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Research Article

Induced Abortion is a Risk Factor for Intrauterine Adhesion Among Sub-fertile Sub-sahara Black African Women

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Abstract

Introduction: Infertility may be caused by many factors among which is intrauterine adhesion (IUA) which, among Black African women, may be consequent upon one or more series of induced abortion (IA).

Objective: To evaluate the role of induced abortion as a risk factor for the development of IUA in women presenting for fertility management in Nigeria.

Methodology: Medical records of 1631 sub-fertile women were analyzed retrospectively to investigate parity, frequency of IA and IUA prior to fertility management. Obstetrics and gynecological history were taken. Hysteroscopy was used for the diagnosis of IUA. Data analysis was conducted using NCSS21 statistical software.

Results: Majority of the study subjects (1256, 77.0%) were nulliparous, with the lowest mean age (38.33 ± 6.51). Subjects who had undergone IA (n = 706, 43.3%) were significantly older (t-test=-5.55, P-value<<0.00001) and heavier (t-test = -2.50, P-value <0.01) than those who had not. Of the 1631 study subjects, 925 (56.7%) had never undergone any IA, while 348 (21.3%), 201 (12.3%), 96 (5.9%) and 61 (3.7%) had undergone 1, 2, 3 and 4 or more IA. Prevalence of IUA was significantly higher (χ^2=24.51, P-value<<0.0001) among those who had induced abortion compared to those who had not. Those who had never undergone any IA were least (0.56) likely to develop IUA (χ^2=25.38, P-value=0.00000047, OR=0.56, 95% CI=0.45, 0.70) with a risk ratio of just 0.76 (95% CI=0.68, 0.86). The probability of IUA increased to 1.09, 1.47, 2.02 and 2.54 and the risk ratio to 1.07, 1.40, 1.92 and 2.44 among study subjects who had had 1, 2, 3 and ≥4 IA. Linear regression analysis and correlation study indicated causal relationship between IA and IUA.

Conclusion: This study observed that induced abortion is a risk factor for intrauterine adhesion. The probability of IUA among nulliparous women, who formed the bulk of the study subjects, increased steadily from those who had never had induced abortion to those who had had four or more induced abortions. Likewise, the risk of IUA was least among those who had had no IA and highest among those who had had four or more IA. Significant negative correlations were observed between frequency of IU and IUA.

Keywords: *Black Women; Induced Abortion; Infertile; Intrauterine Adhesion; Nigeria; Parity; Risk Factor; Sub-fertile; Sub-Sahara Africa*

Introduction

Guttmacher Institute [1] stated: "unintended pregnancy and abortion are experiences shared by people around the world". Unintended pregnancy is a reproductive health outcome that is shared among women throughout the world regardless of occupational, social or legality status of abortion. Annually, between 2015 and 2019, approximately 121 million unintended pregnancies occurred, 90% in low income countries, 66% in middle income countries and only 34% in high-income countries. Of these 121 million unintended pregnancies, 61% ended in abortion [1], with about 40% of them in low-income countries. Whether intended or unintended, induced or spontaneous, abortion refers to the termination of a pregnancy before fetal viability at 28 weeks of gestation, and induced abortion refers to abortion done intentionally by drugs and, for the purpose of this study, by mechanical means [2]. Induced abortion has been a controversial issue for decades, if not centuries. Some old studies pointed out that about 26 million legal and 20 million illegal abortions were performed worldwide in 1995, resulting in a worldwide abortion rate of 35 per 1,000 women aged 15-44 [3], that interest in abortion research is reemerging, partly as a result of political changes and partly due to evidence of the contribution of induced abortion to maternal mortality in developing countries [4], and that unsafe abortions and their complications are a major cause of maternal mortality as hospital-based studies from most African countries confirm that up to 50% of maternal deaths are due to abortion [5]. Up to five million unsafe abortions are performed in Africa every year, with young women disproportionately affected [6]. In Nigeria, out of 5 million pregnancies, 54,000 resulted into induced abortion [7]. Studies have suggested possible link between induced abortion and intrauterine adhesion. For example, Mentula., *et al*. [8] referred to Intrauterine adhesions (IUAs) as "problematic complication after termination of pregnancy", Hooker [9] suggested that the association between intrauterine adhesions and induced termination of pregnancy remains a challenge and Luk., *et al.* [10] concluded that Intrauterine adhesions are a cause of failed surgical abortion, March [11] posited that curettage in about the first trimester of pregnancy, more than any other endometrial trauma, may likely result in intrauterine adhesion and in a systematic review Hooker., *et al*. [12] acknowledged the existence of a link between termination of pregnancy (TOP) and adhesion formation. Intrauterine adhesions (IUAs) are considered one of the main reproductive system diseases affecting females worldwide, characterised by endometrial fibrosis with partial to complete obliteration of the uterine cavity and/or cervical canal [13-16]. Infertility is a global health problem. Datta., *et al.* reported that about 12.5% of women had experienced infertility, defined by unsuccessfully attempting pregnancy for a year or longer, and little more than half of these people sought medical or professional help [17]. A study in Denmark concluded that infertility is a common experience among couples attempting to become parents, though assisted reproduction in the public health-care system in Denmark has high success rates, i.e. pregnancies, deliveries and high patient satisfaction [18]. However, studies in Africa associate female infertility mainly to bilateral tubal factor, not to IUA consequent on induced abortion [19-20]. Infertility is also a common phenomenon in Africa, for which a significant number of women (and men) seek medical intervention. Meheus., *et al.* [21] cited a WHO study that portrayed bilateral tubal occlusion to be thrice as frequent in Africa as in other developing areas as a cause of infertility, that 85% of African women had an infectious etiology (vs. 36%) as causes of infertility and that Pelvic inflammatory disease (PID), the main cause of tubal blockage, causes infertility in 15% of women after 1 bout. Nevertheless, information is lacking on all aspects of the triad of induced abortion, intrauterine adhesion and infertility, particularly among Black African women. For example, a study reported that tubal factors remain the most common abnormality seen in the hysterosalpingogram (HSG) of infertile women in Africa [22]. Elsewhere, Mo., *et al.* [23] in China reported that, among others, high negative pressure suction evacuation and long suction evacuation time are risk factors for the development of IUA. Further, Mentula., *et al.* [8] in Finland ascertained that surgical evacuation following medical or surgical termination of pregnancy is a risk factor for the diagnosis of IUA. Data on IUA among sub-fertile sub-Saharan Black African women, consequent primarily on induced abortion, is rare. One of the few recent studies on IUA in Nigeria observed that infertility-related menstrual abnormalities is an important majority of gynecological consultation in Africa, traced to IUA and are related to lower educational status and sub-fertility [24]. Data on infertility induced by IUA consequent upon IA is rare in African setting. Therefore, the objective of this study was to evaluate the incidence of IUAs detected at hysteroscopy prior to IVF management, among sub-fertile Black African women who had undergone induced abortion.

Materials and Methods

This study was approved by the Nigerian Institute for Medical Research Institutional Review Board (NIMR IRB/18/007). The materials and methods was described in an earlier paper [25]. In short, medical records of 2857 out of a total of 4233 women in child-bearing age who consulted at a private fertility center for fertility management from 2001-2019 were fetched from the archives of the facility. A 2-day training, supervised by one of the authors (VDA) was provided for 3 data managers to acquaint them with precise medical information to be extracted from the medical records of the study subjects, cleaning and transcribing the data into Excel spreadsheet. Data extraction, entry and management lasted from June to December 2019 and it included, among others, anthropometric (age and body mass index) and socio-demographic (religious affiliation, marital status, occupation) information, parity, past history of surgical procedures on the uterus and gynecological conditions presented at consultation prior to IVF treatment. Inclusion criteria were (i) previous uterine surgeries (ii) previous history of recurrent failed IVF treatment in the form of three or more cycles (iii) at least one or two IVF treatment attempts at the fertility center; (iv) poor/non-distension of the endometrium at sonohysterogram; (v) abnormal findings at Hysterosalpingogram (HSG) done within the previous one year. Those excluded had (i) history of pelvic inflammatory disease (ii) pelvic cancer (iii) infertility mainly due to male factor (iv) incomplete data (v) refusal to participate. Of the initial 2857 eligible clients, 1631 (57.1%) met all the inclusion criteria. Before any surgery, the operating surgeons would have given detailed explanation of the procedures to all women presenting for infertility management. Hysteroscopy, a minimally invasive procedure that uses a thin, flexible telescope-like instrument (hysteroscope), inserted in the vagina, was used to examine the uterine cavity under short general anesthesia for medical diagnosis and corrective procedure.

- **Patients consent:** At consultation, each study subject gave informed consent for their data to be used in the research and that the data will be discreet, coded, and unnamed. The benefits of using data for teaching and research purposes were explained to the study subjects.

- **Statistical Analysis*:*** Induced abortion was classified as no (0) or yes (1-7) and parity was categorized as never had a child (nulliparous), has had one or more than one child. Data entry and cleaning were conducted before statistical analysis was performed using NCSS 2021 (NCSS, Utah, USA) software. Chi-square test (with Odd ratio at 95% confidence interval) and Student's t-test were used to analyze difference between two continuous variables. Analysis of variance (ANOVA) was used to describe difference in means of more than two variables. Pearson's correlation coefficient and correlation analysis were used to determine association between induced abortion and intrauterine adhesion. A p-value of <0.05 was taken to be statistically significant. The presentation of data in this study was in form of numbers, percentages for qualitative data, means with standard deviation for quantitative data, Tables, Graphs and Figures.

Results

Schematic diagram of patients' classification relative to induced abortion, intrauterine adhesion and parity is as illustrated in figure 1. Pooled analysis shows significant differences in age (years) (F-statistics = 4.1, P-value = 0.002) and BMI (Kg/m^2) (F-statistics = 9.3, P-value << 0.0001) of women in different stages of parity, with women of parity 4 (n = 8, 0.49%) having the highest mean age (43.0 ± 9.8) and mean BMI (33.3 ± 12.0) and nulliparous women (n = 1256, 77.0%) having the lowest age (38.3 ± 6.5) and the lowest BMI (27.7 ± 5.1) (Table 1, Figures 2a, b). The minimum ages (years) of nulliparous and those with parity of 4 were 24.0 and 29.0 respectively while the maximum ages were 29.0 and 61.0 respectively. Those who had undergone induced abortion (n=709, 43.3%) were significantly older (t-test = -5.55, P-value <<0.00001) than those who has not (n=922, 56.7%). Those who had undergone induced abortion were significantly heavier (t-test = -2.50, P-value = 0.01) than those who had not. Pooled analysis also shows no significant difference (F-statistics = 0.47, P-value = 0.76) in the mean number of induced abortion regardless of the parity of study subjects. The prevalence of intrauterine adhesion was significantly higher among those who had induced abortion compared to those who had not (χ^2=24.51, P-value<<0.0001). Frequency

distribution of intrauterine adhesion relative to parity and frequency of induced abortion are as shown in table 2. Among nulliparous women, the probability of IUA steadily increased from 0.53 in those who had never had IA to 2.82 among those who had had ≥4 IA. In all study subjects with parity of 0-2, the probability of IUA was highest among those who have had ≥4 IA. The number of subjects with parity of 3 and 4 were few to ascertain this observation. Parity, with or without induced abortion may also predispose a woman to intrauterine adhesion. Table 3 shows that of the 1631 study subjects, 926 (56.8%) had never undergone any induced abortion, while 347 (21.3%), 201 (12.3%), 96 (5.9%), 37 (2.3%), 19 (1.1%), 3 (0.2%) and 2 (0.1%) had undergone 1 to 7 induced abortions respectively. The total number of IA was 1,312 with a ratio of 1:80 (1312/1631) IA among all the study subjects and a ratio of 1: 1.90 (1312/705) among those who had undergone IA. Intrauterine adhesion was observed in 401 (24.6%) of the study subjects and not in the remaining 1230 (75.4%). Those who had never undergone any IA were least (0.56) likely to develop IUA (χ^2=25.38, P-value=0.00000047, OR=0.56, 95% CI=0.45, 0.70) with a risk ratio of just 0.76 (95% CI=0.68, 0.86). Among study subjects who had undergone 1, 2, 3 and 4 IA, the probability of IUA increased to 1.09, 1.47, 2.02 and 2.54 and the risk ratio to 1.07, 1.40, 1.92 and 2.44 with a simultaneous increase in risk ratio. Figures 2a-e illustrate frequency distribution of induced abortion among nulliprarous (Figure 3a), parity 1 (Figure 3 b), parity 2 (Figure 3c), parity 3 (Figure 3d) and those with parity 4 (Figure 3e). Nulliparous women had the highest frequency of IA (n = 703) (Figure 2a). Figure 4 buttresses the finding that increased prevalence of IUA is associated with rise in the frequency of IA. Linear regression analysis and correlation of intrauterine adhesion (dependent variable) with any induced abortion (a) and with frequency of induced abortion (b) as independent variables are reflected in figures 5a and b. In figure 5a, the equation of the straight line relating Intrauterine adhesion (IUA) and Any induced abortion (AIA) was estimated as: IUA = (1.80) + (-0.11) AIA using the 1631 observations in this data-set. The y-intercept, the estimated value of IUA when AIA is zero, was 1.80 (SE=0.01). The slope, the estimated change in IUA per unit change in AIA, was -0.11 (SE=0.02). The value of R^2, the proportion of the variation in IUA that can be accounted for by variation in AIA, was 0.01. There was a significant negative correlation (r = -0.12, t-value = -5.00, P-value <<0.0001) between IUA and AIA.

Variable	Unit	Stat.	Parity					All	Induced abortion		F-stat	P-value
			0	1	2	3	4		Yes	No		
		n	1256	273	67	27	8	1631	709	922		
		%	77.0	16.7	4.1	1.7	0.5	100.0	43.3	56.7		
Age	years	Mean	38.3	39.7	39.6	39.5	43.0	38.7	39.7!	37.9!	4.1	0.002
		± sd	6.5	6.0	5.1	5.8	9.8	6.4	6.1	6.6		
		Min.	24.0	20.0	26.0	26.0	29.0	20.0	24.0	20.0		
		Max.	61.0	55.0	49.0	50.0	57.0	61.0	57.0	61.0		
BMI	Kg/m^2	Mean	27.7	29.1	29.4	31.0	33.3	28.1	28.5#	27.8#	9.3	<<0.0001
		± sd	5.1	5.4	5.3	4.5	12.0	5.3	5.3	5.2		
		Min.	17.0	18.0	20.0	24.0	20.0	17.0	17.0	17.0		
		Max.	59.0	50.0	45.0	42.0	57.0	59.0	59.0	55.0		
Any induced abortion	Yes	Freq.	553	115	25	11	5	709	-	-	-	-
		%	44.0	42.1	37.3	40.7	62.5	43.3	-	-	-	-
		Mean	0.8	0.8	0.7	0.7	0.8	0.8	-	-	0.5	-0.76
		± sd	1.2	1.1	1.1	1.2	0.7	1.2	-	-		
	No	Freq.	703	158	42	16	3	922	-	-	-	-
		%	56.0	57.9	62.7	59.3	37.5	56.7	-	-	-	-
	χ^2 (P-value)		0.69 (0.41)	0.24 (0.62)	1.08 (0.30)	0.08 (0.77)	0.53 (0.46)^	-	-	-	-	-
	P-value		0.41	0.62	0.30	0.77	0.46	-	-	-	-	-
	OR		1.10	0.94	0.77	0.89	2.18	-	-	-	-	-
	95% CI		0.87, 1.39	0.72, 1.22	0.46, 1.27	0.41, 0.93	0.52, 9.13	-	-	-	-	-

Any intrauterine adhesion	Induced abortion = Yes	Yes	Freq.	169	35	9	3	1	217	217	492	*24.5	<<0.0001
			%	30.6	30.4	36.0	27.3	20.0	30.6				
		No	Freq.	384	80	16	8	4	492				
			%	69.4	69.6	64.0	72.7	80.0	69.4				
	Induced abortion = No	Yes	Freq.	132	37	11	4	0	184	184	738		
			%	18.8	23.4	26.2	25.0	0.0	20.0				
		No	Freq.	571	121	31	12	3	738				
			%	81.2	76.6	73.8	75.0	100.0	80.0				

Table 1: *Demographic, obstetric and gynecologic profile of study subjects.*

*!Subjects who had undergone induced abortion were significantly older (t-test = -5.55, P-value <<0.00001) and #were significantly heavier (t-test = -2.4975, P-value = 0.01). Subjects with parity of 4 appeared to be 2.18 times more likely to have had induced abortion, but this should taken with caution as the number is fewer, necessitating Fisher's exact test. *Pearson's χ^2=24.5 (P-value =<<0.0001), Ho is rejected at α=0.05, therefore H_1: Induced abortion and Intrauterine adhesion are significantly associated (not independent); ^Fisher's Exact test.*

Pathology	**Condition**	**Parity**									
		0		**1**		**2**		**3**		**4**	
		(n = 1256)		**(n = 273)**		**(n = 67)**		**(n = 27)**		**(n = 8)**	
		Induced abortion = 0									
		Freq.	**%**	**Freq.**	**%**	**Freq.**	**%**	**Freq.**	**%**	**Freq.**	**%**
		703	56.0	158	57.9	44	65.7	17	63.0	3	37.5
Intrauterine adhesion	Yes	132	18.8	37	23.4	11	25.0	4	23.5	0	0.0
	No	571	81.2	121	76.6	33	75.0	13	76.5	3	100.0
	χ^2 (P-value)	23.57 (<0.000001)		1.68 (0.19)		0.22 (0.64)		0.00 (1.00)		0.00 (1.00)	
	OR (95% CI)	0.53 (0.40, 0.68)		0.70 (0.41, 1.20)		0.76 (0.24, 2.34)		0.72 (0.12, 4.16)		0.00 (undefined)	
		Induced abortion = 1									
		272	21.7	59	21.6	8	11.9	5	18.5	4	50.0
	Yes	65	23.9	20	33.9	2	25.0	2	40.0	1	25.0
	No	207	76.1	39	66.1	6	75.0	3	60.0	3	75.0
	χ^2 (P-value)	0.0009 (0.98)		2.19 (0.14)		0.00 (1.00)		0.05 (0.82)		0.00 (1.00)	
	OR (95% CI)	1.00 (0.73, 1.36)		1.60 (0.86, 2.98)		0.90 (0.16, 4.90)		2.23 (0.29, 17.58)		0.00 (undefined)	
		Induced abortion = 2									
		155	12.3	33	12.1	11	16.4	1	3.70	1	12.5
	Yes	52	33.6	7	21.2	4	36.4	0	0.0	0	0.0
	No	103	66.4	26	78.8	7	63.6	1	100.0	1	100.0
	χ^2 (P-value)	8.91 (0.003)		0.51 (0.47)		0.16 (0.69)		0.00 (1.00)		0.00 (1.00)	
	OR (95% CI)	1.72 (1.20, 2.48)		0.72 (0.30, 1.75)		1.71 (0.44, 6.74)		0.00 (undefined)		0.00 (undefined)	
		Induced abortion = 3									
		78	6.2	13	4.8	2	3.0	3	11.1	0	0.0
	Yes	30	38.5	4	30.8	0	0.0	1	33.3	0	0.0
	No	48	61.5	9	69.2	2	100.0	2	66.7	0	0.0
	χ^2 (P-value)	9.58 (0.002)		0.002 (0.96)*		0.003 (0.95)		0.00 (1.00)		-	
	OR (95% CI)	2.09 (1.30, 3.37)		1.25 (0.37, 4.21)		0.00 (undefined)		1.50 (0.11, 16.64)		-	
		Induced abortion = ≥4									
		48	3.8	10	3.7	2	3.0	1	3.70	0	0.00.
	Yes	22	45.8	4	40.0	1	50.0	0	0.0	0	0.00
	No	26	54.2	6	60.0	1	50.0	1	100.0	0	0.00
	χ^2 (P-value)	11.09 (0.0003)		0.40 (0.53)*		0.00 (1.00)		0.00 (1.00)		-	
	OR (95% CI)	2.82 (1.57, 5.04)		1.91 (0.52, 6.98)		2.82 (0.17, 47.68)		0.00 (undefined)		-	

Table 2: *Frequency distribution of intrauterine adhesion relative to parity and frequency of induced abortion.*

Among nulliparous women, the probability of IUA steadily increased from 0.53 among those who had never had IA to 2.82 among those who had had ≥4 IA. Among all study subjects with parity of 0-2, the probability of IUA was highest among those who have had ≥4 IA. The number of subjects with parity of 3 and 4 were few to ascertain this observation. Parity, with or without induced abortion may also predisposed a woman to intrauterine adhesion.

Uterine pathology	Condition	Stat.	Frequency of induced abortion								Total
			0	1	2	3	4	5	6	7	
		n	926	347	201	96	37	19	3	2	1631
		%	56.8	21.3	12.3	5.9	2.3	1.1	0.2	0.1	100.0
		Total number of induced abortion		347	402	288	148	95	18	14	1,312
		Ratio of induced abortion per woman		1:1.9							1:0.80
Intrauterine adhesion	Present	Freq.	184	90	63	37	19	3	3	2	401
		%	19.9	25.9	31.3	38.5	51.4	15.8	100.0	100.0	24.6
	Absent	Freq.	741	258	138	59	18	16	0	0	1230
		%	80.1	74.1	68.7	61.5	48.6	84.2	0.0	0.0	75.4
χ^2			25.38	0.39	5.64	10.71	13.22	0.39	5.59	2.74	-
P-value			0.00000047	0.53	0.002	0.001	0.0003	0.53	0.02	0.10	-
Odd ratio			0.56	1.09	1.47	2.02	2.54	0.57	Undefined	Undefined	-
95% CI			0.45, 0.70	0.83, 1.43	1.07, 2.03	1.31, 3.09	1.51, 4.26	0.17, 1.97	Undefined	Undefined	-
Risk ratio			0.76	1.07	1.40	1.92	2.44	0.58	Undefined	Undefined	-
95% CI			0.68, 0.86	0.87, 1.32	1.06, 1.85	1.30, 2.86	1.49, 3.99	0.17, 1.96	Undefined	Undefined	-

Table 3: *Frequency of induced abortion relative to intrauterine adhesion among Black African women.*

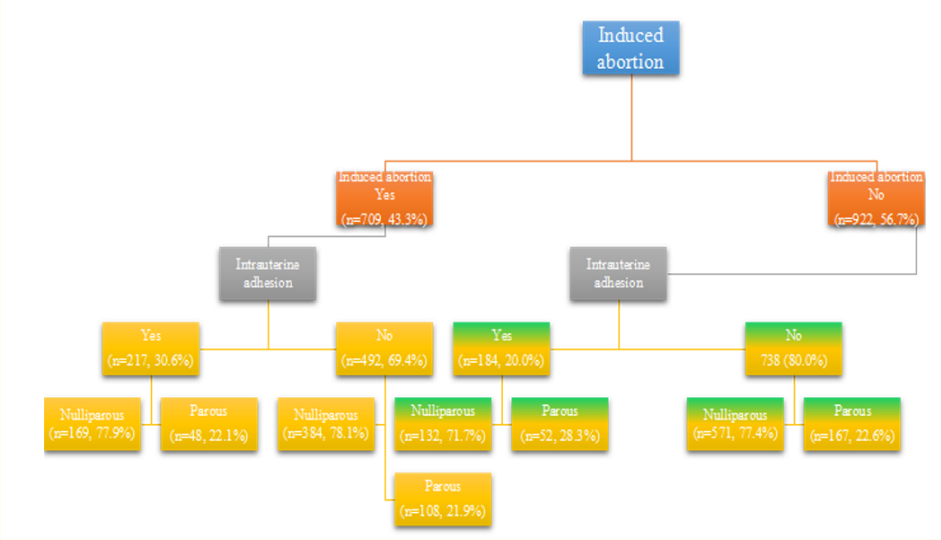
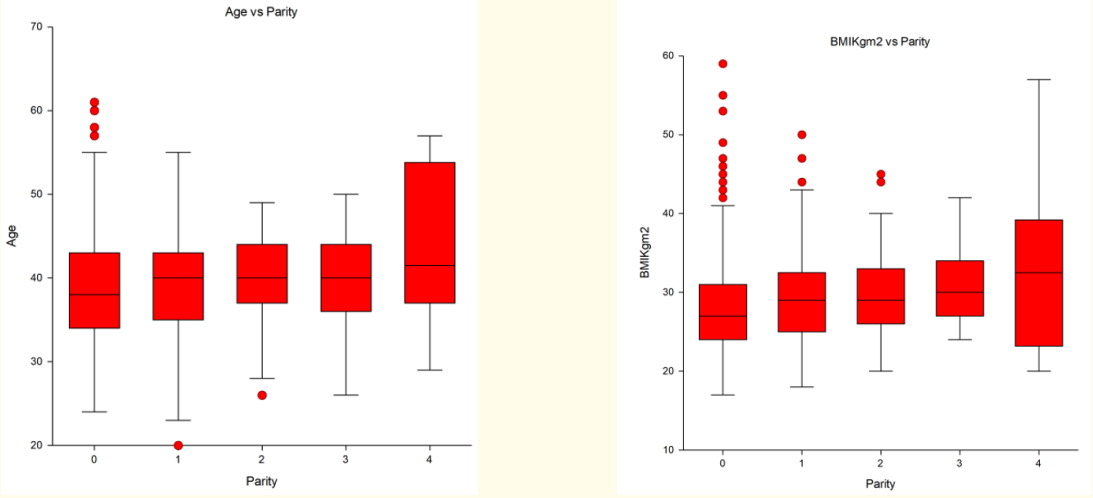
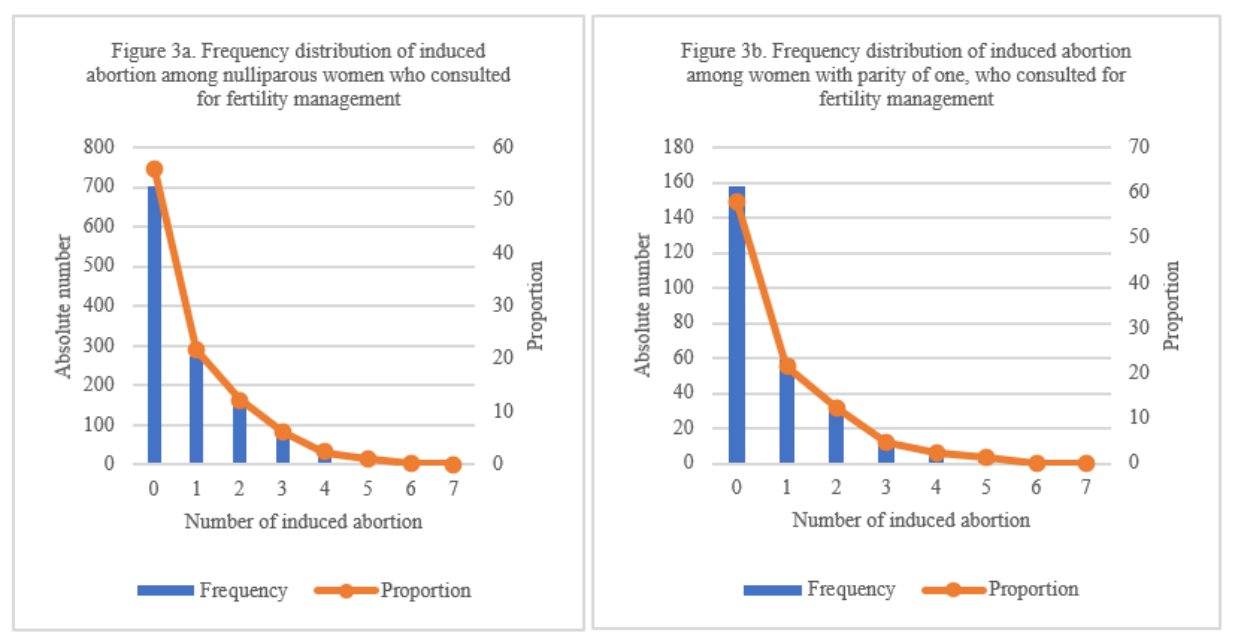


Figure 1: *Schematic diagram of patients' classification relative to induced abortion, intrauterine adhesion and parity.*



a ***b***

Figure 2: *Analysis of variance comparing the means of age (a) and of BMI (b) by parity.*



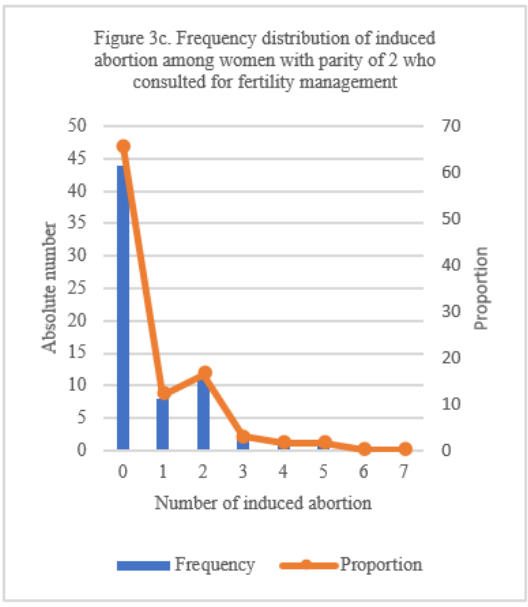


Figure 3c. Frequency distribution of induced abortion among women with parity of 2 who consulted for fertility management
Absolute number
Proportion
Number of induced abortion
Frequency
Proportion

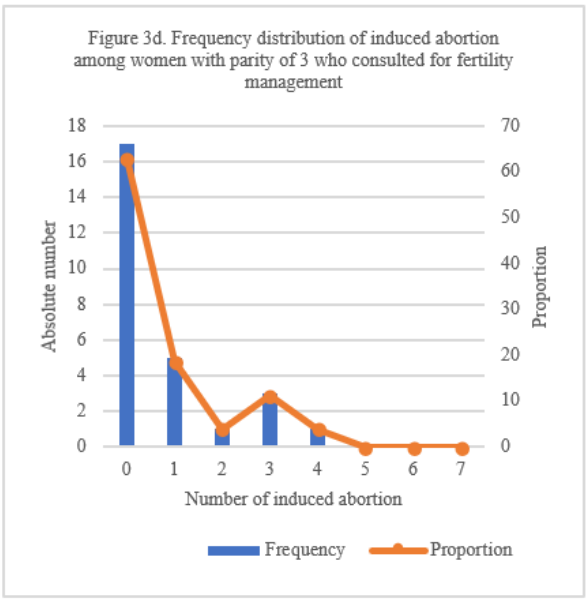


Figure 3d. Frequency distribution of induced abortion among women with parity of 3 who consulted for fertility management
Absolute number
Proportion
Number of induced abortion
Frequency
Proportion

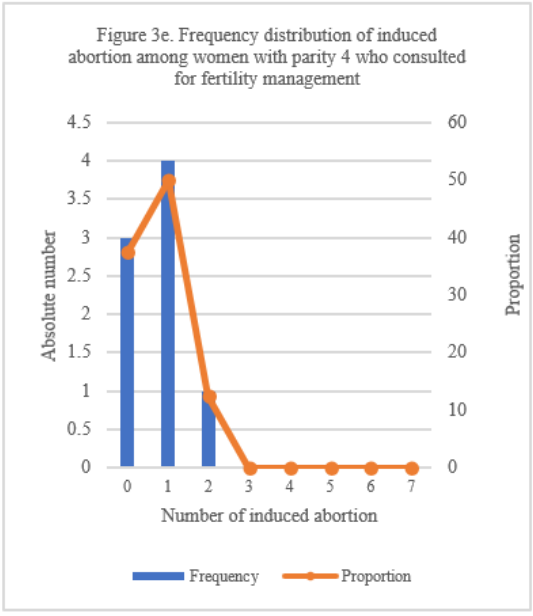


Figure 3e. Frequency distribution of induced abortion among women with parity 4 who consulted for fertility management
Absolute number
Proportion
Number of induced abortion
Frequency
Proportion

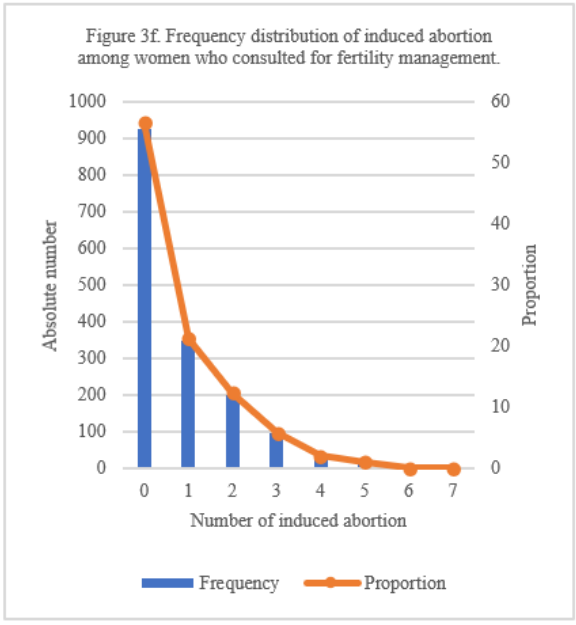


Figure 3f. Frequency distribution of induced abortion among women who consulted for fertility management.
Absolute number
Proportion
Number of induced abortion
Frequency
Proportion

Figure 3

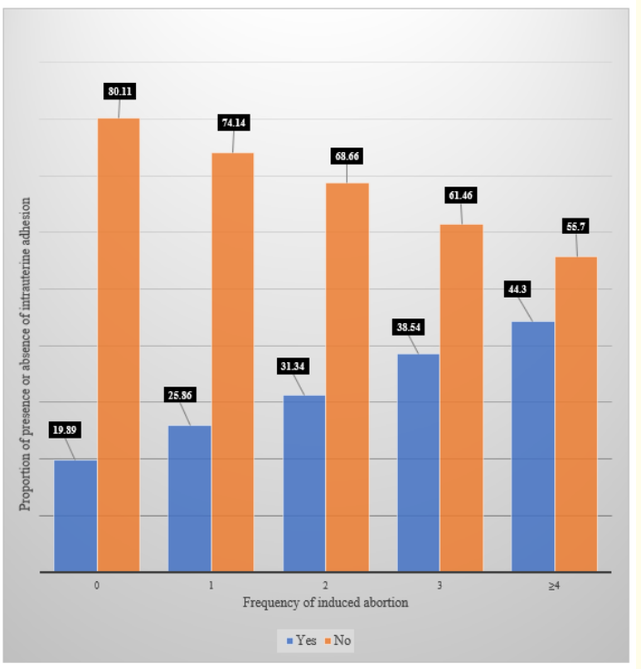
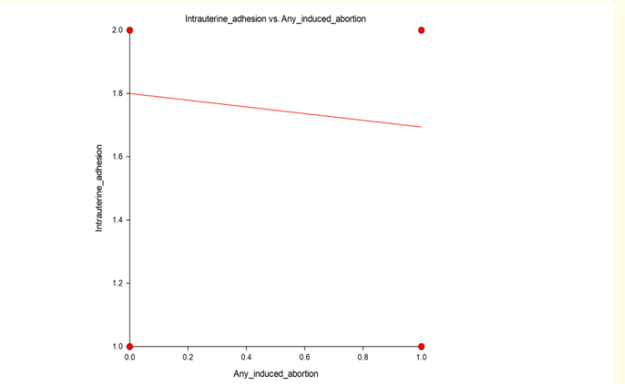
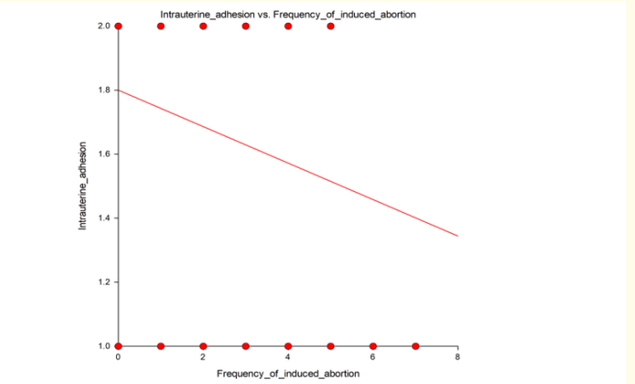


Figure 4: *Relationship between induced abortion and intrauterine adhesion. Prevalence of IUA was the lowest at 19.89 among those who had never had IA and incrementally highest at 44.30 among those who had had IA of 4 or more.*



(a)

The more there is any induced abortion (x-axis 0.0 [No] - 1.0 [Yes]), the more the prevalence of intrauterine adhesion (2.0 [No] - 1.0 [Yes]). There was a significant negative correlation (r = -0.12, t-value = -5.00, P-value <<0.0001) between Intrauterine adhesion and Any induced abortion.



(b)

The more the frequency of induced abortion (x-axis 0 - 8), the more the prevalence of intrauterine adhesion (2.0 [No] - 1.0 [Yes]). There was a significant negative correlation (r = -0.16, t-value=-6.32, P-value <<0.0001) between Intrauterine adhesion and Frequency of induced abortion.

Figure 5: *Linear regression and correlation of intrauterine adhesion (dependent variable) with any induced abortion (a) and with frequency of induced abortion (b) as independent variables.*

In figure 5b, the equation of the straight line relating intrauterine adhesion (IUA) and frequency of induced abortion (FIA) was estimated as: IUA = (1.80) + (-0.06) FIA using the 1631 observations in this data-set. The y-intercept, the estimated value of IUA when FIA is zero, was 1.80 (SE= 0.0128). The slope, the estimated change in IUA per unit change in FIA, was -0.06 (SE= 0.01). The value of R^2, the proportion of the variation in IUA that can be accounted for by variation in FIA, was 0.02. There was a significant negative correlation (r = -0.16, t-value = -6.32, P-value <<0.0001) between IUA and FIA.

Discussion

There are many reasons why a pregnancy is terminated voluntarily. One medical reason is eclampsia, when the mother's life is at risk and termination of the pregnancy is the only option left to save her life. Globally, the most frequently cited reasons for having an abortion were socioeconomic concerns, partner related, risk to fetal health, want no more children, too young/parents and/or others object to pregnancy, wants to postpone having children, child-spacing or limiting childbearing with socioeconomic reasons being the predominating reason in Africa [26]. Women in reproductive age use either or both contraception and abortion for desired fertility [27] but for some, the outcome is undesired infertility. Complications of unsafe abortion such as intrauterine adhesion, infertility and even death affect many women each year, especially in very low and low income countries, where abortion may still be illegal. In this study, the prevalence of any induced abortion was 43.3%, a figure much higher than the 19.6% reported in Ghana [28]. The prevalence this is correct among nulliparous women in this study was slightly higher than the 40.67%, but much more higher than that among those with parity 1 (24.82%), parity 2 (19.85%), parity 3 (6.06%) and parity 4 (5.61%) reported in 2018 by Centers for Disease Control and Prevention (CDC) [29]. Another significant finding in this study is that induced abortion was more prevalent among nulliparous women than among all parous women. This finding agrees with the conclusion of Skjeldestad [30] that abortion ratio continuously increased in nulliparous women in contrast to parous women with relatively stabilized abortion ratio. The main finding however is that the prevalence of intrauterine adhesion was notably higher among women who had undergone induced abortion when compared with those who had never undergone such surgical procedure. This resonates with what Pongpattanawut., *et al.* [31] reported that early TOP by dilatation and curettage (D&C) was the most prevalent cause of IUA. Intrauterine adhesion on its own, suggested to be caused mainly by uterine instrumentation, is viewed as an enigma, a mystery which contributes to major damage of female reproductive functions such as infertility among others [32].

The pathophysiology of adhesion formation is suggested to involved 5 critical steps - (i) endometrium basal layer damage (ii) endometrial glands are scattered and cystically dilated (iii) pale anemic micro-environment (iv) lack of vascular stromal tissue leading to hypoxia and (v) endometrial fibrosis and scarring [32]. The major pathways involved in intruaterine adhesion formation is beyond the scope of this paper. However, the process includes trauma-induced inflammation, facilitated by macrophages, cytokines and growth factors, which trigger a remedial procedure by promoting fibrin exudate formation, coagulation, fibrin clots and inflammatory cells [33]. It is also noteworthy that in general, this paper observed that the risk of IUA increased with increase in the frequency of IA and specifically nulliparous women who had never had induced abortion had the lowest probability of IUA. This finding correlates with what was reported by another study in China that multiparity, and long suction evacuation time are stand-alone risk factors for the development of IUA after IA procedure [23]. In support of findings in this paper, a study in Nigeria documented relatively high prevalence of abortion among nulliparous women [34].

Conclusion

Intrauterine adhesion is a consequence of dynamic imbalance between fibrin that is deposited during coagulation and fibrin that is resolved, directed by the fibrinolytic system. This study observed that induced abortion is not only a risk factor for intrauterine adhesion but also more prevalent among nulliparous than parous women in reproductive age.. The probability of IUA among nulliparous women, who formed the bulk of the study subjects, increased steadily from those who had never had induced abortion to those who had had four or more induced abortions. Likewise, the risk of IUA was minimal among those who had never undergone IA and highest among those who had had four or more IA. Significant negative correlations were observed between frequency of IU and IUA. This paper calls for an extensive multi-center and inter-departmental research on the health of Black women in sub-saharan Africa in the concept of their reproductive and general health.

Study Limitations

The study subjects were not categorized by age or by type of infertility - primary or secondary, aspects that are being considered in another manuscript. The study also did not evaluate the severity of intrauterine adhesion because this was not the focus of the paper. Also, we did not investigate use of contraceptive among the women in this study. Data on contraceptive use in this study would have given us the idea of those who did not want to get pregnant and thus sought induced abortion should they eventually become pregnant. Since this is a facility-based retrospective study, we did not calculate the incidence rate of abortion and the findings reported here may not necessarily

reflect the true picture from a community perspective or current national figure on women's health. Our intention was to link induced abortion among women of varying parity with intrauterine adhesions detected at hysteroscopy and with infertility, especially among women presenting for Assisted Reproduction Technology

Conflict of Interest Statement

The authors hereby declare that no competing or conflict of interests exist.

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