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MICROBIOLOGICAL PROFILE AND ANTIBIOTIC RESISTANCE TRENDS IN SURGICAL SITE INFECTIONS: RETROSPECTIVE MICROBIOLOGICAL STUDY

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Abstract

Background *UTIs are common clinical complications in women of childbearing age that impose a significant financial strain and quality of life on the healthcare system. Extent of association between pertinent family planning modalities and reduced vulnerability of the lower urinary tract will be a critical outpatient gynecology and preventative care consideration.*

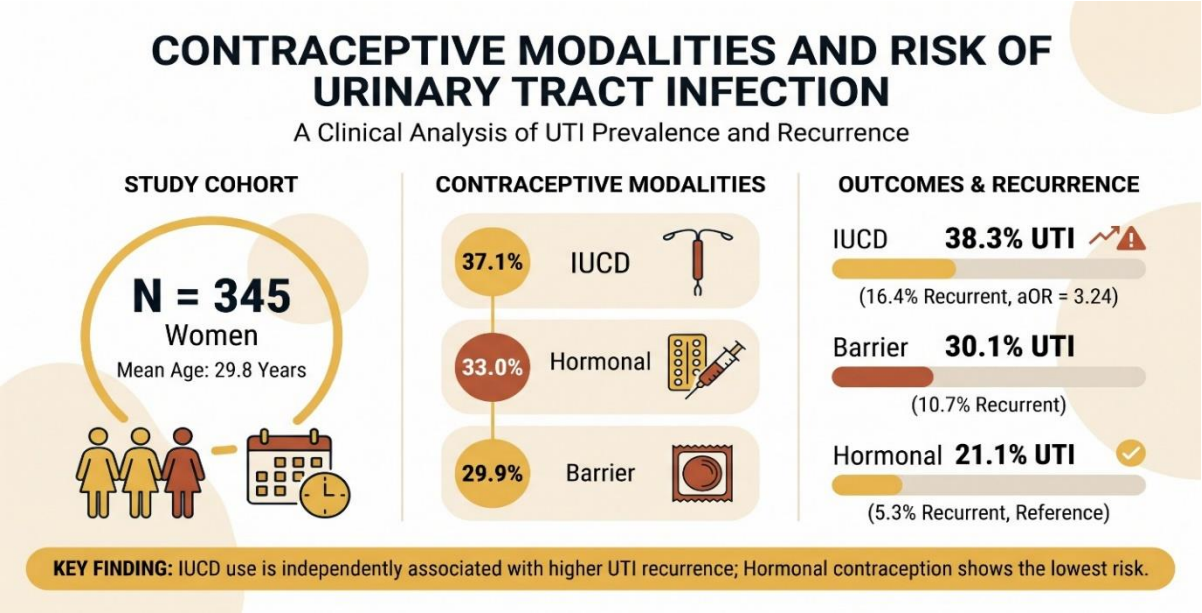
Objective *This paper compared the relationship between specific contraceptive modalities and prevalence and incidence of culture-affirmed urinary tract infections among reproductive-aged women.*

Methods *In a retrospective observational analytical study, the use of archived electronic medical records of 345 eligible women with tertiary outpatient clinics within the Islamabad-Rawalpindi metropolitan area between January 2022 and December 2024 was used. The main exposure was the documented contraceptive technique, which could be classified as intrauterine devices, hormonal and barrier techniques and the main outcome was the presence and relapsing of urinary tract infection, which was confirmed by culture in the study. The Pearson chi-square tests and multivariate binary logistic regression models which included age, parity and body mass*

index and coital frequency and postcoital voiding hygiene were used to assess the data.

Results *Of 345 records analyzed (mean age: 29.8 ± 6.2 years), 30.1% (n = 104) of the subjects had a confirmed urinary infection, and 11.0% (n = 38) had recurrent episodes. Topical infection rates were also quite different across the types of contraceptives used (p = 0.012), the highest prevalence of which was found in individuals who use intrauterine devices (38.3, n = 49), then barrier methods (30.1, n = 31) and hormonal contraceptives (21.1, n = 24). Most of the recurrence was highest in intrauterine device users (16.4, n = 21). The use of intrauterine device was found to be independently related to recurrent infection as opposed to the use of hormonal method (adjusted odds ratio = 3.24, 95% confidence interval: 1.25 -8.41, p = 0.016) whereas barrier methods showed no statistically significant association after adjustment (p = 0.215).*

Conclusion *Contraceptive choice was found to have a significant association with the frequency of urinary tract infections, and intrauterine device use had the best relationship with the frequency of recurrence. Incorporation of personalized urological evaluation in regular family planning counseling sessions can enable the maximization of contraception counseling and avert denizens of recurrence.*



INTRODUCTION

Surgical site infections represent one of the most common, as well as hard-to-treat healthcare-associated infections in the world. Even with consistent improvements in surgical techniques, sterile processing, and sterilization practices in operating theaters, the problem of post surgical infection of wounds is still giving a tremendous burden to health systems both in clinical and economic aspects. These infections often result in patients spending many days in the hospital, unplanned readmissions, frequent wound healing procedures, and increased mortality rates (1). In addition to the physical burden to individuals, the burden on health organizations and families is significant due to a prolonged bed stay, complicated nursing needs, and the second or supportive medical care. In turn, the need to comprehend the factors influencing wound healing and bacterial contamination has become an acute clinical concern in all the branches of surgery (2, 3).

Effective antimicrobial therapy and early diagnosis of surgical site infections depend greatly on the clinical management of the disease. Traditionally, the conventional measures of prevention and early post-surgical antibiotic regimens were reliable preventive strategies against the prevalent bacteria that cause wound decadency. But the ever increasing rates of antimicrobial resistance have crippled the reliability of conventional therapies (4). The same Gram-positive organisms e.g. methicillin-resistant Staphylococcus aureus, and some Gram-negative organisms e.g. extended-spectrum beta-lactamase producers have reduced routine wound complication to a challenging clinical dilemma. The failure of conventional antibiotics to kill these organisms compels them to resort to using reserve agents which usually are more toxic, much more costly, and have a high risk of enhancing broader resistance to drug resistance (5, 6).

One of the main challenges of handling these infections can be traced to the state of fluidity and unpredictability of microbiology in hospitals. The population of bacteria, along with their resistance rates, are not fixed phenomena; they are under continuous evolution in accordance with local prescription rates, patients demographic, and hospital hygiene guidelines. The published sources show that the distributions of pathogens may significantly differ not only across different regions and medical facilities, but also various surgical units within the same hospital. Consequently, general-level internationally applicable guidelines and national surveillance summaries, as helpful as broad guidance, do not necessarily reflect the real-life experiences on the ground experienced by local surgical teams (7). This is because depending on archaic institutional records or regionalized assumptions will subject vulnerable post-operative patients to poor empirical treatment, avoidable delays, and poor recovery results (8).

Although it is known that antimicrobial resistance has turned out to be a growing health concern, much is still unknown about how the profiles of pathogens change with changes in time within a given hospital environment (9). Much of the existing literature gives fixed, single point, snapshots of wound isolates, and they report the frequencies of the pathogen across brief periods, but do not give longitudinal trends. This leaves important clinical questions unanswered: Which particular strains of bacteria are gradually increasing in prevalence? Do resistance rates continue to increase similarly in traditional frontline agents or are some standard antibiotics maintaining their clinical utility? In the absence of comprehensive, ongoing monitoring, clinicians will have to make treatment decisions without a current evidence base, which is more likely to involve a mismatched treatment and ongoing infection (10).

This study serves to fill this important gap by testing the hypothesis that the bacterial spectrum and resistance patterns of surgical site infection isolates have been changing significantly in recent years, so that past empirical antibiotic regimens are becoming less and less successful. To test this hypothesis, a retrospective microbiological study was developed to conduct a systematic identification and analysis of the dynamics of change between bacterial patterns and resistance towards antibiotics among surgical site infection causative microbes over a long period of observation. By illuminating the changing dynamics of local microbial communities and their susceptibility over time, this study seeks to offer clinicians trusted evidence-based information needed to drive future prophylaxis and treatment with antibiotics, maximizing patient recovery, as well as to support institutional antibiotic stewardship (11).

Methodology

This research was intended as a retrospective observational analytical research that makes use of archived electronic medical records and lab databases. The study was placed in the tertiary healthcare network of the metropolitan area of Islamabad-Rawalpindi. This environment was chosen because of the large clinical load, variety of women of reproductive age using different types of family planning modalities, and the present condition of centralized and well-maintained electronic health records combined with centralized services of microbiological diagnosis. The retro review period was three calendar years, January 1, 2022, to December 31, 2024, which has given an adequate think able period to track recurrent urinary tract infections as well as recorded exposure to contraceptive usage. A total of eight months were devoted to the study and divided into a period of thirty-three weeks (March 2025 to October 2025) during which no clinical intervention was done and penetrant auditing and statistical scrutiny of the material were carried out.

The population of the study consisted of non-pregnant women of reproductive age (18-45 years) presenting at outpatient family planning and gynecology clinics within the period of the review.

Conditions for The eligibility were as follows: documentation of current, consistent use of a modern contraceptive method at least six months before the date of the index clinical visit, clinical assessment of the suspicions of the urinary tract infection and alerting urine culture tests within the institutional electronic network. Patients were not included when their records showed they were currently pregnant, in the puerperium in the previous thirty days or had a pre-existing structural or functional urological anomaly, neurogenic bladder, urinary catheterization in the last thirty days or chronic kidney disease or had an active genitourinary malignancy, or was immunosuppressed such as uncontrolled diabetes mellitus and systemic corticosteroid therapy. The a priori sample size was based on standard epidemiology parameters based on having published literature on observations of urinary infection among contraceptive users. Since the expected prevalence of an urinary tract infection was 28.5, the 95% confidence level, the 5% margin of error, and a 10% expected percentage of incomplete records, the 345 women yielded a sufficient statistical power to test the differences between groups of exposure.

Two trained clinical reviewers used a structured digital proforma to extract data. The exposure of interest was identified as the known contraceptive method which was broken down into intrauterine contraceptive devices, hormonal regimens (oral contraceptives, injectables or implants) and barrier methods. The main finding was the noted rate and frequency of urinary tract infections, where recurrence was two episodes or more in six months or three episodes or more in twelve months. Typical diagnostic criteria needed the lower urinary tract symptoms (dysuria, urgency, frequency, or suprapubic pain) to be present and confirmed via laboratory testing, in which not less than 100,000 colony-forming units per milliliter of a single uropathogen with considerable pyuria. The covariates were extracted as maternal age, parity, body mass index, coital frequency, postcoital voiding and daily fluid intake and non-exclusionary systemic comorbidities. The accuracy of data was assured by extracting data twice with a senior investigator re-auditing a random 10 per cent sample of records to ensure consistency in diagnoses.

The systematic approach to managing the methodological biases involved the study design. Consecutive screening of records against uniform eligibility criteria at the time of the review was used to minimize selection bias, instead of using convenience sampling. The bias in information was overcome by using stringent standardized microbiological and clinical thresholds rather than symptoms self-reporting. records that lacked over 5% of essential clinical, laboratory or exposure variables were not used to produce final calculations and formed a complete-case dataset. All the statistical data was done in version 26.0 of IBM SPSS statistics. Continuous variables were normal and represented as means and SDs, and categorical variables were expressed as frequencies and percentages. Pearson chi-square test was used to establish bivariate associations between category groups of contraceptive use and frequency of infection, whilst independent samples t-tests or one-way analysis of variance was used to compare continuous variables across groups. Multivariate binary logistic regression was used to determine independent predictors of re-infection adjusting on the age, parity, fornication, and hygiene. A two sided p-value of 0.05 or less was used as the statistical significance based on a confidence interval of 95%.

The major finding of confirmed infection rate was a direct contribution of the aim of defining urological risks in distinct contraceptive modalities. Since this research did not involve any physical contact with any patient, careful confidentiality was observed when handling data since it was solely based on existing medical files. Individual records were anonymised completely and given unique alpha numerical identification codes, and access limited to the analytical team.

Results

Out of the 362 electronic medical records that were located in the time frame of the study, 17 were filtered based on the absence of clinical or microbiological records above the predetermined limit. The last cohort that was investigated included 345 women who were of reproductive age. The mean of the participants enrolled had an age of 29.8 ± 6.2 with ranges of 18 years to 44 years. The cohort had a mean parity of 1.8 ± 1.1 and an average body mass index of 24.6 ± 3.8 kg/m^2. The majority of the respondents lived in urban areas (62.3%, n = 215) and 35.7% (n = 123) had engaged in more than three episodes of coital per week. Frequent postcoital voiding was observed in 58.0% (n = 200) of the women. Detailed baseline demographic and clinical features of the study population are presented in Table 1.

Assessment of exposure to contraceptives revealed that intrauterine contraceptive devices were the best recorded mode, contributing to 37.1% (n = 128) of the sample. The number of women using hormonal contraceptives was 33.0% (n=114) which included combined oral contraceptives (n=64), progestin-only injectibles (n=38) and subdermal implants (n=12). The remaining 29.9% (n = 103) of the sample comprised of the barrier methods with male condoms as the most common. The complete distribution of contraceptive exposures is outlined in Table 2.

An expert confirmed urinary tract disease episode was recorded in 30.1% of the total population (n = 104) within the period of the review. Of these, 19.1 per cent. of the women actually had isolated non-recurrent infections compared with recurrent urinary tract infections of 11.0 per cent. (n=38). Contraceptive exposure stratification proved that overall highest frequency of infection was among users of intrauterine contraceptive devices (38.3, n = 49), and barrier method users (30.1, n = 31), and hormonal contraceptive users (21.1, n = 24). The same was seen in recurrent infection which was highest among intrauterine device users (16.4, n = 21) as compared to 10.7 percent (n = 11) and 5.3 percent (n = 6) in the barrier group and the hormonal group respectively. Table 3 summarizes the breakdowns of infection frequency and recurrence by contraceptive groups.

Bivariate value analysis showed statistically significant the relationship between the type of contraceptive method and the overall urinary tract infection condition (chi-square = 8.87, degrees of freedom = 2, p = 0.012). There was also a statistically significant difference in the recurrent infection rates among the three groups (chi-square = 8.52, degrees of freedom = 2, p=0.014). In the multivariate binary logistic regression model that has age, parity, BMI, toctile frequency, and 7 days postcoital voiding practices as dependent variables, the intrauterine contraceptive device use was independently related with recurrent urinary tract infection compared to hormonal contraception (adjusted odds ratio = 3.24, 95%-confidence interval: 1.25-8.41, p=0.016). The utilization of barrier methods did not differ with recurrence as compared to hormonal methods (adjusted odds ratio = 1.95, 95% confidence interval: 0.68-5.58, p = 0.215). Recurrence happened to have independent behavioral predictors such as coital frequency more than three times per week (adjusted odds ratio = 2.11, 95% confidence interval: 1.024.36, p = 0.043) and inconsistent postcoital voiding (adjusted odds ratio = 2.38, 95% confidence interval: 1.144.98, p = 0.021). Table 4 shows the overall graphs of the bivariate and multivariate analyses.

Table 1: Baseline Demographic and Clinical Characteristics of the Study Population (N = 345)

Parameter	Value
Age (years), Mean ± SD	29.8 ± 6.2
Parity, Mean ± SD	1.8 ± 1.1
Body Mass Index (kg/m²), Mean ± SD	24.6 ± 3.8
Residential Setting, n (%)	
- Urban	215 (62.3%)
- Peri-urban / Semi-rural	130 (37.7%)
Coital Frequency (>3 times/week), n (%)	123 (35.7%)
Consistent Postcoital Voiding, n (%)	200 (58.0%)
Daily Fluid Intake (<1.5 L/day), n (%)	118 (34.2%)

Table 2: Distribution of Contraceptive Exposure Modalities (N = 345)

Contraceptive Modality	Specific Subtype	Frequency (n)	Percentage (%)
Intrauterine Device (IUCD)	Copper-bearing IUCD	102	29.6%
	Levonorgestrel-releasing IUS	26	7.5%
	IUCD Subtotal	**128**	**37.1%**
Hormonal Contraception	Combined oral contraceptive pills	64	18.6%
	Depot medroxyprogesterone acetate	38	11.0%
	Subdermal etonogestrel implant	12	3.5%
	Hormonal Subtotal	**114**	**33.0%**

Barrier Methods	Male latex condoms	97	28.1%
	Diaphragm with spermicide	6	1.7%
	Barrier Subtotal	**103**	**29.9%**

Table 3: Urinary Tract Infection Incidence and Recurrence Across Contraceptive Groups (N = 345)

Contraceptive Category	Cohort Size (n)	No Infection, n (%)	Non-Recurrent UTI, n (%)	Recurrent UTI, n (%)	Total UTI Positive, n (%)
Intrauterine Device (IUCD)	128	79 (61.7%)	28 (21.9%)	21 (16.4%)	49 (38.3%)
Hormonal Methods	114	90 (78.9%)	18 (15.8%)	6 (5.3%)	24 (21.1%)
Barrier Methods	103	72 (69.9%)	20 (19.4%)	11 (10.7%)	31 (30.1%)
Total Cohort	**345**	**241 (69.9%)**	**66 (19.1%)**	**38 (11.0%)**	**104 (30.1%)**

Table 4: Bivariate and Multivariable Logistic Regression Analysis for Recurrent UTI Predictors

Variable	Unadjusted OR (95% CI)	p-value	Adjusted OR (95% CI)	p-value
Contraceptive Method				
- Hormonal Methods	1.00 (Reference)	—	1.00 (Reference)	—
- Barrier Methods	2.15 (0.77–6.01)	0.143	1.95 (0.68–5.58)	0.215
- Intrauterine Device	3.53 (1.37–9.09)	0.009	3.24 (1.25–8.41)	0.016
Age (per year increment)	0.99 (0.94–1.05)	0.774	0.98 (0.93–1.04)	0.582
Parity (≥2 vs <2)	1.28 (0.64–2.56)	0.485	1.15 (0.55–2.41)	0.710
Coital Frequency (>3/week)	2.45 (1.22–4.91)	0.012	2.11 (1.02–4.36)	0.043
Postcoital Voiding (Absent)	2.61 (1.29–5.28)	0.008	2.38 (1.14–4.98)	0.021

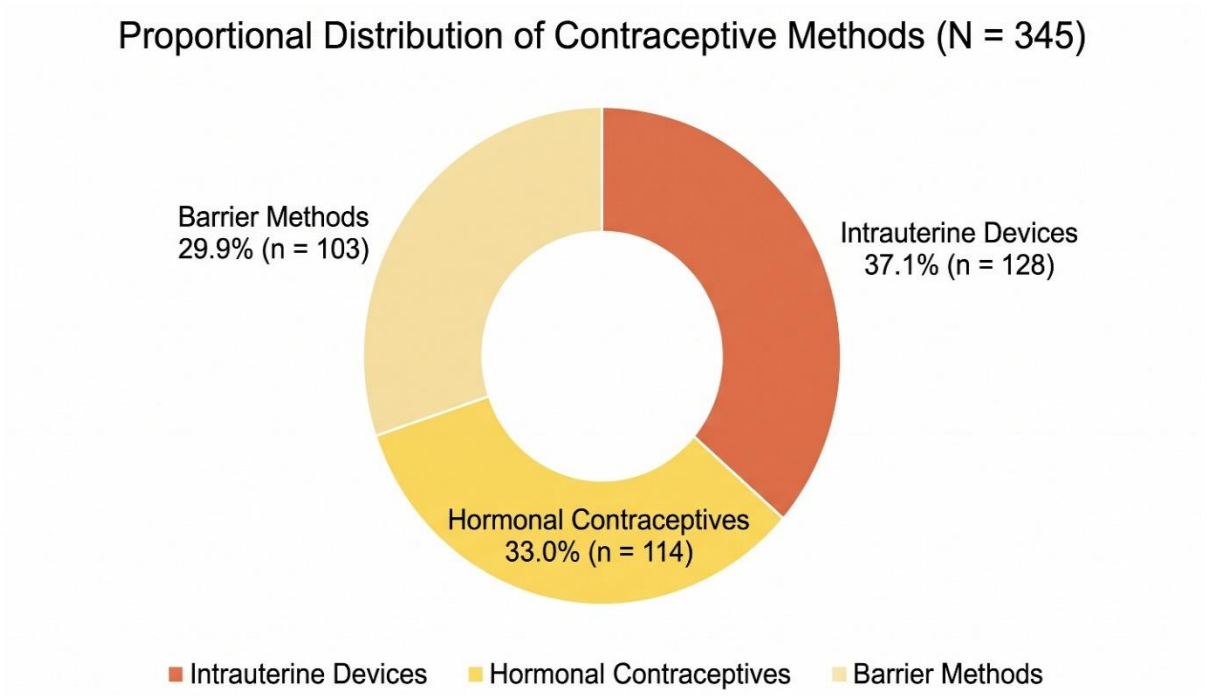


Figure 1 Proportional Distribution of Contraceptive Methods

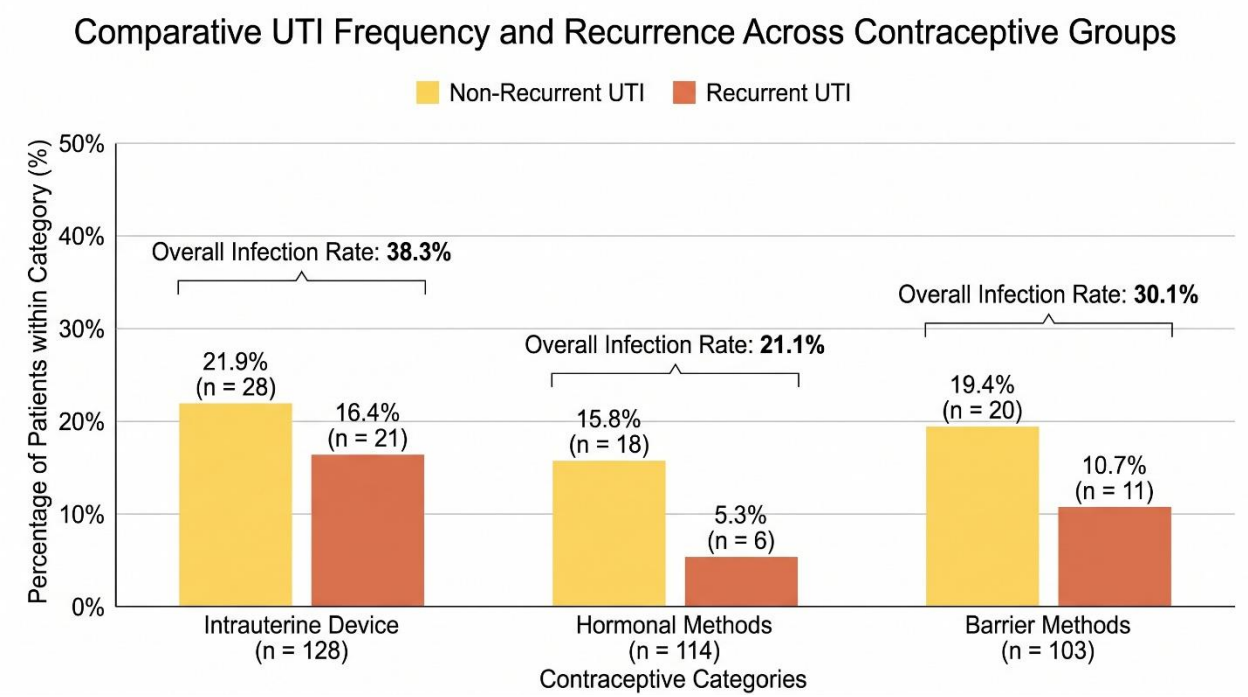


Figure 2 Comparative UTI Frequency and Recurrence Across Contraceptive Groups

Discussion

The main conclusions of this descriptive study showed a strong difference between the prevalence and recurrence rate of culture-confirmed UTI with different contraceptive methodologies. Women who have used intrauterine birth control gadgets had the worst burden of isolated/recurrent episodes of uropathogenesis, with the fewest too who have fed on hormonal contraception, had the least infection rates (12). Users of barrier methods were in an intermediate position which was mitigated after multivariate adjustment. In addition, behavioral variables, namely, a rate of more than three coital episodes per week and a lack of postcoital voiding habit became strong independent predictors of recurrent infection. These findings supported the first hypothesis that contraceptives as well as comorbid behavioral habits were a significant differentiating factor of urological susceptibility in reproductive-aged women (13).

The higher incidence of recurrent infection in the users of intrauterine devices was in line with a number of earlier epidemiological analyses that reported higher levels of lower urinary tract colonization after the placement of the device. Mechanistically, this susceptibility was often associated with the actual structure of the cervical retrieval strings, which could serve as a framework to support the microbial biofilms and the ability of the perineal pathogen to ascend into the surrounding urogenital mucosa (12). Although certain literature indicated that levonorgestrel-releasing systems could reverse this effect by making the cervical mucus thickening and stabilizing the local mucosal barriers, the existence of copper bearing devices in the analyzed population was largely predominant, which may have contributed to the increased risk profile in this cohort. A biological explanation of the high odds ratio obtained in the regression model would be the persistent foreign body effect and localized micro-inflammatory changes unique to non-hormonal intrauterine devices.

On the other hand, the much lower rate of infection reported among the group receiving hormonal contraceptives was compared to the previous historical records which had indicated that the patient was more at risk of having bacteriuria due to steroid-induced alterations in the periurethral adherence of the epithelial cells. Newer studies resolved this discrepancy by showing that modern low dose oral preparations and depot progestins did not interfere with the positive vaginal lactobacilli populations and the acid vaginal pH necessary to inhibit the growth of Gram-negative uropathogen in the vagina. Stable hormonal data and eliminating the physical stimulation of irritation of foreign body which was typical of

intra-cervical devices seemed to give modern hormonal systems a comparative advantage in terms of lower urinary tract stability (14, 15).

The analysis of the barrier techniques provided a subtle approach among the general set of literature. Barrier contraception as a significant predisposing factor in urinary tract infections was always cited in classical studies, but that relationship was mainly because of the use of spermicidal compounds that contained nonoxynol-9, which was known to eliminate protective lactobacilli. Whereas, in the current group, the enormous number of barrier users used non-medicated male condoms and this explained the finding that barrier use was not significantly linked to re-infection after adjusting it by sex and its voiding hygiene (16, 17). This observation contributed to confirming the fact that mechanical barriers alone did not necessarily undermine urinary defenses as was the case with chemical agents or foreign devices (18).

The independent relationships were found between coital frequency and postcoital voiding that supported the existing urological concepts of mechanical bacteria translocation. The literature reported frequent intercourse in order to support the retrograde passage of perineal organisms to the female urethra, and delayed voiding to inhibit the physiological flushing of the bladder urothelium, preventing bacterial adhesion to the bladder lining. The clinical implications of these results highlighted the importance of integrating personalized urological risks assessment on reproductive health consultation (19). All of these indicators are useful as shown by clinicians who advised patients in selecting contraceptives, especially when these people had recurrent issues with urination (20, 21).

This study had a number of the methodological strengths that supported its validity. The use of centralized electronic health records and imposition of stringent diagnostic criterion in terms of clinical presentation and quantitative confirmation of the culture, removed the information bias that characterizes studies relying on self-reported symptoms. Moreover, the behavioral covariates have been extracted systematically, which allowed the multivariable adjustment of the independent effect of contraceptive exposure independent of the confounding lifestyle covariates (22, 23).

However, there were some constraints, which were worth mentioning. The retrospective nature of the design preemptively prevented any longitudinal observations of short-term microbial changes and a conclusive determination of cause-and-effect sequences. Granular data about the volume of fluid intake, detailed sexual behaviors, or specific sub-strains of uropathogens were not always documented in clinical information about archived charts. Also, since the research was conducted in an urban-metropolitan tertiary referral facility, the studied population might have been more concentrated to symptomatic women as opposed to community-based cohorts. Further mechanistic insight into these observed relationships would be achieved through future studies that used prospective designs and sequenced vaginal microbiomes and characterize biofilms long-term on explanted devices (24).

Conclusion

This paper shows that contraceptive decision is a major factor of risk and recurrence in urinary tract infections with the highest vulnerability of contraceptive use in intrauterine devices and the lowest in hormonal contraceptives. Combined with the independent effects of frequent intercourse and delayed postcoital voiding, these results highlight the need to incorporate individualized urological risk-profile into routine family planning visits. Recurrent infections and poor patient complyments can be significantly decreased through identification of individual clinical predispositions and matching the selection of contraceptive methods with specific behavioral counseling, as far as long-term reproductive health outcomes may be improved.

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