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Frequency and Incidence of Bacterial Infection in the Female Reproductive System

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ABSTRACT

This study aimed to assess the frequency and incidence of bacterial infections in the female reproductive system, particularly focusing on vaginal infections. The research involved the analysis of high vaginal swab and urine samples from a population of women presenting with various gynecological concerns. Notably, the study investigated the prevalence of bacterial vaginosis (BV), candida, and trichomonas in both symptomatic and asymptomatic cases. Several crucial findings emerged from the research. First, there was a high prevalence of pus cells (90.0%) observed, which could indicate underlying inflammation or infection. Concurrently, yeast cells were detected in a substantial 86.0% of cases, suggesting a notable presence of yeast infections among the study participants. Age-wise analysis revealed an intriguing pattern, with the 26-30 age group standing out in terms of significant bacterial growth. This age group recorded the highest count of samples with such growth (15), potentially highlighting a higher susceptibility to bacterial infections within this demographic. *Candida albicans* emerged as a dominant microorganism with a frequency of 47.6%, implying a significant presence of this yeast and potential fungal infections within the study population. The study examined antibiotic sensitivity patterns among bacterial isolates. This analysis underscored the need for tailored antibiotic treatments, as there were varying degrees of sensitivity and resistance to different antibiotics among the isolates. The findings emphasize the importance of personalized approaches to antibiotic therapy based on the specific bacterial species and their susceptibility patterns. This study contributes valuable insights into the frequency and incidence of bacterial infections in the female reproductive system. The prominent tables, including the prevalence of pus and yeast cells, the age-specific susceptibility to bacterial infections, the dominance of *C. albicans*, and the antibiotic sensitivity patterns, collectively enhance our understanding of women's reproductive health and emphasize the significance of individualized medical interventions.

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***Keywords*: ** Bacterial infections, Vaginal infections, Pus cells, Yeast infections, *Candida albicans*, Antibiotic sensitivity

1. INTRODUCTION

The vaginal is a delicate and complicated environment, hosting various microbial species in varying quantities and proportions (Vitali et al., 2017; Leonardi et al., 2020). This complex balance of microorganisms is responsible for maintaining normal vaginal flora, which can be influenced by various life events (Wessels et al., 2018). Vaginitis encompasses a range of conditions that lead to symptoms such as itching, burning, irritation, odor, and vaginal discharge (Chee et al., 2020). The dominant microbial species, Lactobacillus, plays a crucial role in maintaining the vaginal pH at an acidic level. It's important to note that the presence of other bacteria, including *Gardnerella vaginalis*, group B streptococci, and *Escherichia coli*, referred to as commensal bacteria (Laren and Monif, 2001), do not necessarily indicate infection (Wessels et al., 2018). Research by Wessels et al. (2021) suggests that *E. coli* is present in approximately 21% of normal, pre-menopausal, non-pregnant, asymptomatic women. Additionally, certain microorganisms like *Neisseria gonorrhoeae*, *Streptococcus pyogenes, Streptococcus pneumonia*, *Haemophilus influenza, Listeria monocytogenes*, and *Trichomonas vaginalis* are not typically part of the female genital tract flora but have the potential to cause disease in the vaginal/endocervical area due to their inherent biological properties (Pelzer et al., 2018). However, the mere presence of these properties doesn't guarantee disease occurrence (Happel et al., 2020).

Vaginal infections can be caused by microorganisms, but preventive measures, such as wearing loose, absorbent underwear, can help reduce the risk of infection (Madere & Monaco, 2022). Vaginitis is characterized by inflammation of the vagina, and vulvovaginitis involves inflammation of the external female genital organs. Various factors, including infection, hormonal imbalances, mechanical irritation, and allergic reactions, can contribute to vaginitis. It often leads to discomfort and can become quite painful, resulting in changes in vaginal discharge, itching, odor, and other symptoms (Al-Nasiry et al., 2020). Normal vaginal discharge typically has a mild odor and appears clear, white, or yellow, serving the purpose of keeping the vagina clean and moist. Some women may experience a few days of heavy, clear, slippery discharge around the midpoint of their menstrual cycles, which occurs when an ovary releases an egg. Among the most common vaginal infections are yeast infections (monilia or Candida) and bacterial vaginosis (Yu et al., 2020; Villa et al., 2020).

Vaginal infections often manifest through symptoms like vaginal discharge, discomfort, and vaginal odor, frequently accompanied by itching, redness, and sometimes burning and soreness (Amabebe & Anumba, 2020). It's essential to note that these symptoms don't exclusively point to an infection; they can also result from other factors affecting the vagina. For instance, irritants such as chemicals or various materials like hygiene products, bubble bath, laundry detergents, contraceptive foams and jellies, and synthetic underwear can lead to vaginal irritation, triggering a discharge and discomfort. This form of inflammation is referred to as noninfectious (inflammatory) vaginitis. Moreover, a vaginal discharge might stem from conditions affecting other reproductive organs rather than just the vagina itself (Peric et al., 2019).

Sexually transmitted diseases like chlamydial infection or Gonorrhea gingelmaier (Mirmonsef et al., 2012) can cause a discharge, as the bacteria responsible can spread from the vagina to the cervix and uterus, leading to pelvic inflammatory disease (Fichorova et al., 2020). Genital herpes, characterized by blisters on the vulva, within the vagina, and on the cervix, can also result in a vaginal discharge. The course of treatment depends on the underlying cause, and medical professionals typically perform examinations using vaginal or cervical fluid samples to detect microorganisms responsible for infections (McKinnon et al., 2019).

Diagnosing bacterial vaginosis, candida, and trichomonas presents a significant challenge, primarily because most cases manifest no symptoms, as highlighted in a report from the Centers for Disease Control and Prevention (Mohammadzadeh et al., 2015). When an infection is suspected, diagnostic tests are essential to confirm the presence of bacterial overgrowth in the vagina. These tests typically include a pelvic examination, an analysis of vaginal secretions, and a pH test to assess vaginal acidity. Self-testing kits are also available, enabling individuals to monitor vaginal pH levels (Campisciano et al., 2018; Łaniewski et al., 2020; Dabee et al., 2021; Byrne et al., 2021). Normal vaginal discharge is usually clear or slightly cloudy and serves as a natural cleaning mechanism for the vagina. Its appearance and consistency can vary throughout the menstrual cycle, ranging from minimal thin or watery discharge to thicker and more abundant secretion. Globally, an estimated minimum of 150 million symptomatic cases of vaginal infections is reported annually, although the true incidence is likely underestimated due to many vaginal infections resolving without medical intervention (Sabo et al., 2020; Masson et al., 2020; Brandão & Gonçalves-Henriques, 2020; Taylor et al., 2021; Chadchan et al., 2019). Notably, the prevalence of vaginal infections tends to be higher in females compared to males.

The objective of this study was to determine the rate and frequency of bacterial infections in the female vaginal tract within the studied population. It sought to establish the prevalence of bacterial vaginosis (BV), candida, and trichomonas among females presenting with vaginal discharge, as well as investigate the specific microorganisms responsible for both symptomatic and asymptomatic cases of bacterial vaginosis. This research aims to enhance our understanding of these infections and their prevalence within the female population.

2. RESULT/EXPERIMENTAL

2. 1. Research Methodology

The research was conducted at Elim Medical Center Laboratory, located in Isale Ake, Abeokuta. It was a retrospective study that focused on a sample of 20 patients. Additionally, data from high vaginal swab culture and sensitivity records of 30 patients were collected for analysis. These records were gathered from cases observed between January and March. The study involved the examination of high vaginal swab specimens obtained from a total of 50 patients. These specimens were sourced from patients who had sought medical evaluation not only at the laboratory but also from various peripheral clinics within the metropolitan area under the guidance of medical professionals.

HVS sample

The research involved a wet preparation of each vaginal swab specimen. This process included adding a few drops of physiological saline to a test tube, followed by shaking and placing a small amount of the solution on a grease-free slide for microscopic examination. Subsequently, the Gram staining technique was employed to determine the Gram reaction of each sample. To facilitate further analysis, dilution procedures were carried out. This involved transferring one milliliter from a 10^{-1} dilution into a fresh tube containing nine milliliters of Ringer's solution, resulting in a 10^{-2} dilution.

The next step was the inoculation of the samples onto chocolate agar, MacConkey's agar, and chocolate agar, following established standard protocols as described by Taylor et al. (2021). The Petri dishes containing the inoculated media were then incubated at 37 °C for a duration of 24 hours. Additionally, the chocolate agar media were subjected to anaerobic incubation. For further analysis, duplicate plates of plate count agar (PCA) were inoculated from each dilution and incubated aerobically at 37 °C for 24 hours. The colony counts that yielded bacterial growth equal to or greater than 10^5 colony-forming units per milliliter (cfu/ml) of pure isolates per milliliter were recorded as demonstrating significant growth. To identify different morphological colonies from the plate count, subculture procedures were followed, involving repeated streaking onto nutrient agar slants. These slants were then incubated at 37 °C for a period ranging from 24 to 48 hours to facilitate the further characterization of the isolates.

Urine sample

The urine samples obtained underwent a specific preparation process. Initially, a volume of 10-15 milliliters was centrifuged in a test tube to separate the sediment from the supernatant. After discarding the supernatant, the sediment was carefully mixed by tapping, and a drop of it was placed on a grease-free slide. A cover glass was then used to cover the drop, and microscopy was conducted using the 10x and 40x objectives to detect various elements, including white cells (pus cells), red cells, yeast cells, casts, and epithelial cells. Following the microscopy examination, the urine samples were thoroughly mixed and streaked onto both chocolate and MacConkey agar plates.

These agar plates were subsequently incubated overnight at 37 °C to facilitate the isolation of both gram-positive and gram-negative organisms. Bacterial colonies that grew on the MacConkey agar after the incubation period were further sub-cultured onto nutrient agar plates. These sub-cultured plates were then incubated at 37 °C for a duration of 24 hours. To determine the identity of suspected bacterial species, standard bacteriological methods were employed for characterization and identification.

Biochemical characterization and identification of bacterial isolates

The bacterial colonies were subjected to a detailed examination, considering various aspects of their appearance, including shape, elevation, edge, and pigmentation. The characterization of these bacterial isolates followed established methods, as outlined by Cheesbrough (2000) and cited by McKinnon et al., (2019). The colonial characteristics observed on chocolate agar and MacConkey agar plates were assessed. Additionally, the Gram reaction of the isolates was determined to categorize them as either Gram-positive or Gram-negative bacteria. Further biochemical tests were conducted to refine the characterization process. These tests encompassed catalase, coagulase, indole, urease activity, and motility tests. Each of these tests played a crucial role in identifying and categorizing the bacterial isolates based on their unique biochemical profiles.

Gram Reaction: The Gram reaction was employed to classify the bacterial isolates into either Gram-positive or Gram-negative bacteria following an examination of the agar plates. The process involved several key steps:

1) A thin smear of a young bacterial culture, typically 18-24 hours old, was prepared on a clean, grease-free glass slide.
2) The smear was allowed to air dry, and then it was heat-fixed by passing it through the flame of a Bunsen burner approximately three times. This step ensured that the bacterial cells adhered firmly to the slide.
3) The heat-fixed smear was covered with crystal violet stain for a duration of 30 to 60 seconds. This stain helps in the initial staining of the bacterial cells.
4) After the staining with crystal violet, the stain was quickly washed off with clean water. The water was gently tipped off, and the smear was subsequently covered with Lugol's iodine for another 30 to 60 seconds. Lugol's iodine is used to form complexes with crystal violet within the bacterial cells.
5) Following the iodine treatment, the smear was washed again with clean water to remove excess iodine.
6) To differentiate between Gram-positive and Gram-negative bacteria, the smear was then rapidly decolorized for about 20 seconds using 95% ethanol.
7) The smear was once again washed with clean water to halt the decolorization process.
8) Finally, the slide was covered with dilute carbol fuchsin stain for 30 seconds, which serves as a counterstain.
9) After washing off the carbol fuchsin stain with clean water, the stained slide was allowed to air dry at room temperature.
10) The Gram-stained slide was examined under the microscope, initially using the 40x objective lens to check for staining and the distribution of the Gram-stained bacteria. Subsequently, the slide was observed with the oil immersion objective lens (100x) to closely examine the bacterial cells.

During the examination, Gram-positive bacteria appeared purple, while Gram-negative bacteria appeared red or pink. This staining technique allowed for the differentiation and classification of bacterial isolates based on their Gram reaction.

2. 2. Results

The presented data from Tables 1 and 2 reveals significant insights into women's reproductive health. In Table 1, microscopic examination of high vaginal swab and urine samples shows that the "Significant sample" category exhibits notable patterns. Epithelial cells constitute a high percentage (70.0%), possibly indicating a normal vaginal environment. However, the prevalence of pus cells (90.0%) suggests potential inflammation or infection, while the presence of yeast cells (86.0%) hints at yeast infections in these cases.

Table 1. Microscopic Examination of High vaginal swab & urine samples.

	Significant sample	Scanty sample	No sample
Epithelial cells (%)	70.0	18.0	12.0

Pus cells (%)	90.0	4.0	6.0
Yeast cells (%)	86.0	10.0	4.0

Field Study, 2021

Table 2 provides demographic data stratified by age groups, douching methods, and the number of sex partners. Douching practices vary among age groups, with specific age groups favoring different methods such as antiseptic soap and water. Additionally, the number of sex partners varies across age groups, with implications for reproductive health. These findings emphasize the need for further research to understand the complex relationships between age, douching practices, and the presence of specific cells in high vaginal swab samples, which could have significant implications for women's health.

Table 2. Demographic Data stratified by douching methods and number of sex partners.

Age range	No of vaginal swabs & urine sample examined	No of sex partners (0-30)	Douching with antiseptic soap (%)	Douching with antiseptics (%)	Douching with water (%)
20-25	15	2-8	33.3	20	46.6
26-30	22	1-15	59	22.7	18.1
31-40	13	0-7	30.7	15.3	53.8
Total	50	30	22	10	18

Field Study, 2021

Figure 1 provides valuable insights into the distribution of microorganisms isolated from high vaginal swab (HVS) and urine samples, with a focus on age groups. The data is categorized into three distinct age groups (20-25, 26-30, and 31-40), alongside a total count. Notably, the 26-30 age group emerges as a key focal point in the findings. This age group had the highest number of samples examined (22) and exhibited the highest count of samples with significant bacterial growth (15), indicating a potential vulnerability to bacterial infections. Additionally, this group also had the highest count of samples with scanty growth (7), suggesting a range of microbial dynamics in this demographic. Furthermore, yeast growth is presented as a percentage, and it's intriguing to note that the 26-30 age group had the highest percentage of samples with yeast growth (55.5%).

This could signify a higher susceptibility to yeast infections within this age cohort. Overall, these findings underscore the importance of considering age as a significant factor in understanding microbial patterns in HVS and urine samples, emphasizing the need for further research to elucidate the clinical implications of these microbial variations and their potential impact on women's reproductive health.

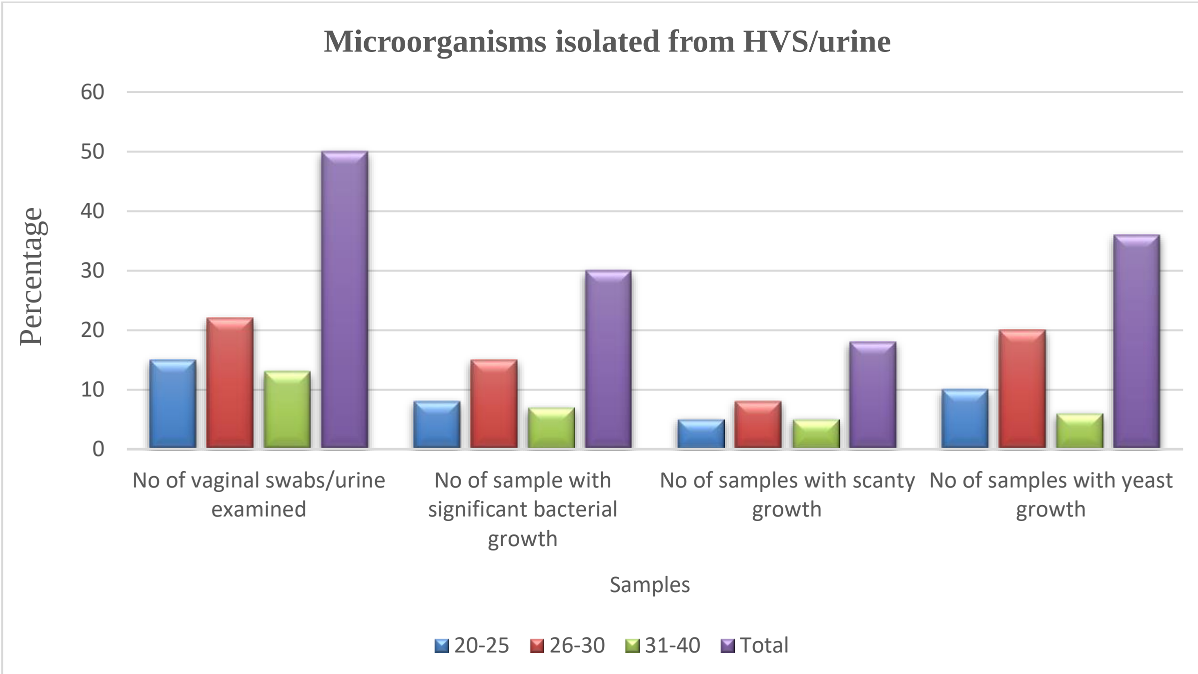

Figure 1. Distribution of microorganisms isolated from HVS/urine samples.

Table 3 provides a comprehensive overview of the occurrence of various microorganisms isolated from both vaginal swab and urine samples. Notably, *Candida albicans* (*C. albicans*) stands out with the highest frequency at 47.6%, indicating a significant presence of this yeast in the samples, suggesting potential fungal infections in the study population. *Escherichia coli* (*E. coli*) follows with a frequency of 23.8%, implying the presence of this bacterium in the samples, which could be associated with urinary tract or vaginal infections. It's noteworthy that other microorganisms, including Chlamydial, Trichomonas, Gonorrhea, *Proteus* spp, Beta haemolytic, and *Klebsiella* spp, showed no occurrence in the examined samples. This absence could have implications for disease prevalence and healthcare interventions. Overall, the table underscores the importance of microbial surveillance in women's reproductive health, with the need for further investigation to understand the clinical significance and potential treatment implications of these microbial patterns.

Table 3. Occurrence of Microorganisms isolated from vaginal swabs & urine samples.

Organism	Frequency (%)	Total swab sample	Total urine sample
E. coli	23.8	35	15
S. aureus	11.9	35	15
C. albicans	47.6	35	15

Chlamydial	9.5	35	15
Trichomonas	4.7	35	15
Gonorrhea	0	35	15
Proteus spp	0	35	15
Beta haemolytic	0	35	15
Klebsiella spp	2.3	35	15

Field Study, 2021

Table 4 presents the prevalence of various organisms at different age groups. In the 20-25 age group, Candida spp was the most prevalent organism, with 10 cases observed. This suggests a relatively high occurrence of fungal infections in this age category. *E. coli* was also detected in 5 cases, indicating potential bacterial infections, and there was one case of Staph aureus. Notably, Trichomonas, Chlamydia, and *Klebsiella* spp were absent in this age group. Moving to the 26-30 age group, *Candida* spp remained prevalent with 4 cases, though at a lower frequency than the 20-25 age group.

E. coli was observed in 2 cases, and there was one case each of *Klebsiella* spp and Trichomonas. *Staph aureus*, Chlamydia, and Gonorrhea were not detected in this age group. In the 31-40 age group, *Candida* spp continued to be prevalent with 6 cases. *E. coli* was observed in 3 cases, *Klebsiella* spp in 4 cases, and Trichomonas in 2 cases. *Staph aureus* and Chlamydia were also detected once each in this age group. In total, across all age groups, there were 40 cases examined.

The combined prevalence of various organisms in these age groups highlights the varying susceptibility to microbial infections across different age categories. Further analysis and investigation are necessary to understand the clinical implications of these findings and to tailor healthcare interventions accordingly.

Table 4. Organism prevalence at different age groups.

Age group	20-25	26-30	31-40	Total
ORGANISMS				
Candida spp	10	4	6	20
E. coli	5	2	3	8
Staph aureus	1	0	4	5
Klebsiella spp	0	1	2	3
Trichomonas	0	2	1	3

Chlamydia	0	0	1	1
Total	16	7	17	40

Field Study, 2021

Table 5 provides valuable insights into the antibiotic sensitivity patterns of bacterial isolates, specifically *E. coli* and *S. aureus*, with a focus on the percentage of sensitivity and resistance to a range of antibiotics. Analyzing the data, we find that *E. coli* displayed varying degrees of sensitivity and resistance to different antibiotics. Gentamycin showed the highest sensitivity at 60.0%, while Colistin and Tetracycline exhibited lower sensitivity percentages of 10.0% and 20.0%, respectively. Ampicillin and Penicillin's had equally low sensitivity percentages of 10.0%. Streptomycin and Contrimoxaxole displayed intermediate sensitivity percentages of 30.0% and 40.0%, respectively. Chloramphenicol had a sensitivity of 20.0% among E. coli isolates. In contrast, *S. aureus* demonstrated a distinct antibiotic sensitivity pattern. Gentamycin had a relatively high sensitivity percentage of 60.0%, while Colistin and Tetracycline exhibited a lower sensitivity of 20.0%. Ampicillin and Penicillin's showed sensitivities of 20.0% and 40.0%, respectively. S. aureus displayed better responsiveness to Streptomycin and Contrimoxaxole, with both antibiotics having 80.0% sensitivity. Chloramphenicol also exhibited a relatively high sensitivity of 80.0% among S. aureus isolates.

These findings underscore the importance of tailoring antibiotic treatment to the specific bacterial species and their susceptibility patterns to ensure effective therapy while minimizing the risk of antibiotic resistance development. Further research and clinical evaluation are warranted to inform antibiotic selection for infections caused by these bacterial isolates, the result here is inine with the findings from Dabee et al., (2021).

Table 5. Antibiotic sensitivity pattern of bacterial isolates.

Antibiotics	Percentage (%) of sensitivity of isolates to various antibiotics	
	E. coli (n = 10)	*S. aureus* (n = 5)
	Sensitive resistance	Sensitive resistance
Gentamycin	60.0 - 20.0	60.0 - 20.0
Colistin	10.0 - 70.0	20.0 – 40.0
Tetracycline	20.0 - 60.0	20.0 – 80.0
Ampicillin	10.0 - 60.0	40.0 – 80.0
Penicillins	30.0 - 40.0	20.0 – 80.0
Streptomycin	40.0 - 80.0	20.0 – 60.0

Contrimoxaxole	20.0 - 70.0	20.0 – 100.
chloramphenicol	20.0 - 90.0	20.0 80.0

Field Study, 2021

3. DISCUSSION

The data presented in this study provides significant insights into the frequency and incidence of bacterial infection in the female reproductive system. The examination of high vaginal swab and urine samples in the first section reveals distinct cellular patterns, with notable percentages of epithelial cells indicating a potentially normal vaginal environment. However, the prevalence of pus cells suggests the possibility of inflammation or infection, while the presence of yeast cells hints at potential yeast infections. In the following section, demographic data stratified by age groups, douching practices, and the number of sex partners unveils the diversity in women's reproductive health behaviors. Variations in douching methods and the number of sex partners underscore the importance of considering these factors in reproductive health research. The distribution of microorganisms in the subsequent section, particularly across age groups, highlights the 26-30 age group as a focal point. This group shows higher counts of significant bacterial growth and yeast growth, indicating potential vulnerability to bacterial and fungal infections. Furthermore, the prevalence of various microorganisms, with Candida albicans being the most frequently detected, suggests variations in disease prevalence and healthcare considerations. Exploring the prevalence of different organisms across age groups underscores differences in susceptibility to microbial infections, emphasizing the need for tailored healthcare interventions and further research to understand the clinical implications of these patterns. Lastly, the antibiotic sensitivity patterns of bacterial isolates, specifically E. coli and S. aureus, inform antibiotic selection for treatment. These patterns stress the importance of precise therapeutic approaches to ensure effectiveness while minimizing the risks of antibiotic resistance.

4. CONCLUSIONS

In conclusion, the comprehensive data presented here contributes significantly to our comprehension of various dimensions of women's reproductive health. It provides crucial insights into the cellular composition of vaginal and urine samples, shedding light on the state of the vaginal environment and potential infections. Understanding these cellular patterns is fundamental for diagnosing and managing reproductive health issues. Moreover, the demographic data, particularly the breakdown by age groups, douching practices, and the number of sex partners, underscores the multifaceted nature of women's reproductive health.

This diversity in behaviors and practices among different age groups highlights the need for personalized healthcare interventions that consider individual circumstances and risk factors. The distribution of microorganisms across age groups underscores the importance of age as a significant factor in reproductive health. The varying susceptibility to microbial infections among different age cohorts suggests the importance of age-specific healthcare strategies and preventative measures.

The prevalence of specific microorganisms, such as *Candida albicans* and *Escherichia coli*, provides valuable information for clinicians and researchers alike. These findings can inform targeted treatment approaches and guide the development of interventions to address prevalent infections effectively. Furthermore, the antibiotic sensitivity patterns of bacterial isolates highlight the importance of judicious antibiotic use. Tailoring antibiotic treatments based on the specific bacterial species and their susceptibility patterns is essential to ensure effective therapy while mitigating the risk of antibiotic resistance.

Recommendations

Promoting improved hygiene practices is key to reducing asymptomatic lower genital tract infections, such as bacterial vaginosis. Public education campaigns should emphasize the dangers of self-medication with antibiotics and discourage indiscriminate antibiotic use. Preventing overcrowding in facilities, particularly restrooms, can help minimize the spread of bacterial and yeast infections among women. Encouraging condom use or abstinence among female undergraduates can play a pivotal role in reducing sexually transmitted infections, including BV. Additionally, teaching proper hygiene techniques, like wiping from front to back after using the toilet, can mitigate the transfer of microorganisms from the bowel to the vagina, thereby reducing asymptomatic BV infections. Raising awareness about the risks associated with douching, especially with antiseptics, is crucial, as it is often misconceived as a healthy hygiene practice. Timely reporting of any lower genital tract infection symptoms is essential for prompt laboratory investigation and treatment to prevent potential complications. Discouraging multiple sexual partners and advocating for protective barriers like condoms is vital. Regarding screening and treatment of BV in pregnant women, recommendations vary based on symptoms and risk factors. Symptomatic pregnant women should be tested and treated, while asymptomatic women without risk factors should not undergo routine screening. Women at increased risk for preterm birth may benefit from screening and treatment with specific antibiotics, followed by a one-month post-treatment follow-up to ensure a cure.

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