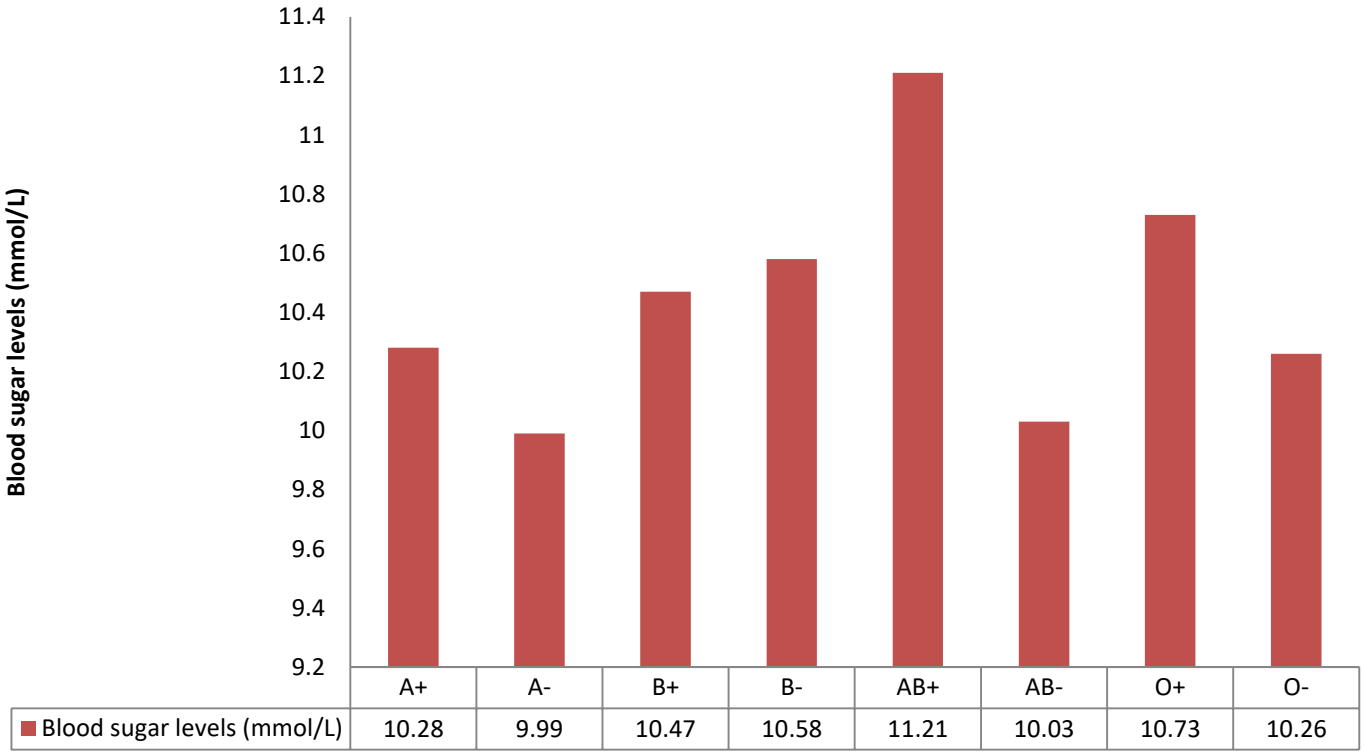


Figure 4: Shows blood sugar levels in different blood groups

Relationship between blood groups and blood sugar levels. Pearson's correlation coefficient was, R=0.24, SE=0.45, CI=95%, p>0.05. This therefore means a no relationship between blood groups and blood sugar levels, with 5% change in blood sugar level accounted for by the effect of blood groups as shown in figure 5.

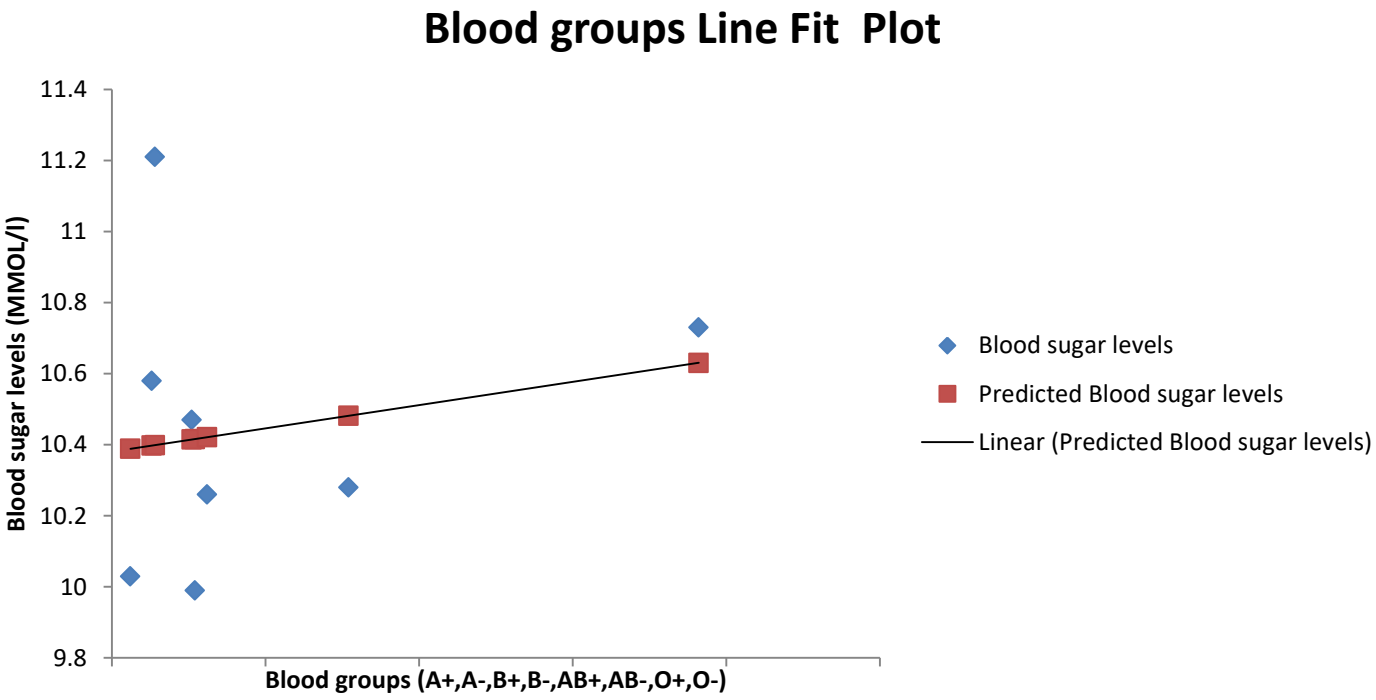


Figure 5 Shows a line fit plot showing relationship between blood groups and blood sugar levels with a Pearson's correlation coefficient.

4.0 Discussion

The current study's findings support the concept that hereditary factors associated with the distribution of certain blood groups may have a role in the development of diabetes mellitus. The distribution of blood types across population groupings is an essential consideration in healthcare. Several research have investigated the link between diabetes mellitus and Rh blood group; however, the populations varied, and the results were inconclusive.

This study demonstrated that, the diabetic patients, blood group O+ had the highest genotype frequency, followed in order by A+, A-, O-, B+, AB+, B-, and AB-. Blood group O+ having the highest prevalence in both male and female diabetic patients of 47% and 51% respectively and blood group AB – having the lowest prevalence of 2% in both male and female diabetic patients respectively (Figure 3.1a). There was no male diabetic patient with blood group AB+.
A study in India by Wang, (2012), reported blood group O+ being the most prevalent at 37.12%. In addition, Wang, (2012) reported a rhesus prevalence of 94.61%. However, studies on prevalence of blood groups in the United States stated reported a different prevalence rate with blood group A+ as the most predominant blood group at 41% (Roteskreuz, 2006). Similar patterns were reported in Australia (Australian red cross, 2020), Cameroon (Ndoula, 2021), Egypt (Aristocousle, 2017) and in Somalia (Ali, 2020).
Blood group O+ had the highest genotype frequency because a protein known as non-Willebrand factor is more common in people with non-O+ blood types and has been linked to raised blood sugar levels. These blood types are also associated with numerous chemicals that have been linked to type 2 diabetes mellitus (T2DM). Age and blood sugar levels have a strong positive link, with a rise in age group accounting for 45% of the change in blood sugar level. Type 2 diabetes is most typically connected with those over the age of 45, although it is also affecting children, teenagers, and young adults (CDC, 2021). In 2017, type 2 diabetes affected approximately 462 million people, accounting for 6.28% of the global population (4.4% of those aged 15-49 years, 15% of those aged 50-69, and 22% of those aged 70+), or an incidence rate of 6,059 cases per 100,000 (KHAN, 2017).

GDM reported frequency globally varies between 1 and 45% of pregnancies (Buckley, 2012). The total frequency of

gestational diabetes mellitus was 13.2% in America. Frequency rose with age, from 8% to 26% in women aged 45 years or more (American Diabetes Association (ADA), 2016). The pre-test was most commonly received by younger women; the rate of getting both tests rose with age (Zhang, 2016). Some of the factors reported to contribute to the increase in prevalence of diabetes include family history/ hereditary, age, being overweight and unhealthy lifestyle. The prevalence continues to rise due to a lack of widespread public health prevention programmes and accessible educational resources.

Diabetic patients with blood group AB+ had the highest blood sugar levels of 11.21 mmol/Lwhile blood group A- had the lowest blood sugar level of 9.99mmol/L. However, the levels of blood sugar levels in male and female diabetic patients did not vary significantly among the blood groups in different age groups. Pearson correlation coefficient was, R=0.24, SE=0.45, CI=95%, p>0.05. This therefore means a no correlation between blood groups and blood sugar levels, with 5% change in blood sugar level accounted for by the effect of blood groups.

Type 1 diabetes mellitus (T1DM) has been reported to highly linked with blood group A+ and B+ (Waseem, 2012; Tanu, (2017). In addition, association between T1DM, T2DM and GDM with blood groups, especially with A+, AB+ and Rhesus positive blood groups have been reported (Sidhu, 2015). Blood group "B+" has a high association with T2DM and "O+" blood group has a minimum association with T2DM. Blood group "A" and "AB" are nearly similarly dispersed in both diabetic and non-diabetic populace (Suraya, 2016). On the contrary, a study conducted in Pakistan found that blood group AB+ was more common in diabetes than blood groups A+ and B+ (Zenon, 2020). Studies on the link between ABO blood groups and diabetes are equivocal. While some research found no evidence of a relationship between ABO and diabetes.

Reason why there is no correlation between blood groups and blood sugar levels was because many diabetic patients are already on aggressive treatment and are aware on ways of managing diabetes mellitus. Conflicting results on the association between ABO blood types and DM could also be explained by racial and geographical variations in the genetic expression of the disease, sample size, age, and gender distribution.

Conclusion

The Rh blood system may play a function in glucose metabolism and alter the clinical presentation of diabetes mellitus. However, our findings indicate that there is no link between Rh blood group and diabetes mellitus. The methods by which specific genes influence blood glucose levels are poorly understood; thus, further research is required to completely understand the genetic components of diabetes mellitus. The current study had several limitations, including the prevalence of blood groups being affected by geographical distribution, race, and ethnicity, as well as underaged children whose parents did not consent for them to participate in the study, resulting in a low number of children participants:

It is established that there is no link between diabetes and ABO blood groups, and persons with Group-AB+ are more likely to develop the condition. However, these findings are insufficient to draw a strong conclusion. Other genetic factors may be involved, necessitating more in-depth and thorough analysis.

Recommendations

Murang'a County Government department of Health to plan more outreach services to people in the villages so as to reach more people who cannot acces health services easily to create more awerness on their sugar levels so as to make Murang'a county a diabetes free county.

Blood sugar screening should be made a compulsory screening service to every patient visiting the hospital to make them aware of their sugar levels for earlier detection of diabetes mellitus.

Murang'a County Government to provide more laboratory supplies (blood sugar strips and blood grouping anti-seras) so as to test many people visiting the hospital.

Authors Contribution

M.N-the main researcher of the whole study, data collection, grouping, analysis, formulation of the manuscript and original draft. J.N- conceptualizing of the project, methodology, preparation and reviewing of the manuscript and supervision. S.W-reviewing of the manuscript, supervision and data interpretations. All authors read and approved the final manuscript.

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Abbreviations

AHG- Anti-human globulin
ADA- American diabetes association
CDC- Centers for Disease Control
CHS-Centre for health solutions
DKA- Diabetic Ketoacidosis
FBS- Fasting blood sugar
GDM- Gestational Diabetes Mellitus
T1DM- Type 1 Diabetes Mellitus
T2DM- Type 2 Diabetes Mellitus

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