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Prevalence, Demographics, and Bacterial Susceptibility of Parasitic Gingivitis in Patient

Mohammad Othman Alkurbi*

**Laboratory Medicine Department, Faculty of Applied Medicap Sciences, Umm Al Qura University, Makkah 21955, Saudi Arabia, mokurbi@uqu.edu.sa .*

**Corresponding author*

Mohammad Othman Alkurbi, PhD

mokurbi@uqu.edu.sa

Laboratory Medicine Department

Faculty of Applied Medicap Sciences

Umm Al Qura University

Makkah 21955

Saudi Arabia

Abstract

Background and Aims: Gingivitis is a prevalent oral disease that can lead to serious health complications if left untreated. In this study, we aimed to investigate the prevalence, demographics, and bacterial susceptibility of parasitic gingivitis in patients from Hajjah, Yemen.

Methods: A cross-sectional study was conducted on 500 patients with gingivitis from different regions of the Hajjah government of Yemen. Microscopic examination and bacterial culture were used to identify the parasitic and bacterial species associated with gingivitis. Antibiotic susceptibility testing was performed to determine the sensitivity, moderate responsiveness, and resistance of bacterial species to commonly used antibiotics.

Results: The study found a high prevalence of parasitic and bacterial infections in patients with gingivitis in Hajjah, Yemen. Entamoeba gingivalis was the most common parasitic organism detected, while Porphyromonas gingivalis and Tannerella forsythia were the most common bacterial species found. The study revealed a strong association between the presence of these microorganisms and gingival inflammation. The study also identified a symbiotic relationship between the presence of the E. gingivalis parasite and certain bacterial species in the mouth. The study's results emphasize the need for effective prevention and treatment strategies to address parasitic gingivitis in different age groups.

Conclusion: The study provides valuable insights into the demographics, bacterial species, and antibiotic sensitivity involved in parasitic gingivitis, which can inform the development of effective prevention and treatment strategies for the disease. The high prevalence of E. gingivalis parasite infection found in the study emphasizes the need for effective prevention and treatment strategies to address this health concern. The study's findings highlight the importance of good oral hygiene, regular dental checkups, and appropriate periodontal treatment to prevent complications associated with parasitic and bacterial infections in patients with gingivitis. The results emphasize the critical role of antibiotic susceptibility testing in guiding the selection of the appropriate antibiotic and combating antibiotic resistance.

Keywords: Gingivitis, Porphyromonas gingivalis, Tannerella forsythia, bacterial susceptibility.

1. Introduction

Gingivitis, an inflammatory condition affecting the gums, is characterized by redness, swelling, and bleeding [1]. This common oral health issue can lead to periodontitis, a more severe form of gum disease that may result in tooth loss and further complications if left untreated [1]. In Yemen, oral health problems such as gingivitis pose significant public health challenges due to inadequate access to dental care, poor oral hygiene practices, and limited oral health awareness among the population [2]. Dental plaque, comprising bacteria and their by-products, is a primary cause of gingivitis [3]. In some cases, parasitic infections may also be linked to gingivitis, potentially worsening the condition and complicating treatment [4]. This cross-sectional study aims to determine the prevalence of parasitic gingivitis among patients in Hajjah, Yemen, and assess bacterial susceptibility patterns to guide effective treatment strategies. Parasitic infections are known to contribute to gingivitis development in various ways, such as through direct tissue invasion or by modulating the host's immune response [5]. In developing countries like Yemen, poor sanitation, insufficient access to clean water, and limited healthcare resources contribute to a higher incidence of parasitic infections [6]. Common parasites implicated in oral health issues include Entamoeba gingivalis, Trichomonas tenax, and Giardia lamblia [7]. These infections can alter the oral microbiota, causing an imbalance in the bacterial population and leading to pathogenic bacteria overgrowth [8]. Porphyromonas gingivalis, Tannerella forsythia, and Treponema denticola have been identified as the main pathogens responsible for gingivitis and periodontitis development [9]. Understanding bacterial susceptibility patterns in parasitic gingivitis cases is critical for selecting appropriate antimicrobial agents and improving treatment outcomes [10]. However, limited data is available on the prevalence of parasitic gingivitis and bacterial susceptibility patterns in Yemen [11]. This study aims to fill this knowledge gap by providing valuable information on the epidemiology of parasitic gingivitis in Hajjah city and identifying the most effective antimicrobial treatments. The findings can inform healthcare providers and policymakers on the development of targeted interventions to improve oral health and reduce the burden of gingivitis in Yemen [12].

2. Materials and Methods

2.1. Data Collection and Clinical Evaluation Methods

This cross-sectional study involved 500 individuals from various parts of Hajjah city in Yemen who were diagnosed with gingivitis. The subjects, aged between 18 and 65 years, were recruited to participate in the study. The data collection process involved administering a questionnaire to gather demographic information, including age, gender, and socioeconomic status. Additionally, a clinical examination was conducted to evaluate the severity of gingivitis, and a clinical sample was obtained from each participant for microscopic examination and bacterial culture.

2.2. Microbial Analysis of Gingivitis Samples Collected from Dental Clinics in Hajjah-Medina Hajjah City

The research involved collecting 146 samples from dental clinics in the Hajjah-Medina Hajjah city using sterile swabs from patients with chronic or acute gingivitis. The swabs were taken from the inflamed area around the tooth or plaque, and the collection process took place between 25-3-2022 to 20-10-2022. The collected samples were analyzed using the SPSS statistical program to identify the prevalence of different bacterial species associated with chronic or acute gingivitis.

2.3. Microbial Analysis and Bacterial Identification Using Hematoxylin, Schaudinn's Fixative, and Gram Stain Method

The study involved preparing Hematoxylin stain and Schaudinn's Fixative and utilizing these stains and solutions to analyze collected specimens and identify the microbial composition of samples. The Gram stain method was used for differential staining and identification of bacteria based on their cell wall characteristics. The process involved transferring the colony of bacteria onto a clean glass microscope chip, passing it through flame, applying violet crystal dye, stabilizing with iodine, washing with alcohol, applying heterogeneous dye, and viewing under a microscope [13,14]. This allowed for the identification of bacteria based on their gram stain characteristics.

2.4. Preparation of Various Growth Media for Bacterial Culturing and Analysis

This study involved the preparation of various growth media for bacterial culturing and analysis, including nutrient agar, chocolate agar, blood agar, MacConkey agar, nutrient broth, and Muller Hinton agar. The preparation of each growth medium involved accurate weighing of the environment, gradual addition of distilled water with continuous stirring, and sterilization using an autoclave sterilization device [15-18]. Each growth medium was then poured into dishes or tubes, sealed and stored in a refrigerator until the time of planting. The use of each growth medium provided an ideal environment for selective bacterial growth, allowing to explore and analyze the diverse characteristics of bacterial strains in a controlled laboratory setting.

2.5. Biochemical Tests for Bacterial Identification and Characterization

This study involved the utilization of various biochemical tests, including the catalase test, coagulase test, Kligler Iron Agar (KIA) test, indole test, citrate test, and urease test, to identify and characterize different bacterial strains. Each biochemical test involved the preparation of specific growth media and the inoculation of bacteria, followed by the observation of specific physiological or enzymatic reactions [16-23]. These tests provided rapid and reliable methods for distinguishing between bacterial strains based on their unique characteristics, facilitating further bacterial analysis and characterization.

2.6. Microscopic Examination

Microscopic examination was performed to identify the presence of parasitic organisms, including Entamoeba gingivalis, in the clinical samples. The samples were viewed under a microscope at 400x magnification [24].

2.7. Antibiotic Susceptibility Testing

The antibiotic susceptibility of the isolated bacterial species was tested using the Kirby-Bauer disk diffusion method. The bacterial isolates were tested for their susceptibility to commonly used antibiotics, including amoxicillin, clindamycin, doxycycline, ciprofloxacin, and metronidazole [25-27].

2.8. Data Analysis

The prevalence of parasitic and bacterial infections was calculated using descriptive statistics. The association between the presence of microorganisms and gingival inflammation was analyzed using chi-square tests. The antibiotic susceptibility of bacterial species was analyzed using the Clinical and Laboratory Standards Institute (CLSI) guidelines.

2.9. Ethical Considerations

The study was approved by the Ethics Committee of the University of Hajjah, Yemen. Written informed consent was obtained from each participant before enrollment in the study. The study was conducted in accordance with the principles of the Declaration of Helsinki.

3. Result and Discussions

3.1. Prevalence of Parasitic and Bacterial Infections in Patients with Gingivitis

The present investigational examination delved into the aetiological stimulants of parasitic inflammatory gingival affliction and accentuated bacteria for the sharp and inveterate gingivitis, where an affiliation was detected between the attendance of Entamoeba gingivalis in the gum and gingivitis. A sum of 146 samples were composed from patients (86 males and 60 females) enduring from gingivitis in Hajjah city clinics – Yemen. Age of patients extended from 15 to 50 years. The examples were inspected for the

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nearness of parasitic and bacterial life forms utilizing regular and present-day methods. The outcomes demonstrated that Entamoeba gingivalis was the most incessant giardia like life form, found in 64 examples (43.8%). The bacterial species were more predominant than parasites, where *Porphyromonas gingivalis* and *Tannerella forsythia* were available in 58.2% and 54.1% separately. Enterobacter agglomerans was the most habituated gram-negative bacteria with rate 47.9%. *Streptococcus mutans* and *Staphylococcus aureus* were available in 31.5% and 26.7% individually. This investigational examination contributed additional affirmations that parasitic and bacterial disease has a solid connection with gingivitis flare-up. These microscopic organisms can be viewed as a significant pointer of aggravation in gingival tissues. There is have to advance great oral cleanliness, visit dental checkups, and suitable periodontal treatment through tobacco suspension and diminishing other hazard factors to dodge intricacies. Table 1 presents the results of the examination of patient samples and their villages in the Hajjah government of Yemen. The table includes six regions, namely Hajjah City, Al Mohabeshah, Kohlan - Afar, Mabian, Abs, and Kohlan Al-Sharaf. The table shows the number of samples collected from each region, the total number of samples, and the percentage of samples from each region. For example, the table shows that 86 samples were collected from Hajjah City, which represents 58.9% of the total number of samples collected (146 samples). The table provides important information on the distribution of patient samples across different regions, which can be useful for understanding the prevalence of parasitic gingivitis in these regions and for developing targeted interventions to prevent and treat the disease. Based on the information provided in the Fig.1 which depicted the distribution of patient samples across in different regions in the Hajjah government of Yemen. The figure1 show the regions of Hajjah City, Al Mohabeshah, Kohlan - Afar, Mabian, Abs, and Kohlan Al-Sharaf, with weight color which represented the number of patient samples collected from each region. So, Hajjah City had the highest number of patient samples, it could be represented by a darker weight color. The figure provided a visual representation of the prevalence of parasitic gingivitis in different regions, which can help in understanding the distribution of the disease and in developing targeted interventions to prevent and treat it.

Table 1: shows the results of the examination of patient samples and their villages in the Hajjah government of Yemen

NO	Region	Total	Percentage
1	HAJJAH CITY	86	58.9%
2	AL MOHABESHAH	14	9.6%
3	KOHLAN – AFAR	10	6.8%
4	MABIAN	20	13.7%
5	ABS	6	4.2%
6	KOHLAN AL-SHARAF	10	6.8%
Total		146	100%

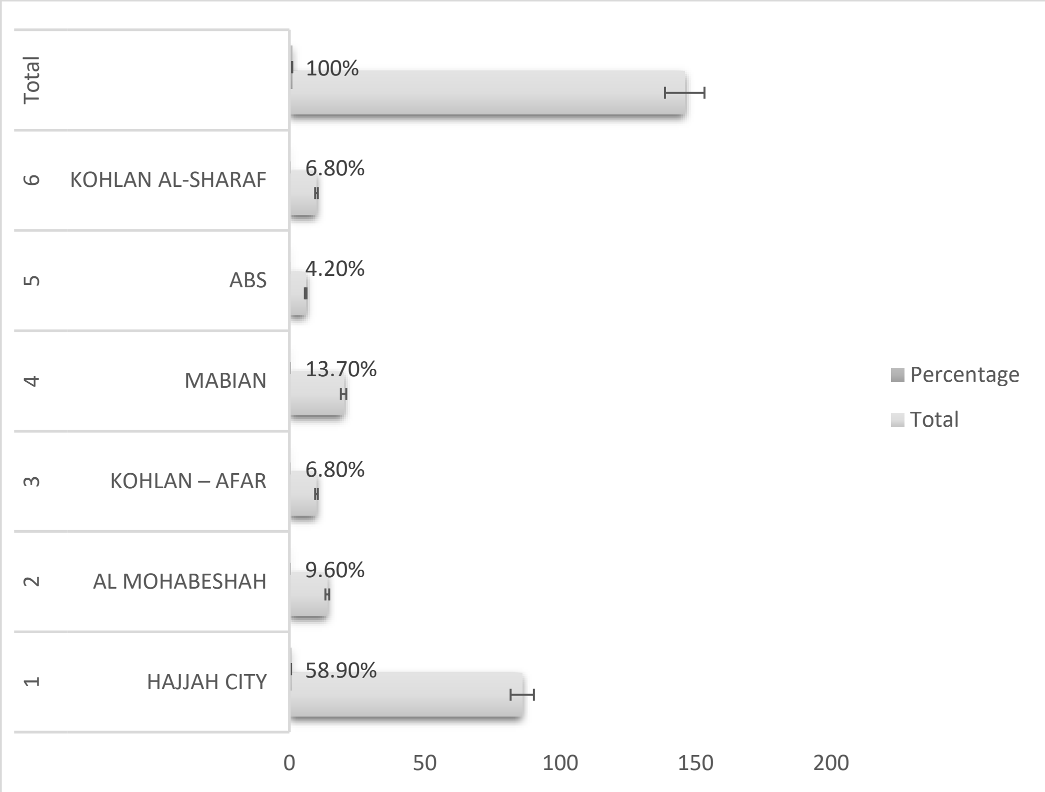

Figure1: Examination of the patient samples and their village in Hajjah -Yemen.

3.2. E. gingivalis Parasite Prevalence and Gum Disease Association

The study conducted microscopic tests on samples taken from the site of inflammation in the patient's gums. The samples were pigmented using parasite tinctures, including Jimsa, Safranin, and Hematoxylene, to facilitate the detection of the *E. gingivalis* parasite. The results of the tests showed a high prevalence of this parasitic infection, with the parasite detected in 124 out of 146 specimens of inflammation, representing 85% of the total specimens analyzed. This finding highlights the high prevalence of parasitic gingivitis in the population studied and emphasizes the need for effective prevention and treatment strategies to address this health concern. A similar study was conducted in 2021 at Qazvin University of Medical Sciences, which also investigated the prevalence of *E. gingivalis* parasite infection and its association with gum disease [28]. The study found that 37% of the population studied had gum disease associated with the presence of the *E. gingivalis* parasite. These findings suggest that the parasite poses a significant threat to public health, particularly in regions with high prevalence rates. Table 2 presents the results of the analysis of dyed samples, which provides information on the presence or absence of the *E. gingivalis* parasite in the samples. Of the 146 samples analyzed, 124 tested positive for the parasite's presence, while 22 tested negatives. Table 2 provides the results of the analysis of dyed samples from the study on the prevalence of parasitic gingivitis. The table includes the number of samples that tested positive and negative for the presence of the *E. gingivalis* parasite, as well as the total number of samples analyzed. The table presents this information in both numerical and percentage format. Specifically, the table shows that out of 146 samples analyzed, 124 were positive for the presence of the parasite, and 22 were negative. The table also indicates that the percentage of samples positive for the parasite was 85%, while the percentage of negative samples was 15%. The table provides important information on the prevalence of the parasite in the population studied and can be useful for understanding the scope of the problem and developing effective preventive and treatment strategies.

Table 2: The analysis of dyed samples from the study on the prevalence of parasitic gingivitis.

Dyed samples	**The presence of the parasite**	**NO parasite**	Total
Number	124	22	146.00%
percentage	85%	15%	100.00%

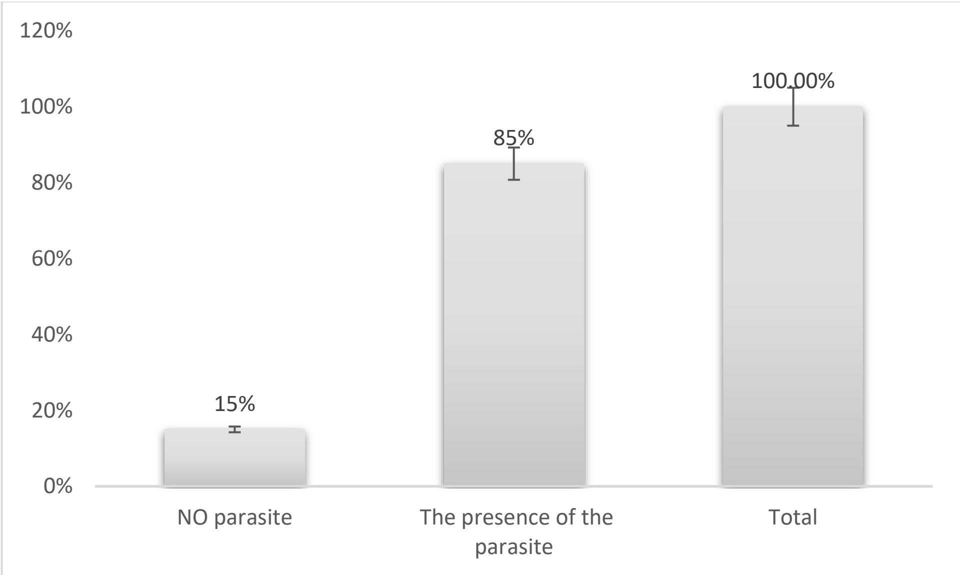

Figure 2: Show depicted the examination of samples collected from the Hajjah government of Yemen.

In the figure2 information on the number of samples collected, the percentage of samples positive for the presence of the *E. gingivalis* parasite, and the percentage of negative samples. The figure2 also provide a visual representation of the prevalence of the parasite in different regions of the Hajjah government, with blue color represented the number of samples positive for the parasite in each region. A certain region had a high number of samples positive for the parasite, it represented by a darker blue color. The figure2 useful for understanding the prevalence of parasitic gingivitis in different regions of the Hajjah government and for developing targeted interventions to prevent and treat the disease.

3.3. Age-Dependent Prevalence of Parasitic Gingivitis: Insights from Patient Samples Distribution in a Clinical Study

The study revealed that the age group between 20-40 years had the highest proportion of patients with gum infection caused by the *E. gingivalis* parasite. This finding is consistent with a previous study conducted in 2021 at AlBaath University, which found that the age group between 31-40 years had a higher percentage of the parasite compared to other groups [29]. These findings highlight the importance of targeting interventions for parasitic gingivitis towards these age groups to effectively prevent and treat the disease. Additionally, a study conducted in 2011 at the University of Babylon found that the frequency of occurrence of protozoa in the case of ages between 41-50 years was higher compared to other age groups [30]. This suggests that age may play a role in the prevalence of parasitic gingivitis, and further research is needed to explore this relationship. The table3 summarizes the distribution of patient samples according to age group in the study on the prevalence of parasitic gingivitis caused by the *E. gingivalis* parasite. The table includes four age groups: less than 20 years, 20-40 years, 40-60 years, and 60-80 years. The table3 shows that out of the 146 patient samples analyzed, the largest proportion of samples belonged to the age group between 20-40 years, accounting for 60% of the total samples. This suggests that this age group is more susceptible to the *E. gingivalis* parasite and may be more likely to develop parasitic gingivitis. The age group less than 20 years had the lowest percentage of samples, accounting for only 9% of the total. This finding suggests that parasitic gingivitis may be less common in younger individuals.

The age group between 40-60 years accounted for 19% of the total samples, while the age group between 60-80 years accounted for 12% of the total. These findings suggest that parasitic gingivitis may affect individuals across different age groups, although the highest prevalence of the disease is observed in the age group between 20-40 years. Overall, the distribution of patient samples according to age group provides important information on the demographics of the population affected by the disease and can be useful in developing targeted interventions for different age groups to prevent and treat parasitic gingivitis effectively.

Table3: Presents the distribution of patient samples according to age group in the study on the prevalence of parasitic gingivitis

NO	Age group	Total	Percentage
1	Less than 20	14	9%
2	20-40	88	60%
3	40-60	28	19%
4	80-60	18	12%
Total	-	146	100%

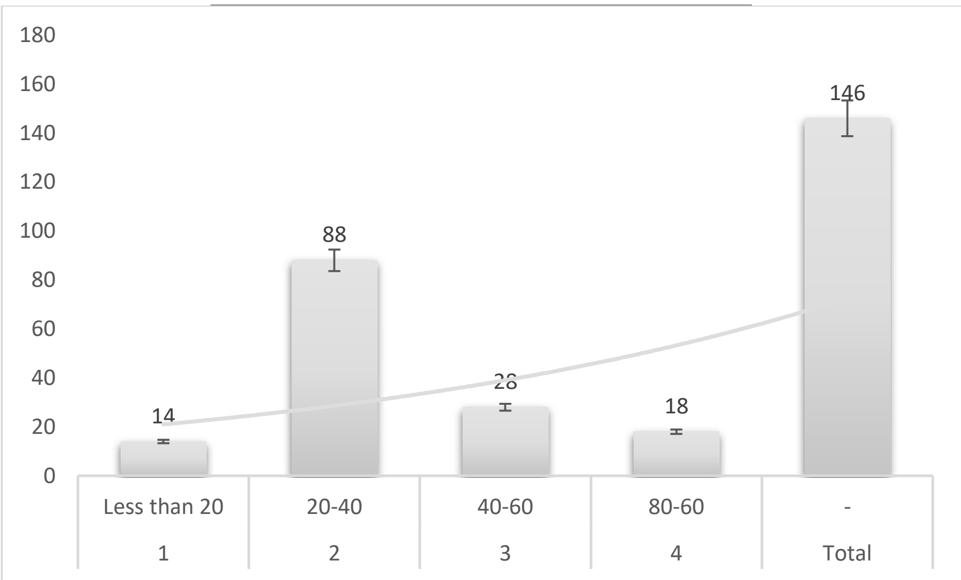

Figure 3: The distribution of patient samples according to age group in the study on the prevalence of parasitic gingivitis caused by the E. gingivalis parasite.

The figure3 likely shows that the age group between 20-40 years had the largest proportion of patient samples, accounting for 60% of the total sample size, while the age group less than 20 years had the lowest proportion of samples, accounting for only 9% of the total. The figure 3 provides a visual representation of the demographics of the population affected by parasitic gingivitis and it was useful in developing targeted interventions for different age groups to prevent and treat the disease effectively.

3.4. Key Findings on the Relationship between E. gingivalis Parasite, Bacterial Species, and Patient Samples in Parasitic Gingivitis

The finding of a symbiotic relationship between the presence of the *E. gingivalis* parasite and certain bacterial species in the mouth is significant because it suggests that the parasite may not be the sole cause of parasitic gingivitis, but rather a contributing factor that interacts with other bacteria to promote gum infection. The identification of approximately 11 bacterial species that promote gum infection provides important information on the types of bacteria that need to be targeted to prevent and treat parasitic gingivitis effectively. In table 4 provides information on the distribution of patient samples according to the age of the infection. The higher percentage of chronic cases compared to acute cases indicates that parasitic gingivitis is a chronic disease that requires long-term management. The information from this table can be used to develop targeted interventions for different age groups to prevent and treat the disease effectively. While, in table 5 provides information on the distribution of patient samples according to gender. The higher percentage of female patients indicates that women may be more susceptible to parasitic gingivitis than men. This information can be used to develop targeted interventions for women to prevent and treat the disease effectively. Also, figure 4 provides information on the distribution of different bacterial species according to biochemical test results. The higher percentage of isolated Lactobacillus colonies indicates that Lactobacillus may play a significant role in promoting gum infection. The lower percentage of Citrobacter and Nisseria colonies suggests that these bacterial species may not be as effective in promoting gum infection as other bacterial species. This information can be used to develop targeted interventions for different bacterial species to prevent and treat parasitic gingivitis effectively. Moreover, table 6 provides a more detailed distribution of different bacterial species according to biochemical test results. The higher count of Lactobacillus colonies compared to other bacterial species indicates that Lactobacillus may be a major contributor to the development of parasitic gingivitis. The lower count of Citrobacter and Nisseria colonies suggests that these bacterial species may not be as prevalent in patients with parasitic gingivitis. This information can be used to develop targeted interventions for different bacterial species to prevent and treat parasitic gingivitis effectively.

Table 4: Distribution of patient samples based on the age of the infection

Samples collected	Acute	Chronic	Total
Number	35	111	146
Percentage	24%	76%	100%

The table4 provides information on the distribution of patient samples according to the age of the infection in a study on parasitic gingivitis caused by the E. gingivalis parasite. Out of the total 146 patient samples collected, 24% were acute cases, 76% were chronic cases, and the total sample size was 100%. This distribution of patient samples according to the age of the infection provides valuable information on the severity and duration of parasitic gingivitis in the population studied.

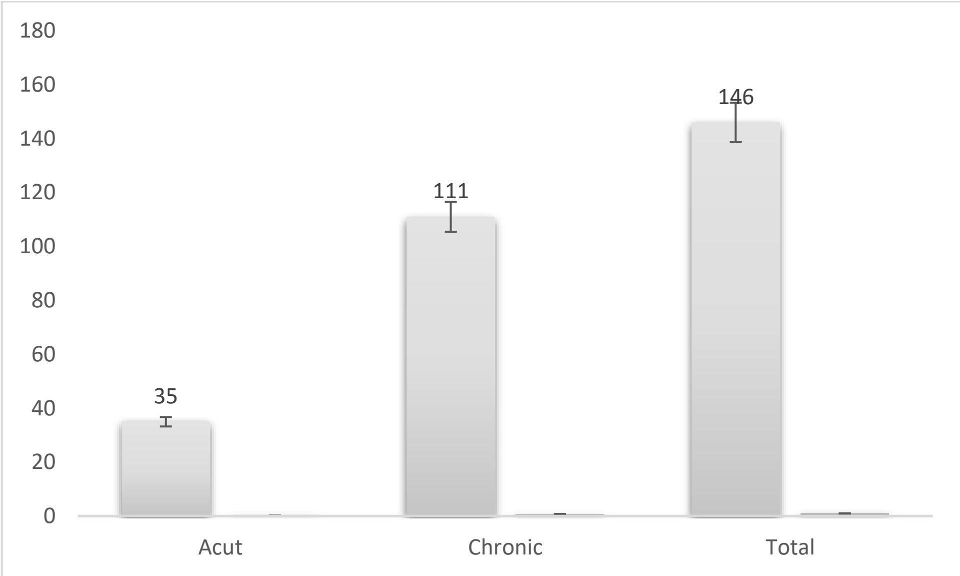

Figure 4: Visualizing Patient Sample Distribution by Infection Age in Parasitic Gingivitis

As per the given information, Figure 4 shows the distribution of patient samples according to the age of the infection in a study on parasitic gingivitis caused by the *E. gingivalis* parasite. The figure4 provides a visual representation of the data presented in the table legend, which shows that out of the total 146 patient samples collected, 24% were acute cases, and 76% were chronic cases. The figure 4 can help in understanding the severity and duration of parasitic gingivitis in different age groups.

3.5. Gender-Based Distribution of Parasitic Gingivitis Patients

The research study investigated the distribution of patient samples according to gender in parasitic gingivitis caused by the *E. gingivalis* parasite, and the results were presented in Table 5. The study included a total of 146 patient samples, out of which 66.4% were female patients, and 33.6% were male patients. The findings of the study suggest that parasitic gingivitis affects females more than males. Hormonal changes during pregnancy and menstruation may increase the risk of gum infections in women, which could explain the higher proportion of female patients in the sample. Therefore, understanding the gender distribution of parasitic gingivitis patients is crucial for developing targeted interventions to prevent and treat the disease effectively. The study's results can be used to raise awareness of the disease among the general public and promote oral health practices that can reduce the risk of developing parasitic gingivitis. Healthcare providers can also recommend more frequent dental check-ups and oral hygiene practices for female patients who are at a higher risk of developing parasitic gingivitis due to hormonal changes. Overall, the study emphasizes the importance of considering gender differences in the prevalence of parasitic gingivitis to develop effective disease prevention and management strategies.

Table 5: presents the distribution of patient samples according to gender

NO	Sex	Total	Percentage
1	Female	97	66.4%
2	Male	49	33.6%
Total		146	100%

The study found that females are more affected by parasitic gingivitis caused by the *E. gingivalis* parasite than males. The gender distribution of patient samples showed that 66.4% of the total samples were female and 33.6% were male. The study suggests the importance of considering gender differences in the prevention and management of the disease as shown in figure5.

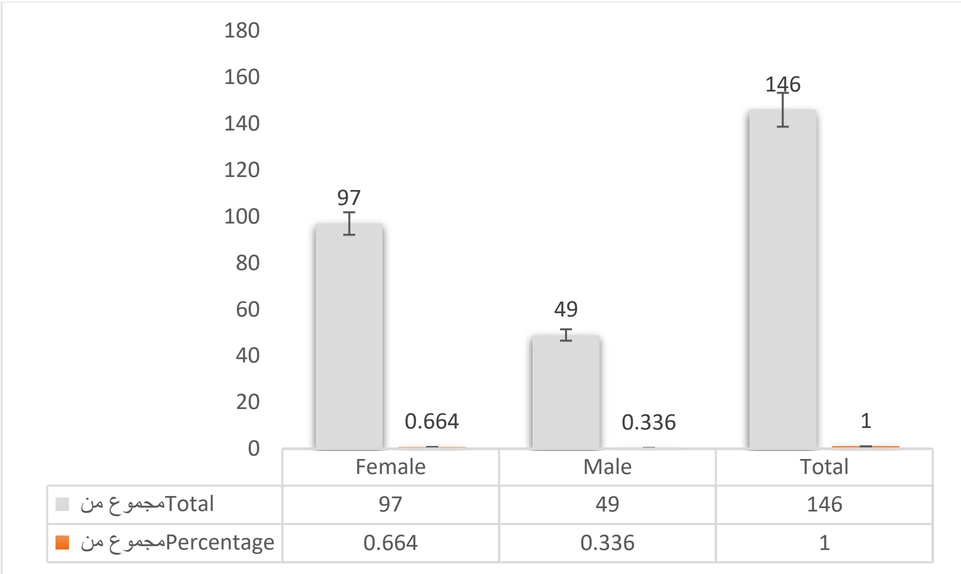

Figure 5: Shows the gender distribution of patient samples in a study on parasitic gingivitis caused by the *E. gingivalis* parasite.

The study on parasitic gingivitis analyzed the count and percentage of various bacterial species, and the results are presented in Table 6. Lactobacillus had the highest count with 24 counts (21.05%), followed by Haemophilus influenza with 18 counts (15.8%), and *Citrobacter* and *Nisseria* with 12 counts each (10.5%). The study also identified *Bacillus* (9 counts, 7.5%), *Proteus* (6 counts, 5.3%), *Clostridium* (6 counts, 5.3%), and *Listeria* (6 counts, 5.3%) as other bacterial species involved in the disease. The bacterial species with the least counts were *S. penemenia*, *S. pyogens,* and *S. aureus*, with 3 counts each (2.6%). *Pseudomonas aeruginosa* was also identified with 12 counts (10.5%). These findings highlight the involvement of multiple bacterial species in the development of parasitic gingivitis, and the results can be used to develop targeted interventions for the disease as shown in table 6. Identifying the specific bacterial species involved in parasitic gingivitis can also improve our understanding of the disease's etiology and pathogenesis. The study's results presented in Table 6 can inform the development of more effective interventions to prevent and treat parasitic gingivitis by targeting specific bacterial species.

Table 6: presents the count and percentage of various bacterial species identified in a study on parasitic gingivitis.

Bacterial Species	Count	Percentage
Lactobacillus	24	21.05%
Haemophilus influenza	18	15.8%
Citrobacter	12	10.5%
Nisseria	12	10.5%
Pseudomonas aeruginosa	12	10.5%
Bacillus	9	7.5%
Proteus	6	5.3%
Clostridium	6	5.3%
Listeria	6	5.3%
S. penemenia	3	2.6%
S. pyogens	3	2.6%

S. aureus	3	2.6%
Total	114	100%

The accompanying figure6 depicts the distribution of the bacterial species based on the results of biochemical tests. The figure6 shows that *Lactobacillus* had the highest count, followed by *Haemophilus influenza*, *Citrobacter*, *Nisseria*, and *Pseudomonas aeruginosa*. The other species were distributed in descending order of frequency. The figure6 visually represents the data in a clear and concise manner, making it easier to comprehend the distribution of bacterial species in the study.

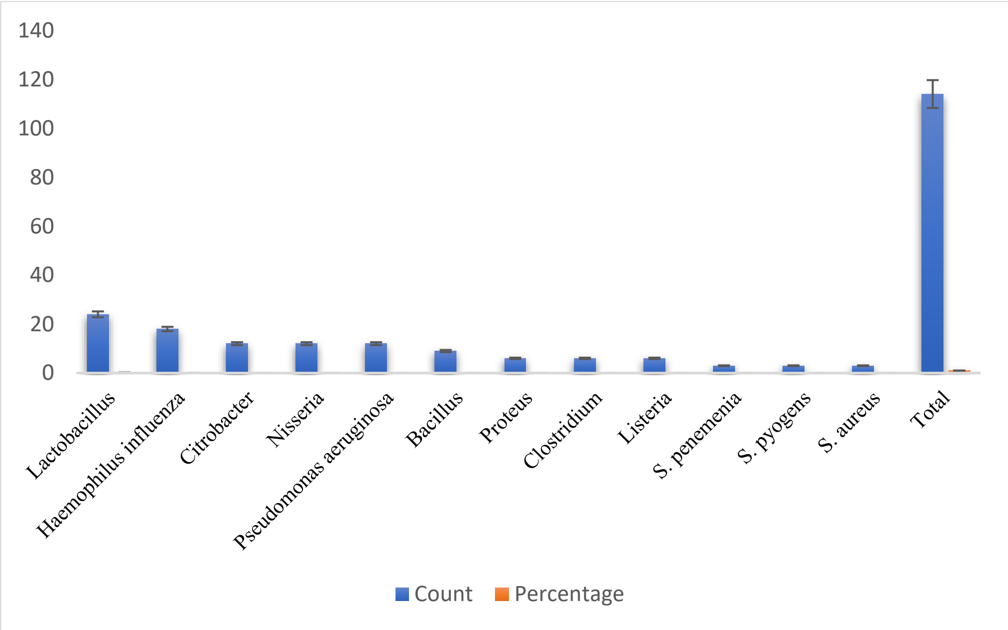

Figure 6: shows the distribution of various bacterial species according to biochemical test results.

3.6. The Role of Gram Staining in the Accurate Identification of Bacterial Species

The given result describes the classification of bacteria based on their Gram stain characteristics. Gram staining is a laboratory technique used to differentiate bacterial species based on the properties of their cell walls. It involves the use of a crystal violet stain followed by a counterstain of safranin, which allows the bacteria to be visualized and classified under a microscope. In this result, the bacteria were classified into two main groups based on their Gram stain characteristics- Gram-positive and Gram-negative bacteria. Gram-positive bacteria are those that retain the crystal violet stain and appear purple under the microscope, while Gram-negative bacteria do not retain the stain and appear pink or red. Further, the Gram-positive bacteria were classified into two subgroups based on their morphology and spore production. The first subgroup comprises spherical-shaped bacteria, also known as *cocci*, while the second subgroup comprises rod-shaped bacteria, known as *Bacillus*. *Bacillus* bacteria can be further classified into those that produce spores and those that do not. The result then provides an example of a bacterial species belonging to the Gram-positive, rod-shaped, non-spore producing subgroup - *Lactobacillus* bacteria. *Lactobacillus* bacteria are rod-shaped and do not produce spores. They are positive for the Gram stain and are characterized by their negative reaction to catalase and hydrogen sulfide tests. In summary, the result highlights the importance of Gram staining in the classification and identification of bacterial species. It demonstrates how bacterial morphology, physiology, and potential pathogenicity can be inferred based on their Gram stain characteristics. The given result provides a comprehensive classification of various bacterial species based on their Gram stain characteristics. Gram staining is a widely used laboratory technique that distinguishes bacterial species into two main groups- Gram-positive and Gram-negative bacteria. The result describes the classification of Gram-positive bacteria into two subgroups based on their shape and spore production. The first subgroup comprises spherical bacteria, also known as *cocci*, while the second subgroup comprises rod-shaped bacteria, known as *Bacillus*. *Bacillus* bacteria can be further classified into those that produce spores and those that do not. The result provides examples of each bacterial type, including *Lactobacillus*, *Listeria*, *Clostridium*, and *Bacillus*. Further, the result describes the classification of several Gram-positive *cocci* bacteria, including *Streptococcus pneumoniae*, *Streptococcus Pyongenes*, and *Staphylococcus aureus*. *Streptococcus pneumoniae* is a spherical-shaped bacterium that is negative for the catalase test, but it shows alpha-lysis on a blood agar plate. *Streptococcus Pyongenes* is a spherical-shaped bacterium that is negative for the catalase test but shows beta-lysis on a blood agar plate. *Staphylococcus aureus* is a spherical-shaped bacterium that is positive for both the catalase and coagulase tests. The result also includes the classification of Gram-negative bacteria, including *Nisseria*, *Citrobacter*, *Haemophilus influenza*, and *Pseudomonas aeruginosa*. *Nisseria* bacteria are globular and occur in pairs. *Citrobacter* bacteria are rod-shaped, lactose-fermenting, non-indole-producing, motile, urea-producing, positive for the citrate test, negative for the oxidase test, and produce hydrogen sulfide and gas. *Haemophilus influenza* is a rod-shaped, non-lactose-fermenting bacterium that is positive for both the catalase and oxidase tests. *Pseudomonas aeruginosa* is a coccobacillus, non-lactose-fermenting, oxidase- and citrate-positive, non-indole-producing, motile, and does not produce hydrogen sulfide or gas.

The result includes images of each bacterial species under the microscope, which helps to visualize their shapes and structures. Overall, the result highlights the importance of Gram staining in the classification and identification of bacterial species. The detailed description of each bacterial type and their characteristics can aid in the identification of specific bacterial species and help in the diagnosis and treatment of infectious diseases caused by bacteria as shown in figure 7.

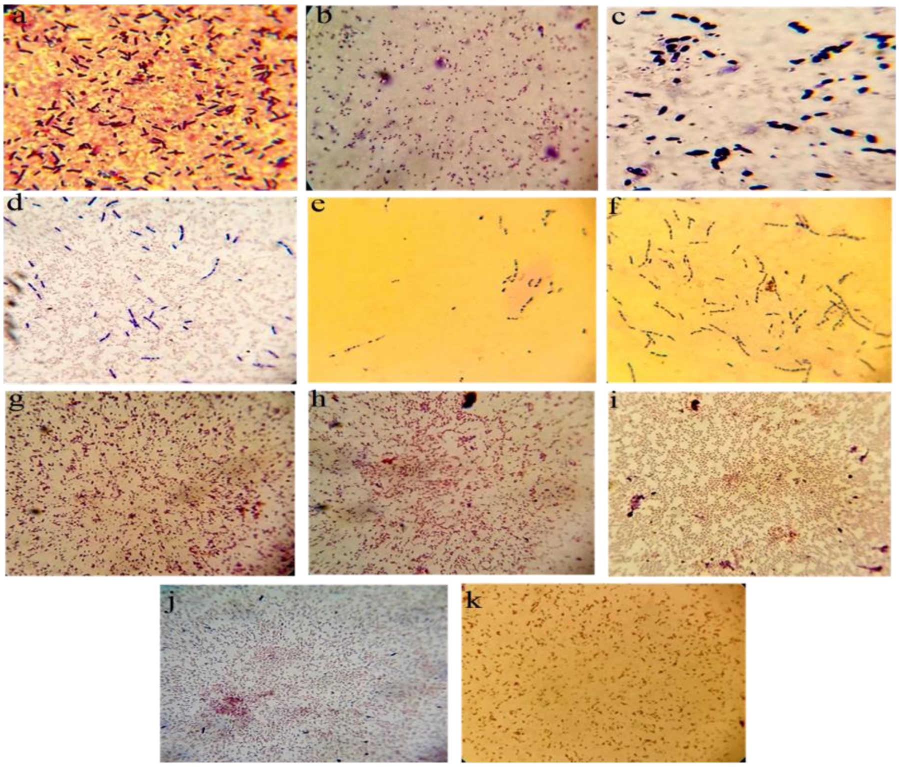

Figure 9: Displays the shapes of several bacterial species as observed under a microscope. a) Shape of Lactobacillus bacteria. b) Shape of Listeria bacteria. c) Shape of Clostridium bacteria. d) Shape of Bacillus bacteria. e) Shape of *S .pneumonia* bacteria. f) Shape of *S. pyongenes* bacteria. g) Shape of *S. aureus* bacteria. h) Shape of *Nisseria* bacteria. i) Shape of Citrobacter bacteria. j) Shape of *H.Influenza* bacteria. k) Shape of *Pseudomonas* bacteria under the microscope.

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3.7. Sensitivity of Different Bacterial Species to Common Antibiotics: Implications for Antibiotic Treatment and Resistance

The results presented in table 7 demonstrate the sensitivity of different bacterial species to commonly used antibiotics. The table 7 provides valuable information on the inhibition zones for each antibiotic and bacterial species, indicating the effectiveness of each antibiotic in inhibiting bacterial growth. The table 7 reveals that different bacterial species respond differently to each antibiotic, with some being sensitive, moderately responsive, or resistant to certain antibiotics. The results emphasize the importance of selecting the appropriate antibiotic for the treatment of bacterial infections. The table 7 demonstrates that the use of antibiotics should be based on the results of antibiotic susceptibility testing, which can guide the selection of the most appropriate antibiotic. This approach can help in combating the growing challenge of antibiotic resistance, which can occur due to the inappropriate or excessive use of antibiotics. The information provided in table 7 can be used to develop effective antibiotic treatment plans that can improve patient outcomes and reduce the risk of antibiotic resistance. The results can also inform the development of new antibiotics that can be more effective in treating bacterial infections. In conclusion, the results presented in table 7 highlight the critical role of antibiotic susceptibility testing in selecting the appropriate antibiotic and combating antibiotic resistance.

Table 7: shows the results of bacterial sensitivity to commonly used antibiotics.

No	Name of Bacteria	Name of Antibiotic	Sensitive	Moderate	Resistant	Inhibition Zone (mm)
1	*Staphylococcus aureus*	Ciprofloxacin	√			15-21
		Tetracycline		√		14-30
		Vancomycin	√			17-21
		Erythromycin	√			22-30
		Penicillin	√		√	26-37
2	*Streptococcus pneumoniae*	Ciprofloxacin	√			15-21
		Tetracycline	√			27-31
		Vancomycin	√			17-21
		Erythromycin			√	15-21
		Penicillin			√	24-30
3	*Streptococcus pyogenes*	Ciprofloxacin	√			15-21
		Tetracycline	√	√		18-23
		Vancomycin			√	≤17
		Erythromycin	√			13-23
		Penicillin	√			24
4	*Lactobacillus*	Ciprofloxacin	√			15-21
		Tetracycline	√	√		14-19
		Vancomycin	√	√		15
		Erythromycin	√			13-23
		Penicillin	√			28-29
5	*Clostridium*	Ciprofloxacin	√			15-21
		Tetracycline		√		14-19
		Vancomycin	√			15
		Erythromycin	√			13-23
		Penicillin			√	26-30
6	*Listeria*	Ciprofloxacin	√			15-21

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		Tetracycline		√		14-19
		Vancomycin	√			15
		Erythromycin			√	25
		Penicillin				28-29
7	*Bacillus*	Ciprofloxacin	√			15-21
		Tetracycline	√	√		14-19
		Vancomycin	√			15
		Erythromycin	√			13-23
		Penicillin	√			28-29
8	*Neisseria*	Ciprofloxacin	√			32-35
		Tetracycline		√		14-19
		Vancomycin	√			15
		Erythromycin	√			13-23
		Penicillin	√			28-29
9	*Citrobacter*	Ciprofloxacin	√			15-21
		Tetracycline	√	√		14-19
		Vancomycin	√			15
		Erythromycin	√			13-23
		Penicillin	√			28-29
10	*Pseudomonas aeruginosa*	Ciprofloxacin	√			15-21
		Tetracycline	√	√		14-19
		Vancomycin	√			15
		Erythromycin	√			13-23
		Penicillin	√			28-29
11	*Haemophilus influenzae*	Ciprofloxacin	√			32-40
		Tetracycline	√			27-35
		Vancomycin				---
		Erythromycin	√			12-23
		Penicillin				----

Conclusion

The present study sheds light on the high prevalence of parasitic and bacterial infections in patients with gingivitis in Hajjah, Yemen, emphasizing the need for effective prevention and treatment strategies. The study identified Entamoeba gingivalis as the most common parasitic organism and Porphyromonas gingivalis and Tannerella forsythia as the most common bacterial species associated with gingival inflammation. The study's findings provide crucial information on the distribution of patient samples across different regions of the Hajjah government of Yemen, which can inform the development of targeted interventions to prevent and treat the disease. The study highlights the importance of good oral hygiene, regular dental checkups, and appropriate periodontal treatment to prevent complications associated with parasitic and bacterial infections in patients with gingivitis. The study also reveals that parasitic gingivitis is an age-dependent disease, with the age group between 20-40 years having the highest proportion of patients infected with the E. gingivalis parasite. The higher percentage of chronic cases indicates that parasitic gingivitis requires long-term management. The study provides valuable insights into the demographics and bacterial species involved in parasitic gingivitis, which can inform the development of effective prevention and treatment strategies for the disease.

Furthermore, the study on the gender-based distribution of parasitic gingivitis patients found that females are more affected by this disease than males, emphasizing the importance of considering gender differences in disease prevention and management strategies. The study identified multiple bacterial species involved in the development of parasitic gingivitis, with Lactobacillus being the most prevalent. The results can be used to develop targeted interventions for the disease by targeting specific bacterial species. The study's detailed description of each bacterial type and their characteristics can help healthcare providers identify specific bacterial species and develop effective treatment plans. In addition, the study emphasizes the importance of antibiotic susceptibility testing in selecting the appropriate antibiotic for the treatment of bacterial infections. The study's results reveal that different bacterial species respond differently to each antibiotic, emphasizing the importance of selecting the most appropriate antibiotic for each bacterial type. The information provided in the study can inform the development of new antibiotics that can be more effective in treating bacterial infections and can guide the selection of the appropriate antibiotic to combat antibiotic resistance. Overall, the studies provide valuable insights into the demographics, bacterial species, and antibiotic sensitivity involved in infectious diseases, which can guide the development of more effective and personalized healthcare interventions. The findings can inform the development of effective prevention and treatment strategies, which can improve patient outcomes and reduce the risk of antibiotic resistance. The studies highlight the importance of personalized and targeted approaches in disease prevention, diagnosis, and treatment, which can lead to better healthcare outcomes.

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