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Risks of Gynecological Illnesses in Different ABO Blood Groups of Black Women with Primary or Secondary Infertility in Sub-Saharan Africa: A Preliminary Study

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Abstract

Background: The aim of this investigation was twofold: first, to determine an association between types of infertility and ABO blood group and, second, to show potential risk ratios of different gynecological diseases in ABO blood groups.

Method: Two hundred and fifty-one women with primary or secondary infertility who presented at a tertiary health facility in Lagos were studied retrospectively. All the cases were seen by consultant gynecologists and all had their ABO blood groups and Rhesus factor determined by standard techniques, though ABO blood group is reported in this study. Statistical methods included mean and standard deviation, χ2, risk ratios and odd ratios (95% CI). P-value was set to be significant at <0.05.

Results: O blood group was dominant (n=125, 49.8%) in the study population. Women with primary infertility were significantly younger (t-test = -3.69, P-value = 0.0003) and were less likely to consume alcohol (χ^2 = 6.08, P-value = 0.01, OR = 0.51, 95% CI = 0.30, 0.88), smoke cigarette (χ^2 = 4.80, P-value = 0.03, OR = 0.43, 95% CI = 0.20, 0.93) or take herbal tea (χ^2 = 0.38, P-value = 0.01, OR = 0.85, 95% CI = 0.51, 1.42) compared to those with secondary infertility. The identified distribution of ABO blood groups in women with primary and secondary infertility was not significantly different (χ^2 = 5.02, P-value = 0.17), though blood group A had the highest risk for primary infertility. The blood group A was more predominant in women with primary infertility, while blood group O was less predominant. Overall, the highest risk ratio in blood group O, A, B and AB were adenomyosis (χ^2 =1.78, P-value=0.18, RR =1.58, 95% CI=1.08,2.32), endometriosis (χ^2 =0.47, P-value=0.49, RR =1.76, 95% CI=0.61, 5.07), uterine polyps (χ^2 =5.62, P-value=0.02, RR =2.32, 95% CI=1.41,3.85) and ovarian tumor (χ^2 =0.45, P-value=0.50, RR = 2.33, 95%CI = 0.65, 8.37).

Conclusion: Women with primary infertility had a 1.29-fold increased risk in the A blood group distribution. The role of blood groups in the development of gynecological conditions among infertile Black African women remains to be determined. Identification of a link between ABO groups, infertility and other gynecological diseases could assist with diagnosis at the early stages of diseases in at- risk women.

Keywords: ABO Blood groups, Black women, Infertility, Prevalence, Risk ratio, Sub Saharan Africa

Abbreviations: ANOVA: Analysis of variance; ART: Assisted Reproductive Technology; BMI: Body Mass Index; CI: Confidence interval; DOR: Diminished ovarian reserve; IUA: Intrauterine adhesion; IVF: In-vitro fertilization; OR: Odds ratio; OHSS: Ovarian hy-

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perstimulation syndrome; PI: Primary infertility; RR: Risk ratio; SI: Secondary infertility; PCOS: Polycystic ovarian syndrome

Introduction

Early in the 20th Century, precisely in 1925, Hirszfeld and Zborowski[1] called attention to the possibility of a serological incompatibility of the gametes as a cause of infertility, a reproductive system disorder usually associated with pituitary, hormonal, immunological, uterine, cervical, or psychological factors. In some cases, clinicians diagnose it as unexplained, idiopathic or of unknown origin, thus requesting a need for intense research to disentangle the cause(s) of such infertility with unknown origin. Schwimmer reviewed earlier studies which identified 3 possible immunologic causes of infertility: autoimmunity, ABO blood group incompatibility and isoagglutination[2] and reported that 13 of 46 couples with organic causes of infertility had ABO incompatibility. Di Nisio studied women < 40 years who underwent IVF and had ABO blood type recorded as part of the routine workup were eligible and confirmed the lack of a significant association between non-O blood type and clinical outcomes of IVF.[3] In China, Zhao conducted a systematic review and meta-analysis to assess the link between ABO blood groups with diminished ovarian reserve (DOR), ovarian hyperstimulation syndrome (OHSS) and outcomes of assisted reproductive technology (ART) and concluded that ABO blood groups may not be associated with DOR, OHSS and miscarriage rate of ART and that blood groups should not be taken into account excessively during diagnosis and treatment of infertile women,[4] but Binder, argued that Blood group A may be associated with early-onset OHSS especially in Caucasians.[5] Further, a study in Pakistan revealed that the prevalence of male infertility in blood group O is invariably higher than in all other ABO blood groups, showing a strong relationship between blood group O and male infertility.[6] In India, a country with higher relative frequency of B positive individuals, one study suggested that 'O' positive females were more susceptible to polycystic ovarian syndrome (PCOS), mixed diet and alcohol consumption being the dominant contributing factors.[7] Endometriosis is one of the gynecological conditions that have also been studied in relation to ABO blood groups. In Iran, a country where blood group O was less dominant among women with endometriosis, Malekzadeh observed no significant correlation between the risk of endometriosis and the ABO and Rh blood group.[8] On the other hand, a study in South Korea observed that since endometriosis and malignant neoplasm of ovary showed more predominant results in blood group A and the relative risks were twice as bigger, it was possible that ABO blood group might be related to the pathogenesis of these two diseases.[9] Metalliotakis also concluded that the blood group A was more predominant in women with endometriosis, while blood group O was less predominant.[10] ABO system has also been studied in relation to neoplasm. Newell reported that no unnecessary risk for cancer of the breast, cervix, or colon was linked with blood group A, though an association between blood group A and cancer of the stomach was found among blacks as well as whites that blood group A is associated with cancer of the pancreas and leukemia.[11] Few studies have been conducted in Nigeria on the issue of ABO blood groups and gynecological health issues. For example, Akpan in Calabar studied the relationship between ABO blood group system and female infertility mainly from hormonal perspective and reported that mean follicular stimulating hormone (FSH) of blood groups A and O individuals were significantly higher than that of group B.[12] Ogbimi, in Benin City, determined ABO blood group incompatibility and infertility in Nigerian couples and reported that infertile and fertile couples for either ABO compatibility or incompatibility did not reveal any statistically significant difference.[13] Since there is a paucity of scientific data on ABO and RH systems and infertility, especially female, in Nigeria, this study aimed to evaluate ABO blood group in relation to primary and secondary infertility and to possible causes of infertility among Nigerian women. Findings from this study may assist clinicians to have a high index of suspicion of particular gynecological condition for an early diagnosis.

Materials and Method

In this retrospective cross-sectional study, we assessed 251 women who, between 2018 and 2019, presented with primary or secondary infertility at a tertiary health institution in Lagos, Nigeria. A total of 1421 and 1590 gynecological cases were originally seen in each of the two years of study making a total of 3011. In each of these years, 202 (14.2%) and 206 (13.0%) female infertility cases were recorded respectively, making a total of 408 cases. Of these, 251 (61.5%) were randomly selected for analysis and presentation in this study. Inclusion criteria consisted of women who had their ABO blood group recorded, consulted at the gynecology clinic of the tertiary health facility, not on admission and not moribund. Exclusion criteria were those whose ABO blood group was not recorded, those hospitalized for any reason, and those with fulminant neoplasm. ABO and Rh blood group typing were performed at laboratories with in the tertiary health facility. Data was extracted from medical records of the patients by two trained research assistants according to a pro-forma questionnaire that was designed by two of the three authors (JO, BMA) and verified by the third author (AO). The data extraction was supervised and verified by one of the authors (AO). Relevant data extracted included age, weight, height (from which Body Mass Index [BMI] was calculated in Kg/m^2), consumption of alcohol or herbal tea, cigarette smoking or use of tobacco, chronic illness, sexually transmitted disease, blood group and genotype, as well as other gynecological indices. In addition, information of investigations given, diagnosis and possible cause(s) of illness were recorded. Data were transferred into excel spreadsheet, verified, cleaned and imported into statistical software for analysis.

Statistical Analysis

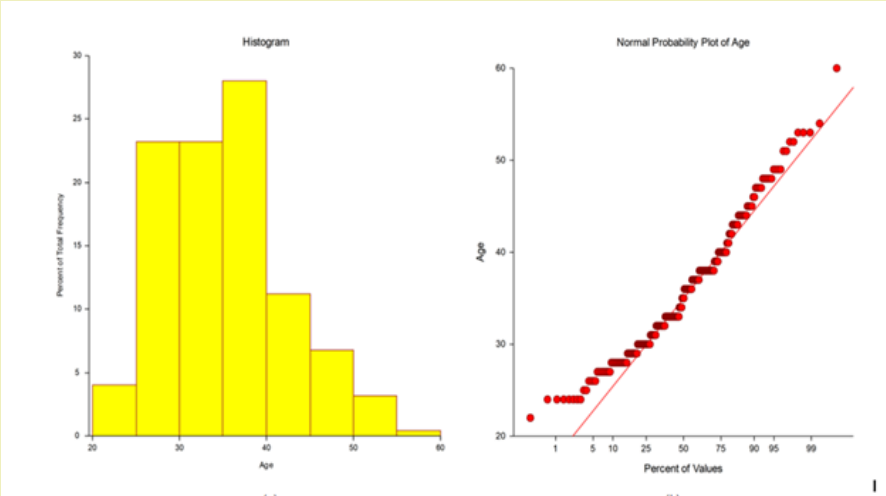
Statistical analysis was performed by using NCSS 2021 (Kaysville, Utah, USA). The chi-square, t test, one-way ANOVA. Relative risk was estimated by calculating odds ratio (OR) and 95% confidence interval (CI). Data are presented as number (percent) or mean ± SD, Tables and figures. P<0.05 was considered significant.

Results

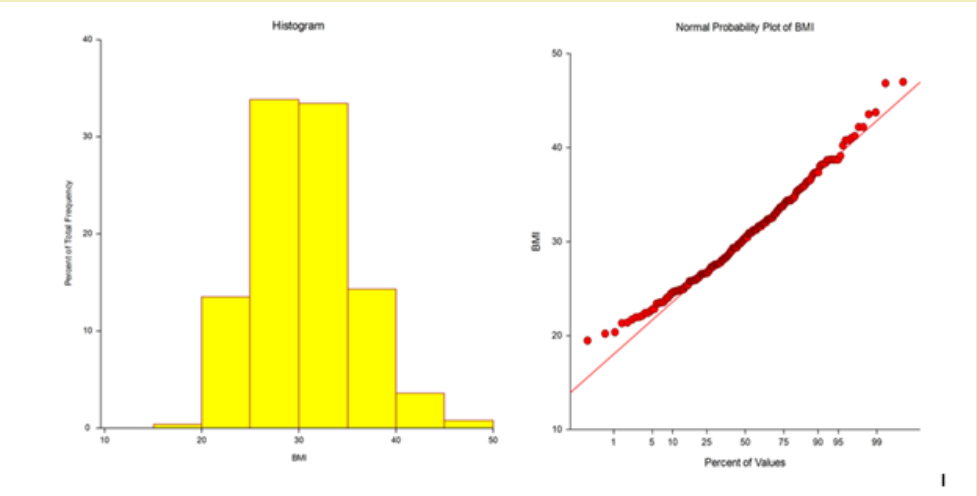
A total of 1421 and 1590 gynecological cases were seen in each of the two years of study, 2018 and 2019, making a total of 3011. In each of these years, 202 (14.2%) and 206 (13.0%) female infertility cases were recorded, making a total of 408 cases. In all, 251 (61.5%) of the 408 cases of infertility were analyzed in this study. The biophysical characteristics of the study patients are as shown in Table 1 indicating a significant difference (t-test = -3.69, P-value = 0.0003) in the mean ages of those with primary (n=158, 63.0%) and those with secondary (n=93, 37.0%) infertility. Body Mass Index (Kg/m^2) and years of education were not significantly different in the two groups of women. The Table also shows that those with secondary infertility (SI) were approximately twice as likely to be consuming alcohol (χ^2 = 6.08, P-value = 0.01, Odds ratio = 1.95, 95% CI = 1.14, 3.31) over two times more likely to be smoking or using tobacco (χ^2 = 4.80, P-value = 0.03, Odds ratio = 2.30, 95% CI = 1.08, 4.92) but as likely to be consuming herbal medicinal tea (χ^2 = 0.38, P-value = 0.54, Odds ratio = 1.18, 95% CI = 0.70, 1.97) when compared with those with primary infertility. Figures 1 and 1b illustrate the histogram and normal probability plot of age of the study subjects which show that age was tilted more to the left and those aged up to 40 years were about 75% of the study population. Figures 2a and 2b also illustrate the histogram and normal probability plot of BMI of study subjects which indicate that underweight infertile women were about 1% and those with normal BMI were less than 20% while majority were either overweight or obese. Table 2 and Figures 3 (a-c) show the distribution of different gynecological diseases in various blood groups in all patients and in those with primary or secondary infertility. In all the ABO blood group, group O occurred most frequently (125, 49.8%) followed by group B (70, 27.9%), A (36, 14.3%) and AB (20, 8.0%). Blood group A was more predominant (χ^2 = 3.96, P-value = 0.046) in those with primary (n=28, 17.7%) than those with secondary (n=8, 8.6%) infertility. Apart from this, there was no significant difference in the prevalence of other blood groups among those with primary or secondary infertility. Women with primary infertility were 2.29 times more likely to have blood group A (χ^2 = 3.96, P-value = 0.046, OR=2.29, 95% CI=1.00,5.26). Those with Blood group O were least likely to present with primary infertility (χ^2=3.05, P-value=0.08, OR=0.63, 95% CI = 0.38, 1.06).

Table 1: Biophysical characteristics of patients in the study.

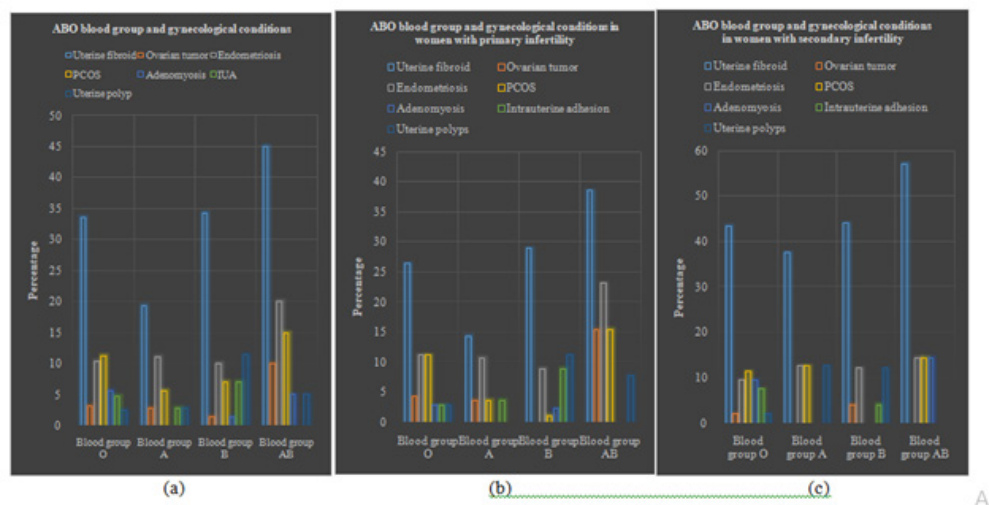
Variable	Statistics		All (n=251, 100.0%)	Primary infertility (PI) (n=158, 63.0%)	Secondary infertility (SI) (n=93, 37.0%)
Age	Mean (±sd)		35.7 (7.1)	34.5 (6.6)	37.9 (7.3)
	Min./Max		22 / 60	22 / 60	24 / 53
	Mode		-	33	38
	t-test (P-value)			-3.69 (0.0003)	
BMI	Mean (±sd)		30.6 (5.1)	30.6 (5.1)	30.6 (5.1)
	Min./Max		19.5 / 47.0	19.5 / 46.8	21.3 / 47
	Mode		-	38.7	30.9
	t-test (P-value)			0.00 (1.00)	
Years of education	Mean (±sd)		15.8 (3.9)	16.1 (3.6)	15.3 (4.2)
	Min./Max		6 / 28	6 / 28	6 / 28
	Mode		12	-	12
	t-test (P-value)			1.53 (0.13)	
Consumes alcohol	Yes	Freq. (%)	89 (35.5)	47 (29.8)	42 (45.2)
	No	Freq. (%)	162 (64.5)	111 (70.2)	51 (54.8)
	χ^2 (P-value) / OR (95% CI)			6.08 (0.01) / 0.51 (0.30, 0.88) PI ; 6.08 (0.01) / 1.95 (1.14, 3.31) SI	
Smokes cigarette/tobacco	Yes	Freq. (%)	31 (12.4)	14 (8.9)	17 (18.3)
	No	Freq. (%)	220 (87.6)	144 (91.1)	76 (81.7)
	χ^2 (P-value) / OR (95% CI)			4.80 (0.03) / 0.43 (0.20, 0.93) PI ; 4.80 (0.03) / 2.30 (1.08, 4.92) SI	
Takes herbal tea	Yes	Freq. (%)	134 (53.4)	82 (51.9)	52 (55.9)
	No	Freq. (%)	117 (46.6)	76 (48.1)	41 (44.1)
	χ^2 (P-value) / OR (95% CI)			0.38 (0.54) / 0.85 (0.51, 1.42) PI ; 0.38 (0.54) / 1.18 (0.70, 1.97) SI	



Figures 1a and 1b: Histogram and Normal probability Plot of age (years) of patients in the study.



Figures 2a and 2b: Histogram and Normal probability Plot of BMI (Kg/m^2) of patients in the study.



Figures 3a, 3b, 3c: Distribution of gynecological illnesses by ABO Blood group among all infertile women (a) in those with primary (b) and secondary (c) infertility in the study.

Gynecological conditions presented by the study subjects were cross-tabulated against different blood groups. (Table 3). In all, 82 (32.7%) women presented with uterine fibroid, 8 (3.2%) with ovarian tumor, 28 (10.9%) with endometriosis, 24 (9.6%) with PCOS, 9 (3.6%) with adenomyosis, 12, (4.8) with intrauterine adhesion and 13 (5.2%) with uterine polyp. In all study subjects, Blood group AB had the highest prevalence of uterine fibroid (9, 45.0%), ovarian tumor (2, 10.0%), Endometriosis (4, 20.0%) and PCOS (3, 15.0%) than other ABO blood groups (Figure 3a). Among those with primary (Figure 3b) and secondary (Figure 3c) infertility, uterine fibroid was most prevalent, especially in Blood group AB, but more in secondary (57.1%) than in primary (38.5%) infertility. However, endometriosis was more prevalent (23.1%) among women with primary infertility in Blood group AB than in secondary infertility with the same blood group. In blood group O, adenomyosis had the highest risk ratio (χ^2 =1.78, P-value=0.18, RR =1.58, 95% CI=1.08,2.32) while the lowest was endometriosis (χ^2 =0.23, P-value=0.63, RR =0.90, 95% CI=0.59, 1.39). However, in blood group A, the highest risk ratio was listed by endometriosis (χ^2 =0.47, P-value=0.49, RR =1.76, 95% CI=0.61, 5.07) while the lowest was uterine polyps (χ^2 =0.00, P-value=1.00, RR =0.84, 95% CI=0.12 ,5.84). Uterine polyps recorded the highest risk ratio (χ^2 =5.62, P-value=0.02, RR =2.32, 95% CI=1.41,3.85) in blood group B while ovarian tumor registered the highest risk ratio (χ^2 =0.45, P-value=0.50, RR =2.33, 95% CI=0.65, 8.37) in group AB. After this, the study subjects were again segregated into two groups of primary and secondary infertility. Of the 158 women with primary infertility, 41 (25.9%) presented with uterine fibroid and only 3 (1.9%) presented with adenomyosis, indicating that uterine fibroid still occupied pole position in the gynecological conditions presented at consultation (Table 4). However, in blood group O, the highest risk ratio (χ^2 =0.04, P-value=0.84, RR =1.52, 95% CI=0.66, 3.50) was registered by adenomyosis and the lowest by uterine polyps (χ^2 =0.61, P-value=0.43, RR =0.39, 95% CI=0.07, 2.03). Endometriosis recorded the highest risk ratio (χ^2 =0.35, P-value=0.56, RR =1.93, 95% CI=0.55, 6.75) in blood group A, uterine polyps in group B (χ^2 =2.28, P-value=0.13, RR =2.11, 95% CI=1.13, 3.93) and ovarian tumor in group AB (χ^2 =0.79, P-value=0.37, RR =2.82, 95% CI=0.80, 9.94). In women with secondary infertility, adenomyosis still retained the highest risk ratio (χ^2 =0.73, P-value=0.39, RR =1.48, 95% CI=0.98, 2.23), uterine polyps in groups A (χ^2 =0.04, P-value=0.85, RR =2.88, 95% CI=0.41, 20.17) and B (χ^2 =1.85, P-value=0.17, RR =2.70, 95% CI=1.17, 6.23) and adenomyosis in group AB (χ^2 =0.00, P-value=1.00, RR =1.97, 95% CI=0.28, 13.81) (Table 5). In all, uterine fibroid was more prevalent in Blood group AB (45.0%) than any other blood groups.

Table 2: Distribution of infertility in ABO blood groups.

ABO Blood group	Type of infertility				Total	%	χ^2	P-value	OR	95% CI	RR	95% CI
	Primary (n=158, 61.8%)		Secondary (n=93, 38.2%)									
	Freq.	%	Freq.	%								
O	72	45.6	53	57.0	125	49.8	3.05	0.08	0.63	0.38, 1.06	0.84	0.70, 1.02
A	28	17.7	8	8.6	36	14.3	3.96	0.046	2.29	1.00, 5.26	1.29	1.05, 1.58
B	45	28.5	25	26.9	70	27.9	0.07	0.78	1.08	0.61, 1.92	1.03	0.84, 1.27
AB	13	8.2	7	7.5	20	8.0	0.04	0.84	1.10	0.42, 2.87	1.04	0.74, 1.45
Total	158	61.8	93	38.2	251	100.0	-					
χ^2(P-value)	5.02 (0.17)				-							

Patients with Blood group A were more than two times as likely to present with primary infertility than other ABO blood groups (χ^2=3.96, P-value=0.046, OR=2.29, 95% CI = 1.00, 5.26). Those with Blood group O were least likely to present with primary infertility (χ^2=3.05, P-value=0.08, OR=0.63, 95% CI = 0.38, 1.06).

Table 3: Frequency distribution and risk ratio of gynecological conditions relative to blood group among infertile patients.

Gynecological conditions presented		Blood Group				Total (%) (n=251, 100.0%)
		O (n=125, 49.8%)	A (n=36, 14.3%)	B (n=70, 27.9%)	AB (n=20, 8.0%)	
Uterine fibroid	Freq. (%)	42 (33.6)	7 (19.4)	24 (34.3)	9 (45.0)	82 (32.7)
	χ^2 (P-value)	0.03 (0.87)	0.06 (0.81)	0.01 (0.94)	0.02 (0.88)	
	RR (95% CI)	1.02 (0.76, 1.37)	0.89 (0.35, 2.29)	1.02 (0.64, 1.62)	0.94 (0.41, 2.15)	

Ovarian tumor	Freq. (%)	4 (3.2)	1 (2.8)	1 (1.4)	2 (10.0)	8 (3.2)
	χ^2 (P-value)	0.00 (0.97)	0.00 (1.00)	0.43 (0.51)	0.45 (0.50)	
	RR (95% CI)	0.99 (0.49, 2.01)	1.40 (0.21, 9.32)	0.42 (0.07, 2.67)	2.33 (0.65, 8.37)	
Endometriosis	Freq. (%)	13 (10.4)	4 (11.1)	7 (10.0)	4 (20.0)	28 (10.9)
	χ^2 (P-value)	0.23 (0.63)	0.47 (0.49)	0.26 (0.61)	0.04 (0.84)	
	RR (95% CI)	0.90 (0.59, 1.39)	1.76 (0.61, 5.07)	0.84 (0.42, 1.67)	1.32 (0.48, 3.66)	
PCOS	Freq. (%)	14 (11.2)	2 (5.6)	5 (7.1)	3 (15.0)	24 (9.6)
	χ^2 (P-value)	0.67 (0.41)	0.00 (1.00)	0.50 (0.48)	0.00 (1.00)	
	RR (95% CI)	1.18 (0.81, 1.72)	0.90 (0.22, 3.73)	0.69 (0.30, 1.56)	1.12 (0.35, 3.53)	
Adenomyosis	Freq. (%)	7 (5.6)	0 (0.0)	1 (1.4)	1 (5.0)	9 (3.6)
	χ^2 (P-value)	1.78 (0.18)	0.14 (0.0)	0.70 (0.40)	0.00 (1.00)	
	RR (95% CI)	1.58 (1.08, 2.32)	undefined	0.37 (0.06, 2.39)	0.98 (0.15, 6.50)	
Intrauterine adhesion	Freq. (%)	6 (4.8)	1 (2.8)	5 (7.1)	0 (0.0)	12 (4.8)
	χ^2 (P-value)	0.00 (0.97)	0.00 (1.00)	0.45 (0.50)	0.32 (0.57)	
	RR (95% CI)	0.99 (0.55, 1.77)	0.91 (0.13, 6.32)	1.49 (0.73, 3.03)	undefined	
Uterine polyps	Freq. (%)	3 (2.4)	1 (2.8)	8 (11.4)	1 (5.0)	13 (5.2)
	χ^2 (P-value)	3.14 (0.08)	0.00 (1.00)	5.62 (0.02)	0.00 (1.00)	
	RR (95% CI)	0.44 (0.16, 1.19)	0.84 (0.12, 5.84)	2.32 (1.41, 3.85)	0.74 (0.11, 5.11)	

In all the patients, blood group AB had the highest prevalence of uterine fibroid (9, 45.0%), ovarian tumor (2, 10.0%), Endometriosis (4, 20.0%) and PCOS (3, 15.0%) than other ABO blood groups

Table 4: Frequency distribution and risk ratio of gynecological conditions relative to blood group in women with primary infertility.

Gynecological condition that was present		**Primary Infertility**				
		Blood Group				
		O (n=72, 45.6%)	**A (n=28, 17.7%)**	**B (n=45, 28.5%)**	**AB (n=13, 8.2%)**	**Total (n=158, 100.0%)**
Uterine fibroid	Freq. (%)	19 (26.4)	4 (14.3)	13 (28.9)	5 (38.5)	41 (25.9)
	χ^2 (P-value)	0.10 (0.75)	0.00 (1.00)	0.01 (0.91)	0.00 (1.00)	
	RR (95% CI)	1.08 (0.69, 1.67)	0.94 (0.28, 3.13)	0.97 (0.54, 1.73)	0.88 (0.31, 2.51)	
Ovarian tumor	Freq. (%)	3 (4.2)	1 (3.6)	0 (0.0)	2 (15.4)	6 (3.8)
	χ^2 (P-value)	0.00 (1.00)	0.00 (1.00)	1.68 (0.19)	0.79 (0.37)	
	RR (95% CI)	1.13 (0.49, 2.61)	1.72 (0.26, 11.44)	undefined	2.82 (0.80, 9.94)	
Endometriosis	Freq. (%)	8 (11.1)	3 (10.7)	4 (8.9)	3 (23.1)	18 (11.4)
	χ^2 (P-value)	0.00 (1.00)	0.35 (0.56)	0.54 (0.46)	0.01 (0.92)	
	RR (95% CI)	1.00 (0.54, 1.77)	1.93 (0.55, 6.75)	0.64 (0.26, 1.60)	1.35 (0.41, 4.41)	
PCOS	Freq. (%)	8 (11.1)	1 (3.6)	5 (11.1)	2 (15.4)	16 (10.1)
	χ^2 (P-value)	0.24 (0.63)	0.01 (0.92)	0.00 (1.00)	0.00 (1.00)	
	RR (95% CI)	1.15 (0.67, 1.99)	0.58 (0.08, 4.24)	0.96 (0.44, 2.12)	0.94 (0.23, 3.86)	
Adenomyosis	Freq. (%)	2 (2.8)	0 (0.0)	1 (2.2)	0 (0.0)	3 (1.9)
	χ^2 (P-value)	0.04 (0.84)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	
	RR (95% CI)	1.52 (0.66, 3.50)	undefined	1.03 (0.20, 5.25)	undefined	
Intrauterine adhesion	Freq. (%)	2 (2.8)	1 (3.6)	4 (8.9)	0 (0.0)	7 (4.4)
	χ^2 (P-value)	0.23 (0.63)	0.00 (1.00)	1.07 (0.30)	0.24 (0.63)	
	RR (95% CI)	0.63 (0.19, 2.06)	1.46 (0.21, 9.94)	1.88 (0.92, 3.83)	undefined	
Uterine polyps	Freq. (%)	2 (2.8)	0 (0.0)	5 (11.1)	1 (7.7)	8 (5.1)
	χ^2 (P-value)	0.61 (0.43)	0.14 (0.71)	2.28 (0.13)	0.00 (1.00)	
	RR (95% CI)	0.39 (0.07, 2.03)	undefined	2.11 (1.13, 3.93)	0.95 (0.14, 6.39)	

Table 5: Frequency distribution and risk ratio of gynecological conditions relative to blood group in women with secondary infertility.

Gynecological condition that was present		Secondary Infertility (n=93)				
		Blood Group				
		O (n=53, 57.0%)	A (n=8, 8.6%)	B (n=25 26.9%)	AB (n=7, 7.5%)	Total (%) (n=93, 100.0%)
Uterine fibroid	Freq. (%)	23 (43.4)	3 (37.5)	11 (44.0)	4 (57.1)	41 (44.1)
	χ^2 (P-value)	0.20 (0.66)	0.00 (1.00)	0.22 (0.64)	0.00 (1.00)	
	RR (95% CI)	0.92 (0.63, 1.34)	0.88 (0.19, 4.08)	1.21 (0.55, 2..67)	1.17 (0.28, 4.88)	
Ovarian tumor	Freq. (%)	1 (1.9)	0 (0.0)	1 (4.0)	0 (0.0)	2 (2.1)
	χ^2 (P-value)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	
	RR (95% CI)	0.85 (0.21, 3.45)	undefined	2.08 (0.49, 8.82)	undefined	
Endometriosis	Freq. (%)	5 (9.4)	1 (12.5)	3 (12.0)	1 (14.3)	10 (10.8)
	χ^2 (P-value)	0.06 (0.81)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	
	RR (95% CI)	0.84 (0.44, 1.60)	1.18 (0.15, 9.27)	1.26 (0.44, 3.55)	1.12 (0.15, 8.33)	
PCOS	Freq. (%)	6 (11.3)	1 (12.5)	0 (0.0)	1 (14.3)	8 (8.6)
	χ^2 (P-value)	0.39 (0.53)	0.00 (1.00)	1.63 (0.20)	0.00 (1.00)	
	RR (95% CI)	1.33 (0.85, 2.08)	1.72 (0.23, 12.98)	undefined	1.44 (0.20, 10.48)	
Adenomyosis	Freq. (%)	5 (9.4)	0 (0.0)	0 (0.0)	1 (14.3)	6 (6.5)
	χ^2 (P-value)	0.73 (0.39)	0.00 (1.00)	0.93 (0.33)	0.00 (1.00)	
	RR (95% CI)	1.48 (0.98, 2.23)	undefined	undefined	1.97 (0.28, 13.81)	
Intrauterine adhesion	Freq. (%)	4 (7.5)	0 (0.0)	1 (4.0)	0 (0.0)	5 (5.4)
	χ^2 (P-value)	0.29 (0.59)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	
	RR (95% CI)	1.40 (0.87, 2.28)	undefined	0.80 (0.13, 4.83)	undefined	
Uterine polyp	Freq. (%)	1 (1.9)	1 (12.5)	3 (12.0)	0 (0.0)	5 (5.4)
	χ^2 (P-value)	1.78 (0.18)	0.04 (0.85)	1.85 (0.17)	0.00 (1.00)	
	RR (95% CI)	0.33 (0.06, 1.91)	2.88 (0.41, 20.17)	2.70 (1.17, 6.23)	undefined	

Discussion

The comparative distribution of A, B, AB, and O blood groups in infertility, both primary and secondary involvement and in gynecological diseases was studied. The results showed an increased percentage of subjects with blood group O (49.8%, 57.0%)), followed by blood group B(28.5%, 26.9%), blood group A (17.7%, 8.6%) and blood group AB (8.2%, 7.5%) in primary and in secondary infertility respectively. While blood group O predominates in secondary infertility, all other blood groups predominate in primary infertility. There was a statistically significant relationship only between frequency distribution of A and type of infertility but not in any other blood group. The reported overall predominance of blood group O (49.8%) is higher than the 39.3% prevalence of the same blood group reported by Pai in India[14] but is in consonance with the reports of other study in Nigeria[12] and of Nejat,[15] and Pal.[16] who hypothesized that the same molecular machinery that determines blood type could affect ovarian cells. As an analogy, erythrocytes have an identifier molecules that project from the cell surface like flagpole. Individuals with blood groups A, AB, B are thought to possess specific enzymes which probably modulate the distal extremity of the flagpole, just like hoisting a flag on the pole. However, in blood type O, though there is a pole, there is no flag hoisted. There is the likelihood that the mechanism which "hoisted" the flag in blood type A, B & AB, but is absent in blood group O, may equally trigger yet unknown functions in the reproductive system, especially in the ovarian cells[15] in the female and the sperm cells in the male human species. This hypothesis appeals for a more in-depth research on the ABO blood system and idiopathic infertility among Black Africans or Africans in diaspora. It is interesting to note that, in this study, the risk of endometriosis was highest among sub-fertile women with blood group A, similar to what Metalliotak is reported.[10] Studies have shown that in the three main allelic forms of the ABO gene locus, the H antigen is an indispensable forerunner to the ABO blood group antigens.[17,18] Further, the gene products of the A and B alleles are glycosyl transferases that catalyze the transfer of carbohydrates to the H antigen, forming the A and B antigens, respectively. The A allele encodes for a glycosyl transferase (A transferase) that catalyzes the transfer of N-acetyl galactosamine to the H antigen, producing the A antigen. It is speculated that this mechanism may be faulty or deficient in women with endometriosis or even in infertility, giving reason why endometriosis

and primary infertility are more prevalent in blood group A. More research is needed in this area. In this study, the risk of ovarian tumor was overwhelmingly high in those with blood group AB. This observation is at variance with what Björkholm in Sweden[19] and Henderson[20] in UK reported that ovarian cancer was more common in Swedish and British women of blood group A than in other blood groups. One suggested mechanism by which women of blood group A might be at higher risk of cancers involves diminished immunological surveillance.[21] However, it may also be possible that not only genetic dispensation but also race influences the distribution of blood groups among women with ovarian tumor. This is another area of research that requires in-depth study. Uterine fibroid has been reported to be more prevalent among black women in general but its association with the ABO blood is extremely rare in literature. This study may be the first, at least in Africa, to report that the risk of uterine fibroid among sub-fertile women is relatively higher among those with either blood group B (RR=1.02, 95% CI=0.64, 1.62) or blood group O (RR=1.02, 95% CI=0.76, 1.37). Likewise, the risks of PCOS and adenomyosis were observed to be relatively higher in blood group O while that of IUA and uterine polyps were observed to be higher in blood group B. At this juncture, one can only speculate and go along with the suggestion of Smith[21] that the mechanism responsible for this distribution of risks relative to ABO blood system may be related to diminished immunological surveillance. However, racial disposition, diet, consumption of alcohol and other conditions not yet known may play a major role in this regard.

Conclusion

Women with primary infertility were significantly younger and less likely to consume alcohol or some cigarette than those with secondary infertility. Women with primary infertility are over two times more likely to have blood group A and less likely to have blood group O. Overall, the risk of uterine fibroid was more in blood groups O and B, while the risk of ovarian tumor was highest in blood group AB, that of endometriosis in blood group B, PCOS and adenomyosis in blood group O respectively, and IUA and uterine polyps have highest risks in blood group B. The relationship between blood group and type of infertility observed in this study may be due to various blood group antigens acting as receptors for yet-to-be-identified agents associated with particular gynecological condition. This relationship between gynecological diseases and ABO blood group points toward susceptibility of subjects with certain blood groups - to uterine fibroid, ovarian tumor, endometriosis, PCOS, adenomyosis, IUA or uterine polyps. A multi-center, multi-disciplinary national study on ABO blood system and infertility is most relevant at this point in time.

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Conflict of Interest

All authors declare no conflict of interest.

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