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Original Research Article

Pelvic Sonographic Findings, Their Relationship with Microorganisms Detected on Endocervical Swabs and Factors Associated with Sonographic PID among Women at Gynaecology Clinic of Mbarara Regional Referral Hospital

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Abstract: ***Aim***: To study Pelvic sonographic findings, their relationship with microorganisms detected on endocervical swabs and factors associated with sonographic PID among women at Gynaecology clinic of Mbarara Regional Referral Hospital. ***Methods*:** 144 women aged 15-49 years with clinical diagnosis of PID at gynaecology clinic of MRRH were interviewed with structured questionnaires about socio-demographic, behavioural and gynaecological factors. Pelvic sonographic examination via transvaginal and transabdominal methods was performed. Analysisof sonographic PID findings, association with factors above and testing for gonorrhea and chlamydia by nucleic acid amplification test (NAAT), a DNA-PCR test was done. Data was entered using EPI info, exported to excel and analysed using STATA© 15.0 software (College Station, Texas, USA). Categorical variables were summarized as frequencies, percentages, Chi-square test followed by logistic regression. Continuous variables were summarized as mean and standard deviation. A factor was considered associated if $p \leq 0.05$. ***Results*:** Sonographic PID was diagnosed in 41.66% (60/144) of patients. Most presented with uterine findings 9.72% (14), free fluid in posterior cul-de-sac 6.94% (10). Few had fallopian tubal and ovarian findings each at 3.47% (5) respectively. However, most patients presented with mixed structural findings 18.05% (26). The rest of the patients 58.35% (84) had normal findings. Women with history of STIs [AOR = 2.8 (95% CI: 1.00–7.57), p=0.05] or had adnexal mass [AOR = 7.1 (95%CI: 1.58–31.90), p=0.01] were statistically more likely to have sonographic PID. Of the 144 women, 29.17% (42) were diagnosed with microorganisms, 22.92% (33) positive for Neisseria, 4.86% (7) positive for chlamydia and 1.39% (2) for both. However, at 5% level of significance diagnosis with *Neisseria gonorrhoeae* was associated with a higher likelihood of sonographic PIDcompared to absence of microorganisms ($p<0.05$). ***Conclusion*:** A high proportion of women with clinical diagnosis of PID at Gynaecology clinic of MRRH have pelvic sonographic PID findings. Patients who had history of STI and/or palpable adnexal mass were more likely associated with sonographic PID. Neisseria positive conferred a high likelihood of sonographic PID compared to absence of microorganisms.

Keywords: PID, Sonographic, Pelvic, Findings, Microorganisms.

INTRODUCTION

Pelvic inflammatory disease (PID) refers to infectious inflammation of the upper genital tract of women i.e., the uterus, fallopian tubes, ovaries, and adjacent pelvic structures due to ascending infection of the lower genital tract i.e., vagina and or cervix. While the majority of PID cases are related to a sexually transmitted infection (STI), some cases are non-sexually acquired (Jennings and Krywko, 2020, Eze *et al*., 2018). The clinical diagnosis of PID is difficult and confirmation of pelvic inflammation or infection due to *Neisseria gonorrhea* and *Chlamydia trachomatis* is

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rarely done (WHO, 2018). Globally the burden of PID is estimated to be 0.28%-1.67% (French *et al*., 2011, Oroz *et al*., 2012). In Africa, especially in sub-Saharan countries, PID accounts for 17-40% of gynaecological admissions (Li and Xu, 2021). In Uganda there is no exact national data on the burden of PID. However, a village population based study revealed the prevalence of PID to be 6% (Althaus, 1991).

The commonest causative organisms of PID are; *Neisseria gonorrhea* and *Chlamydia trachomatis* (Tsevat *et al*., 2017, Wiesenfeld *et al*., 2012). However, clinical studies have demonstrated that in 30-40% of cases, PID has polymicrobial etiology (Sitnik and Levkovska, 2016). Studies have shown that use of intra-uterine devices (IUD), abortion, history of STI, being married, low socioeconomic status and being Muslim predispose to PID (Lata *et al*., 2019, Naaz *et al*., 2016).

In ideal settings, patients with clinical diagnosis of PID are investigated with a combination of laboratory, radiological and laparoscopy techniques (Eze *et al*., 2018, Mitchell and Prabhu, 2013). Pelvic sonography is a well-established and cheap radiological tool for diagnosing PID because it is simple, accessible, affordable and does not use ionizing radiation (Thomassin-Naggara *et al*., 2012). Studies have described; thickened tubal wall ≥ 5mm, dilated oval shaped fallopian tube, incomplete septa, cogwheel sign, beads on a string sign, polycystic like ovary, tubo-ovarian complex, tubo-ovarian abscess, cul-de- sac fluid to be the common pelvic sonographic PID findings (Bugg and Taira, 2016, Romosan and Valentin, 2014). Timely diagnosis of PID is vital because it causes substantial morbidity to women (French *et al*., 2011).

There is scanty data on PID and its pelvic sonographic findings in sub-Saharan Africa, whereas most of the available data is old and from high income countries, society has changed alot in many aspects of social life (Eze *et al*., 2018). The study seeks to respond to this gap by describing the pelvic sonographic findings, their relationship with microorganisms and factors associated with pelvic sonographic PID among women at gynaecology clinic of Mbarara Regional Referral Hospital (MRRH).

METHODS

Ethical Statement

This study adhered to the tenets of the Helsinki declaration. Approval of the study was obtained from the faculty of Medicine research committee and the research ethics committee at Mbarara University of Science and Technology. Informed consent was sought from the enrolled participants.

Design

This was a cross sectional study conducted at Gynaecology clinic of Mbarara Regional Referral Hospital, South western Uganda from June 2021 to October 2021.

Inclusion Criteria

A woman of reproductive age (15-49) years coming through gynaecology clinic with clinical diagnosis of PID was considered eligible for enrolment if she signed a consent/ assent form.

Exclusion Criteria

Women with positive HCG, those who had undergone pelvic surgery like caesarean section, hysterectomy, or salpingectomy for ectopic pregnancy in ≤ 6weeks, those who were having menstrual flow, those who declined to consent and have an endocervical swab taken, those with other sonographic diagnosis apart from PID and finally patients with missing data were excluded.

Variables

We enrolled a total of 144. Data collected include; Sociodemographic & behavioural factors, gynaecological factors, microorganisms (*Neisseria gonorrhoeae, Chlamydia trachomatis*) and pelvic sonographic findings among patients with clinical PID.

Data Analysis

Data was analyzed using STATA© 15.0 software. Participants' characteristics were described using means or medians for continuous variables and proportions for categorical variables, frequency tables were used.

To describe pelvic sonographic findings among women with clinical diagnosis of PID, we described and categorized pelvic sonographic findings as either uterine, free-fluid in posterior cul-de-sac, fallopian tubal, ovarian, pelvic peritoneal findings and mixed structural findings. The frequencies and percentages of each sonographic finding were calculated.

To determine factors associated with pelvic sonographic PID findings among women, a binary variable of pelvic sonographic PID findings was used as the dependent variable coded 0=No and 1= yes. All participants' factors (Sociodemographics, behavior and gynecological factors were used as independent variables in the analysis. In Univariate analysis, based on both Chi-square test and Logistic regression, repeated analysis comparing participants' factors with sonographic PID findings was done. Unadjusted odds ratios with their corresponding 95% CI were reported. A variable was considered significant in the analysis if it had a $p \leq 0.05$. All factors with a p-value <0.2 and those with biological plausibility were considered in the multivariate analysis. In the final multivariate model after controlling for potential confounders and interactions, the factors were then reported together with their adjusted odds ratios and 95% confidence intervals. A variable was considered significant in the analysis if it had a $p \leq 0.05$.

To establish the relationship between microorganisms detected on endocervical swabs with pelvic sonographic findings among women with clinical diagnosis of PID, we used Chi-square test followed by logistic regression, the proportion and likelihood of microorganisms among women with each pelvic sonographic finding were separately compared between women with and without sonographic PID. Odds ratios, confidence intervals and significance levels were presented. The relationship for the likelihood of sonographic PID with microorganisms was adjusted for baseline socio-demographic characteristics of the study participants. A microorganism was considered significantly associated with the likelihood of sonographic PID if the p value was <0.05.

RESULTS

Sociodemographics of Study Participants

Of the 343 women of reproductive age who attended gynaecology clinic of MRRH during the study period from June to October 2021, 144 participants were enrolled into this study (Figure 1). Using consecutive sampling method, data from 144 participants were analyzed. Of these patients the mean age was 29.98 years ±7.67. Most of the women were married 69.44%(100), resided in rural setting 45.83% (66) and were engaged in business/profession occupations 45.14%(65). The rest of baseline characteristics are summarized in table 1.

Pelvic Sonographic Findings among Women with Clinical Diagnosis of PID

Of the 144 women with clinical diagnosis of PID, 41.66%(60) had pelvic sonographic PID findings. Most presented with uterine findings 14(9.72%), followed by free fluid in posterior cul-de-sac 6.94%(10). Few presented with fallopian tubal and ovarian findings each at 3.47%(5) respectively. However, most patients presented with mixed structural findings 18.05%(26) as summarized in table 2.

Factors Associated with Sonographic PID Findings among Women

In the bivariate model, the factors that were associated with sonographic PID among women at p≤0.050 were religion, education, history of STIs, palpable adnexal mass and parity. Specifically, there was a statistically significant high likelihood of PID among women of Muslim affiliation compared to those of Anglican affiliation (UOR = 3.1, 95%: 1.09-9.03, p = 0.033). Women with tertiary education showed a lower likelihood of PID compared to those without formal education (UOR = 0.2, 95%: 0.03-0.83, p = 0.030). In addition, there was high likelihood of PID among women with a history of STIs (UOR = 2.5, 95%: 1.28-5.03, p = 0.007). Women presenting with palpable adnexal mass showed a high likelihood of PID (UOR = 6.2, 95%: 2.16-18.10, p = 0.001). Women with a parity of 1 to 2 were more likely to be diagnosed with PID compared to nulliparous women (UOR = 2.6, 95%: 1.16-6.02, p = 0.021). However, variables with p<0.2 and those with biological plausibility were entered into the multivariate model.

In the multivariate model (after controlling for potential confounders and interactions), women with history of STIs [AOR = 2.8 (95% CI: 1.00–7.57), p=0.050] or had palpable adnexal mass [AOR = 7.1 (95% CI: 1.58–31.90), p=0.01] were statistically more likely to have sonographic PID findings as seen in table 3.

Relationship between Microorganisms Detected on Endocervical Swabs with Pelvic Sonographic Findings

After adjusting for sociodemographic factors, there was a higher likelihood of sonographic PID among women diagnosed with microorganisms (Neisseria AOR = 2.69, 95%CI: 1.12-6.45, p=0.026; Chlamydia AOR = 1.99, 95%CI: 0.39-10.22, p =0.408, Both AOR = 2.30, 95%CI: 0.12-44.84, p =0.582) compared to women without microorganisms. However, at 5% level of significance, only diagnosis with *Neisseria gonorrhoeae* was significantly associated with a higher likelihood of diagnosis with sonographic PID compared to absence of microorganisms (p<0.05). Microorganisms were diagnosed in all categories of pelvic sonographic findings. This is summarized in Tables 4 and 5.

PATIENT RESULTS

Table 1: Socio-demographic characteristics of women with clinical diagnosis of PID at Gynaecology clinic of MRRH (N =144)

Patient characteristics	N=144 Patients (100%)
Mean age, years (SD)	29.98 ±7.67
Age Categories, n (%)	
<25years	47 (32.64)
25-34years	57 (39.58)
35years +	40 (27.78)
Religion, n (%)	
Anglican	**62 (43.06)**
Catholic	44 (30.56)
Muslim	20 (13.89)
Pentecostal	18 (12.50)
Occupation, n (%)	
business/profession	**65 (45.14)**

Patient characteristics	N=144 Patients (100%)
Peasant farmers	49 (34.03)
unemployed/student	30 (20.83)
Education, n (%)	
Secondary	58 (40.28)
Primary	54 (37.50)
Tertiary	19 (13.19)
No formal	13 (9.03)
Marital status, n (%)	
Married	**100 (69.44)**
Cohabiting	20 (13.89)
Single	19 (13.19)
Divorced/widowed/separated	5 (3.47)
Residence, n (%)	
Rural	**66 (45.83)**
Urban	44 (30.56)
Peri-urban	(23.61)

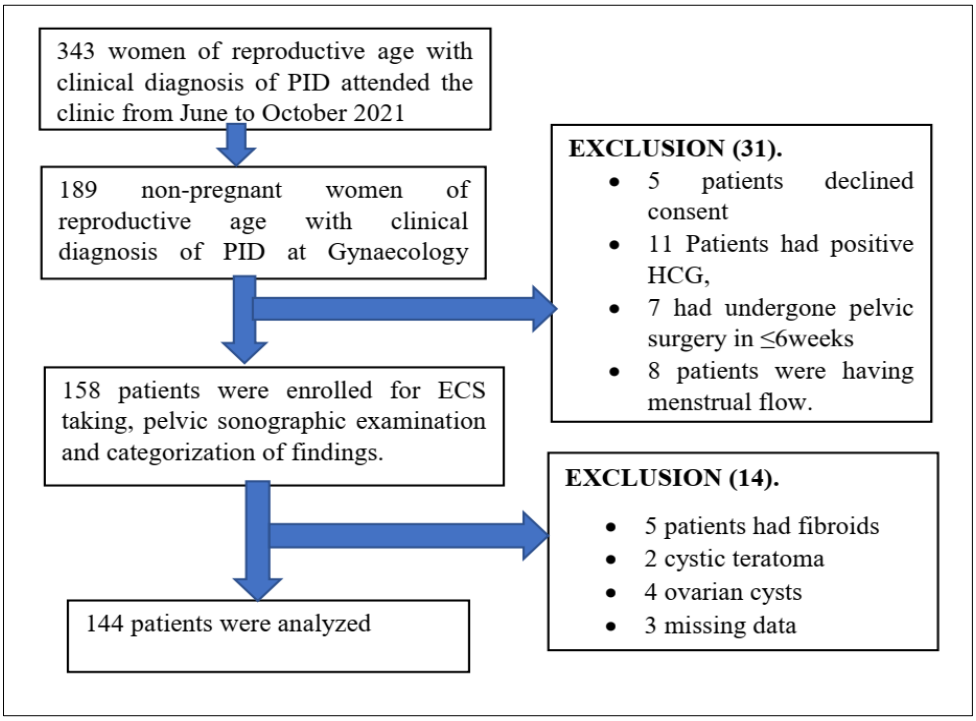

Figure 1: Participants flow chart

Table 2: Pelvic Sonographic findings among women with clinical diagnosis of PID at Gynaecology clinic of MRRH (N = 144)

Pelvic Sonographic Findings	N = 144(100%)
Uterine, n (%)	14(9.72)
Thickened-heterogeneous endometrium	2(1.39)
Increased endometrial vascularity	1(0.69)
Fluid in endometrium	0
Mixed uterine findings	11(7.64)
Fluid in posterior cul-de-sac, n (%)	10(6.94)
Fallopian tubal, n (%)	5(3.47)
Thick wall >5mm	1(0.69)
Thin wall <5mm	1(0.69)
Incomplete septa	0
Cog wheel sign	0
Beads on string sign	0
Tubal hyperemia	0
Mixed tubal findings	3(2.08)

Ovarian, n (%)	5(3.47)
Oophoritis	3(2.08)
PCO	0
Mixed ovarian findings	2(1.39)
Pelvic peritonitis, n (%)	0
Mixed structural findings	26(18.06)
Normal findings	84(58.33)

Table 3: Bivariate and multivariate analysis results of Factors associated with pelvic sonographic PID findings among women at Gynaecology clinic of MRRH. (N = 144)

Variables	UOR (95%CI)	p	AOR (95%CI)	p
Age (years)				
<25	1.0			
25-34	0.9(0.42-2.04)	0.849	0.7 (0.21-2.54)	0.611
35+	1.3(0.57-3.12)	0.508	1.0 (0.18-5.64)	0.986
Age at first sex (years)				
<20	1.0		1.0	
20+	0.3(0.10-1.05)	0.060	0.7(0.15-2.99)	0.604
Sexual partners in past 6 months				
0	1.0		1.0	
1	3.5(0.39-30.85)	0.264	15.6(0.66-368.01)	0.088
>1	6.5(0.68-62.99)	0.104	24.6(0.88-690.01)	0.060
Alcohol use				
No	1.0		1.0	
Yes	1.1(0.48-2.46)	0.835	0.5(0.13-1.93)	0.313
Religion				
Anglican	1.0			
Catholic	1.3(0.59-2.83)	0.528	0.9(0.31-2.41)	0.786
Pentecostal	0.7(0.20-2.07)	0.467	0.3(0.05-1.19)	0.082
Muslim	3.1(1.09-9.03)	**0.033***	1.6(0.30-8.02)	0.594
Occupation				
Unemployed/student				
Peasant farmers	1.1(0.45-2.83)	0.803		
Business/profession	1.1(0.44-2.57)	0.887		
Highest level of education				
No formal	1.0			
Primary	0.9(0.27-3.10)	0.897	2.8(0.55-14.54)	0.213
Secondary	0.5(0.16-1.76)	0.296	0.5(0.10-2.70)	0.437
Tertiary	0.2(0.03-0.83)	**0.030***	0.3(0.04-2.55)	0.280
Marital status				
Single	1.0		1.0	
Married	0.7(0.28-1.98)	0.551	0.6(0.10-3.35)	0.536
Cohabiting	0.7(0.20-2.64)	0.643	0.3(0.04-1.88)	0.183
Divorced/widowed/separated	1.7(0.22-12.35)	0.617	0.3(0.02-4.70)	0.393
Residence				
Urban	1.0			
Peri-urban	1.5(0.60-3.83)	0.368	0.8(0.23-2.99)	0.785
Rural	1.6(0.73-3.55)	0.236	2.1(0.69-6.35)	0.192
Menses in past week				
No	1.0			
Yes	1.1(0.58-2.20)	0.713		
Contraceptive method used				
Barrier	1.0			
Non-barrier	2.6(0.41-16.12)	0.313		
None	1.2(0.21-6.92)	0.829		
Has ever had abortion/miscarriage				
No	1.0			
Yes	1.5(0.74-3.12)	0.256		
History of STI				
No	1.0		1.0	
Yes	2.5(1.28-5.03)	**0.007****	**2.8(1.00-7.57)**	**0.050***

Variables	**UOR (95%CI)**	p	**AOR (95%CI)**	**p**
Vaginal discharge				
No	1.0			
Yes	1.0(0.44-2.44)	0.942		
Vaginal bleeding				
No	1.0			
Yes	1.7(0.73-3.78)	0.222		
Had palpable adnexal mass				
No	1.0		1.0	
Yes	6.2(2.16-18.10)	**0.001*** **	**7.1(1.58-31.90)**	**0.01** **
Infertility				
No	1.0		1.0	
Yes	1.7(0.87-3.35)	0.118	1.7(0.59-4.81)	0.335
Parity				
0	1.0		1.0	
1-2	2.6(1.16-6.02)	**0.021***	**2.6(0.80-8.46)**	0.113
≥3	1.7(0.73-3.97)	0.216	0.8(0.17-3.50)	0.737
Duration of pelvic pain (days)				
0	1.0		1.0	
1-30	2.4(0.47-11.94)	0.298	2.7(0.42-16.82)	0.296
>30	4.8(0.96-23.57)	0.056	3.7(0.59-23.05)	0.164
History of Gynecologic Surgery				
Yes	1.0			
No	0.9(0.42-1.98)	0.818		

*p≤0.05. **p<0.01. ***p<0.001.

Table 4: Relationship between microorganisms detected on endocervical swabs with pelvic sonographic findings among women with clinical diagnosis of PID (N=144).

Micro-organism	Pelvic sonographic findings (N =144)		UOR (95%CI)	*P*	AOR (95%CI)	*p*
	Normal 84 (58.33%)	Sonographic PID 60 (41.66%)				
None (n=102)	65(63.72)	37(36.27%)	1.0			
Neisseria positive (n=33)	14(42.42)	19(57.57%)	2.38(1.07-5.30)	**0.033***	2.69(1.12-6.45)	**0.026***
Chlamydia positive (7)	4(57.14)	3(42.85%)	1.32(0.28-6.21)	0.727	1.99(0.39-10.22)	0.408
Neisseria and Chlamydia (n=2)	1(50.00%)	1(50.00%)	1.76(0.11-28.92)	0.693	2.30(0.12-44.84)	0.582

*p<0.05.

Table 5: Sub-analysis of relationship between microorganisms detected on endocervical swabs with pelvic sonographic findings

Micro-organism	Pelvic sonographic findings (N =144)						UOR (95%CI)	*P*	AOR (95%CI)	*p*
	Normal 84(58.33%)	Uterine 14(9.72%)	Fluid-de- sac 10(6.94%)	Fallopian tubal 5(3.47%)	Ovarian 5(3.47%)	Mixed 26(18.06%)				
None (n=102)	65(63.72)	12(11.76)	7(6.86)	2(1.96)	2(1.96)	14(13.73)	1.0			

Neisseria positive (n=33)	14(42.42)	1(3.03)	3(9.09)	1(3.03)	3(9.09)	11(33.33)	2.38(1.07-5.30)	**0.033***	2.69(1.12-6.45)	**0.026***
Chlamydia positive (7)	4(57.14)	1(14.28)	-	2(28.57)	-	-	1.32(0.28-6.21)	0.727	1.99(0.39-10.22)	0.408
Neisseria and Chlamydia (n=2)	1(50.00)	-	-	-	-	1(50.00)	1.76(0.11-28.92)	0.693	2.30(0.12-44.84)	0.582

*p<0.05.

DISCUSSION

Pelvic Sonographic Findings among Women with Clinical Diagnosis of PID

Pelvic sonography is the most commonly ordered radiological examination among patients with clinical diagnosis of PID because it reveals extent of damage and effect on surrounding tissues (Eze *et al*., 2018, Agarwal, 2013). This study demonstrated that of the 144 women with clinical diagnosis of PID at gynaecology clinic of MRRH, 41.66% had pelvic sonographic PID findings. Whereas the uterus and the posterior cul-de-sac were the most affected parts from sonographic examination while the ovaries and fallopian tubes were least affected. The commonest pelvic sonographic PID findings were mixed structural findings 18.06%(26), this is because PID is an ascending infection of the female genital tract which can have various sonographic findings depending on the time of presentation (Ravel *et al*., 2021). This was followed by uterine findings 9.72%(14) then fluid in the posterior cul-de-sac 6.94%(10). The rest of the patients 58.33% had normal findings. The findings are because the study combined both transvaginal and transabdominal methods of sonographic examination, that enabled detection of even subtle findings. Cueva *et al*., in Ecuador-South America found similar findings among patients with PID, where 37% of patients had pelvic sonographic PID findings (Cueva *et al*., 2020). The similarity in findings is explained by the similar socioeconomic status.

G. Romosan *et al*., in Sweden found more than half of the patients with pelvic sonographic PID findings. The commonest findings were thickened fallopian tubal wall at more than 30%, followed by endometritis and cervicitis was least. The rest, more than 2/5th of patients had other findings not related to PID (Romosan *et al*., 2013). The difference in results is because this was a prospective diagnostic cohort study. Secondly the difference was due to the selection criteria of patients. Endometritis was diagnosed based on histology of endometrial swab but our study used endometrial fluid and vascularity on colour flow doppler.

In patients with clinical diagnosis of PID, pelvic sonography can reveal mixed structural findings in form of unilateral or bilateral tubo ovarian abscess (TOA) in more than 10% of patients (Patel and Crabtree-Burton, 2021). Literature shows that thickened tubal wall, cogwheel sign, tubo-ovarian complex, tubo-ovarian abscess and abnormal adnexal power flow doppler are sonographic findings of acute PID whereas thin wall, beads on a string sign are sonographic findings of chronic PID. Incomplete septum is found in both acute and chronic PID. Fluid in the pouch of douglas and polycystic like ovaries occur in both physiological and pathological phenomenon and cannot be relied on for diagnosis of PID (Romosan and Valentin, 2014).

The findings observed together with our findings suggest that PID can have different pelvic sonographic findings. The variations can be due to patients' demographics, selection criteria, methodology and health seeking behaviors of different populations.

Factors Associated with Sonographic PID Findings among Women

This study established that women with history of STIs [AOR = 2.8 (95% CI: 1.00– 7.57), p=0.050] at Gynaecology clinic of MRRH were more likely to have sonographic PID. Oseni *et al*., Nigeria 2017 had similar findings where more than 70% of participants with previous history of STI had a higher likelihood of developing PID compared to those without history of STI p<0.05 (Oseni and Odewale, 2017). The similarity to our findings is explained by the same geographical location, secondly both studies were conducted in urban tertiary teaching hospitals. The high prevalence of STI among the study participants is largely due to completely no use of any contraceptive method and/or low use of barrier contraceptive methods.

Solomon *et al*., 2019 and Kreisel *et al*., 2021 in the USA found, a high likelihood of PID among women who presented with a prior history of STI (Solomon *et al*., 2019, Kreisel *et al*., 2021). The similarity to our

findings can be explained by behaviors that increase risk for acquiring STI like having multiple sexual partners and low use of barrier contraceptive methods.

However, Goller *et al*., 2017 in Australia among women with clinical PID found no association between history of STI and PID (Goller *et al*., 2017). Similarly, Mohseni *et al*., 2020 USA, among participants with PID revealed no association between STI and developing PID (Mohseni *et al*., 2020). The difference in the findings is because those studies were conducted in high income countries with good health seeking behavior compared to our study. Literature suggests that majority of cases of PID are related to an STI (Savaris *et al*., 2020, Jennings and Krywko, 2020). However, a compressive review of research gaps by Darville *et al*., revealed no association of PID with STI (Darville and Proceedings, 2013).

Gynaecological adnexal masses may originate from the uterus, fallopian tubes, ovaries or from combination of any of the afore mentioned organs. The combination of clinical symptoms, examination findings and radiological evaluation of adnexal masses aid in diagnosis and treatment of patients (Di Tucci *et al*., 2018). This study established that there was an association of palpable adnexal mass with sonographic PID diagnosis (AOR = 7.1 (95% CI: 1.58–31.90), p=0.01).

This finding is in agreement with a study by Romosan *et al*., 2013 in Sweden, where bilateral adnexal masses and bilateral masses lying adjacent to the ovary were common on ultrasound in patients with PID than with other diagnoses p=0.000 (Romosan *et al*., 2013). Similarly, Patel *et al*., 2021 in a case series revealed an association between unilateral or bilateral adnexal masses visualized on ultrasound with diagnosis of PID/TOA (Patel and Crabtree-Burton, 2021).

Kim *et al*., revealed that palpable adnexal mass was associated with pelvic sonographic PID findings in approximately 25% of the patients with clinical diagnosis of PID (Kim *et al*., 2015). Timor-tristch *et al*., found that in patients with PID who underwent transvaginal sonographic examination, there was an association between palpable adnexal findings with acute and chronic PID cases p = 0.03 (Timor-Tritsch *et al*., 1998). The reason for the similarity is because palpable adnexal masses are gross/large pelvic structural abnormalities which are more often than not found at pelvic sonographic evaluation. It is also because most ovarian and tubal sonographic pathologies are palpable on physical examination. Literature shows that palpable adnexal mass and or tenderness are often elicited on physical examination in patients with complicated PID with TOA (Agarwal, 2013).

Relationship between Microorganisms Detected on Endocervical Swabs with Pelvic Sonographic Findings

The study shows that of the 144 patients with clinical diagnosis of PID, 22.90%(33) had *Neisseria gonorrhoeae* diagnosis, 4.86%(7) *Chlamydia trachomatis* diagnosis, and 1.39%(2) were diagnosed with both microorganisms. However, 29.17% (42) patients had laboratory diagnosis of either microorganism. Microorganisms were diagnosed in all sonographic categories.

Additionally, of the women diagnosed with sonographic PID findings, the most microorganisms were found in mixed structural sonographic findings 33.33%(11).

The findings demonstrate that *Neisseria gonorrhoeae* is 4.6 times more common than *Chlamydia trachomatis* among women with clinical diagnosis of PID in our institution. This is contrary to what Reekie *et al*., found in Australia where *Chlamydia trachomatis* was four times more common than *Neisseria gonorrhoeae* and only 1/8th in patients diagnosed with both microorganisms (Reekie *et al*., 2018). Similarly in 2012 WHO reported that among women aged 15 to 49 years with PID, the estimated global prevalence of Chlamydia trachomatis was five times more than Neisseria gonorrhoeae (Savaris *et al*., 2020). The variation in results is because the study was carried out during the COVID-19 era with overuse of Azithromycin which is effective against *Chlamydia trachomatis* but not *Neisseria gonorrhoeae*. Studies have demonstrated various clinical strains of *Neisseria gonorrhoeae* that are resistant to most antibiotics hence its wide spread in untreated patients (Quillin and Seifert, 2018). Additionally, the difference is because this study used a small sample size and for a short study duration.

After adjusting for sociodemographic factors, the study demonstrated a higher likelihood of sonographic PID among women diagnosed with microorganisms (Neisseria AOR = 2.69, 95%CI: 1.12-6.45, p =0.026; Chlamydia AOR = 1.99, 95%CI: 0.39-10.22, p =0.408, Both AOR = 2.30, 95%CI: 0.12-44.84, p =0.582) compared to women without microorganisms. Burnett *et al*., found similar findings where 44% of patients with laboratory confirmed *Neisseria gonorrhoeae* and *Chlamydia trachomatis* had pelvic sonographic PID findings (Burnett *et al*., 2012). However, this study demonstrated that, at 5% level of significance, only diagnosis with *Neisseria gonorrhoeae* was significantly associated with a higher likelihood of diagnosis with sonographic PID compared to absence of microorganisms (p=0.026). This is because *Neisseria gonorrhoeae* has virulence factors that include type IV pili, opacity (Opa) proteins, LOS and the major outer membrane protein porin (PorB). These surface proteins aid in bacterial adherence to the mucosal epithelium but also evades the host immune system by multigene phase variation leading to antigen variation (Chakraborti, 2017,

Lim *et al*., 2021). Mohseni *et al*., in USA found similar results where, having *Neisseria gonorrhoeae* was associated with a high likelihood of PID diagnosis compared to women without any microorganism. Additionally, having *Chlamydia trachomatis* was associated with a lower likelihood of PID diagnosis (Mohseni *et al*., 2020). Reekie *et al*., 2018, showed that there was a high incidence likelihood of PID in women diagnosed with only *Neisseria gonorrhoeae* compared to *Chlamydia trachomatis* (Reekie *et al*., 2018). The similarity in findings to this study could be explained by the same virulence patterns of *Neisseria gonorrhoeae.*

Studies have shown that women with PID have high rates of STIs i.e., gonorrhea and chlamydia (To *et al.*, 2015, Lareau and Beigi, 2008). This is in line with the findings of this study where 29.17%(42) patients had laboratory diagnosis of either gonorrhea or chlamydia.

However, in some instances PID has been shown to result from polymicrobial etiologies including those in the normal vaginal flora (Feuerstein *et al*., 2018, Kreisel *et al*., 2021). This might explain high numbers of participants 36.27%(37) with sonographic PID findings but no *Neisseria gonorrhoeae* or *Chlamydia trachomatis* in this study. This finding is in line with that of Eze *et al*., 2018, where more than three quarters of patients had pelvic sonographic PID findings but no *Neisseria gonorrhoeae* or *Chlamydia trachomatis* isolated (Eze *et al*., 2018). This study tested for only Neisseria and Chlamydia since they are the most common organisms in acute PID (Kreisel *et al*., 2021). Kim *et al*., reported that patients with and without pelvic sonographic PID findings had polymicrobial etiology from culture analysis i.e., Neisseria gonorrhoeae, Chlamydia trachomatis and other anaerobic microorganisms (Kim *et al*., 2015). The similarity is explained by combination of laboratory and sonographic evaluation.

Li and McDermott, 2015 and Kirkcaldy *et al*., 2016 found that PID following gonorrhea infection may be more clinically severe. With the increase in antimicrobial resistance of gonorrhea and its role in development of PID (Kirkcaldy *et al*., 2016, Li and McDermott, 2015), the study on the relationship with pelvic sonographic findings due to this microorganism is important.

PID accounts for 17-40% of gynecological admissions in sub-Saharan Africa. Nigeria has a prevalence of 5.7% and Cameroon 5.2% respectively (Li and Xu, 2021, Nkwabong and Dingom, 2015). The study demonstrates a higher proportion of sonographic PID findings at 41.66% among women with clinical diagnosis of PID.

CONCLUSION, RECOMMENDATIONS, STRENGTH AND LIMITATIONS

Conclusion

1. A high proportion of women with clinical diagnosis of PID have pelvic sonographic PID findings.
2. Patients who have history of STI and/or palpable adnexal mass are more likely associated with sonographic PID diagnosis.
3. Women with PID due to *Neisseria gonorrhoeae* are more likely to have sonographic PID findings.

Recommendations

1. Pelvic sonography should be incorporated in the routine screening of patients with clinical diagnosis of PID.
2. There is need for a longitudinal study to assess the relationship between pelvic sonographic findings with microorganisms.
3. There is need to strengthen community STI screening and use of barrier contraceptive methods to reduce on high rates of infections.

Strengths

1. There is no local data on pelvic sonographic PID findings, their relationship with microorganisms.
2. The study used DNA-PCR for detection of gonorrhea and chlamydia which has a high sensitivity and specificity with a short turn-around time.

Challenges and Limitations

1. The study did not assess other comorbidities which could have affected outcome of sonographic findings.
2. Single study center, so results cannot be generalized to the entire population.
3. Only investigated two microorganisms i.e., *Neisseria gonorrhoeae* and *Chlamydia trachomatis* due to financial constraints.
4. May have overestimated sonographic PID findings by misclassifying neoplastic and physiological ovarian or fallopian tubal findings.
5. There is a possibility of having missed out on high class patients who could have opted for private facilities due to inconveniences of long ques in public hospitals.

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