مجلة الدراسات التربوية والعلمية - كلية التربية - الجامعة العراقية
العدد السابع والعشرون - المجلد الثاني - علوم الحياة - آذار 2026 م
doi.org/10.52866/esj.2026.02.27.17

Investigation of antibiotics resistance of Streptococcus pyogenes causing tonsillitis and its effect on some blood parameters

Reem Muzahim Hamdoon ، Asmaa Easa Mahmood*
1 Department of Pathological Analysis, College of Applied Sciences, University of Samarra, Iraq
*Corresponding author: asma.kurkum@uosamarra.edu.iq
https://orcid.org/0000-0001-6063-7597 reemajely@gmail.com

Abstract :

Tonsillitis is a prevalent upper respiratory tract infection, often caused by *Streptococcus pyogenes* the most common etiological agent. 100 samples are collected from patients with tonsillitis aged 5-55 years for both gender, who visited the ENT consultant at Tikrit Teaching Hospital during the period from November 2024 to April 2025.

Throat swab culture revealed that 82 samples had bacterial growth of which 16 isolates in rate of 19.51%, were of the *S. pyogenes*, 12 isolates of non-group A streptococci (Non-GABHS) 14.63%, *Staphylococcus aureus*. 25.61%, and Coagulase-negative Staphylococci 8.54%, *S. pneumoniae* 6.10% and viridans groups 15.85%, along with some Gram nagetive species 9.76%. The predominant age groups infected with *S. pyogenes* were in 5-15 years in rate of 41.5%, followed by 15-25 and 25-35 with approximately equal numbers of etiology, 35-45 was the least susceptible group to *S. pyogenes* infection, and 45-55 had incidence rate of 6.25%. The antimicrobial susceptibility testing revealed that all isolates were sensitive to Penicillin, Augmentin and Levofloxacin 100%, while resistance was variable for other antibiotics such as Amoxicillin, Cefotaxime, Vancomycin, and Cefotaxime.

The results showed a significant decrease in lymphocyte counts 1.76×10^9/L In patients with tonsillitis compared to the other infected and control group, a significant increase in granulocyte and WBC counts 9.21×10^9/L, 12.49×10^9/L respectively in compared to the other groups and controls, no significant differences were observed in red blood cell count between the groups.

Keywords: Tonsillitis, *Streptococcus pyogenes*, antibiotics, blood, parameters.

التحري عن مقاومة بكتريا المقيحات العقدية المسببة لالتهاب اللوزتين للمضادات الحيوية وتأثيرها على بعض معايير الدم

ريم مزاحم حمدون ، اسماء عيسى محمود*
قسم التحليلات المرضية، كلية العلوم التطبيقية، جامعة سامراء، العراق
Corresponding author: asma.kurkum@uosamarra.edu.iq*
https://orcid.org/0000-0001-6063-7597 ، reemajely@gmail.com

مستخلص:

يُعد التهاب اللوزتين عدوى شائعة في الجهاز التنفسي العلوي وغالبًا ما تسببه المقيحات العقدية وهي العامل المسبب الأكثر شيوعًا. جُمعت 100 عينة من مرضى مصابين بالتهاب اللوزتين تتراوح أعمارهم بين 5 -55 عامًا ومن كلا الجنسين والذين راجعوا استشاري الأنف والأذن والحنجرة في مستشفى تكريت التعليمي خلال الفترة من نوفمبر 2024 إلى أبريل 2025.

أظهرت مسحة الحلق وجود نمو بكتيري في 82 عينة منها 16 عينة وبنسبة ٪19.51 لبكتريا المقيحة العقدية كما تم عزل ٪14.63 من العقديات التي لا تنتمي لمجموعة المقيحات. وعزلت المكورات العنقودية الذهبية بنسبة ٪25.61 وبواقع 21 عزلة ونسبة ٪8.54 من المكورات العنقودية سلبية التخثر وعزلت المكورات الرئوية بنسبة و٪6.10 ونسبة ٪15.85 من المكورات المخضرة بالإضافة إلى بعض الأنواع سالبة الجرام بنسبة ٪9.76..

كانت الفئات العمرية الأكثر إصابة بالمكورات السبحية المقيحة في الفئة العمرية 5 -15 سنة بنسبة ٪41.5 تليها المجموعتان 15-25 و 25-35 سنة بنسب متقاربة من حيث المسببات، بينما كانت المجموعة 35-45 الأقل عرضة للإصابة بالمكورات السبحية المقيحة، بينما بلغت نسبة الإصابة بالمكورات السبحية المقيحة في المجموعة45-55 سنة ٪6.25.

أظهر اختبار حساسية المضادات الحيوية أن جميع العزلات كانت حساسة للبنسلين والأوجمنتين والليفوفلوكساسين بنسبة ٪100، بينما كانت المقاومة متفاوتة تجاه المضادات الحيوية الأخرى مثل الأموكسيسيلين والسيفوتاكسيم والفانكومايسين والسيفوتاكسيم.

أظهرت النتائج انخفاضًا معنويًا في عدد الخلايا الليمفاوية 1.76×10^9/ لتر بالمصابين بالتهاب اللوزتين مقارنة مع مجموعة الاصابات الاخرى ومجموعة السيطرة وزيادة معنوية في عدد الخلايا المحببة 9.21×10^9/ لتر وإجمالي عدد خلايا الدم البيضاء 12.49×10^9/ لتر مقارنةً بالمجموعات الأخرى، ولم تُلاحظ فروق معنوية في عدد خلايا الدم الحمراء بين مجاميع الدراسة.

الكلمات المفتاحية: التهاب اللوزتين، المقيحة العقدية ، المضادات الحيوية، الدم، المعايير.

Introduction

Tonsillitis is a common disease, especially among children and adolescents, *Streptococcus pyogenes* is one of the main causative agents, along with several other bacteria, such as *Haemophilus influenza*, *Staphylococcus aureus*, *Streptococcus pneumoniae* [1].

S.pyogenes, also known as strep throat, is the most common cause of bacterial tonsillitis and localized skin (impetigo) to moderate-to-severe manifestations in the forms of scarlet fever, pneumonia, bacteraemia, erysipelas, cellulitis, and life-threatening conditions such as necrotizing fasciitis and toxic shock syndrome, it has the potential to trigger acute immune responses which in some cases can lead to chronic inflammatory complications in other organs most notably rheumatic fever [2].

S. pyogenes has the ability to colonize, proliferate, and disseminate swiftly inside host tissues while concurrently escaping phagocytosis and perplexing the immune system [3].

Certain immunological and laboratory markers, such as CBC markers are essential tools used to assess the body's response to streptococcal infection and monitor its severity [4].

Tonsillitis symptoms frequently occur before tonsillar abscesses, which are collections of pus between the tonsillar capsule and the pharyngeal constrictor muscle, it is important to remember that the emergence of certain symptoms does not establish causality, antibiotic therapy for tonsillitis decreases abscess, even if the two illnesses are clinically different [5].

These markers are particularly important when linked to potential complications of infection, such as rheumatic fever, a well-known immune complication resulting from an abnormal immune response to *S.pyogenes* antigens.

Materials and Methods

One hundred throat swab were collected from patients and 25 samples from healthy people from both genders ages between 5-55 years from the Ear, Nose and Tonsil (ENT) Consultant at Samarra General Hospital and Tikrit Teaching during a period that was sum-

marized between November 2024 and April 2025.

Throat swab was taken by disposable cotton swab and from all Patients diagnosed with tonsillitis by a specialist doctor and 5 ml of venous blood were taken from patients and healthy groups and put in EDTA tube for hematological test.

Diagnosis of bacterial isolates

The specimen were transferred to the laboratory within two hours using a gel swab and cultured on modified blood agar [6], and incubated aerobically and anaerobically using anaerobic jar, the growing colonies were subjected to some biochemical tests and diagnosed according to the approved diagnostic systems [7,8].

Bacitracin sensitivity test, the bacteria being tested was spreading with a several individual colonies of a pure culture on meuller-hinton agar supplemented with 5% blood and a disk of bacitracin was placed in the plate.

After overnight incubation at 37˚C for 24 hr, a zone of inhibition surrounding the disk indicates the organism was a Group A beta-hemolytic Streptococcus [5].

Strep A rapid test. The Abon Rapid Strep A Test uses a lateral flow immunoassay technique to qualitatively detect the carbohydrate antigen specific for Group A Streptococcus directly from a throat swab [9].

Antibiotic susceptibility Test

The susceptibility of the isolates to antibiotics were against 10 types of antibiotics including Augmentin, Azithromycin, Levofloxacin, Penicillin, Amoxicillin, Erythromycin, Cefotaxime, Ciprofloxacin, Clindamycin, Vancomycin and was determined using the Kirby-Bauer disk diffusion method [10]. The growth inhibition zone around the discs was measured using millimeter ruler bacteria were considered sensitive (S), resistant (R), moderately sensitive (I) by comparing them with [11].

Determination of CBC

A venous blood sample is taken from all patients and healthy groups using an EDTA-containing tube, the sample is placed in an analyzer that automatically counts and evaluates the blood components. The CBC test involves analyzing a sample of the patient's blood using automated hematology analyzers

[Minaray BC-3000 plus].

Statistical analysis

All statistical analyses were performed using GraphPad Prism 10.4.0, the statistical data were articulated as mean ± standard deviation and subjected to comparison via one-way ANOVA in accordance with Tukey's multiple comparisons test, a p-value of less than 0.05 was considered statistically significant.

Results and Discussion

A total of 100 clinical samples were collected from tonsillitis and depending on cultural characteristics on blood agar, 82(82) % samples were yielded positive growth, as shown in table 1 there is no significant difference between males and females, meaning that gender had no effect on the growth of bacterial species in the tonsils, at the same time, some swabs showed no growth in culture plates, this may be because the swabs taken were not from bacterial infections, but rather from other microorganisms, i.e., viral infections that causing tonsils swelling and redding accompanied by fever, so their symptoms are similar to those of bacterial tonsillitis.

Table 1 number of bacterial growths

Throat swab	Male	Female	Total
Growth + ٪	43 52.5%	39 47.5%	82
Growth - ٪	8 44.5%	10 55.5%	18
Total	51	49	100

Isolates which were identified as *S. pyogenes* appeared after 24 hour, semi-transparent, low convex, some colonies were mucoid, small and glistening with the appearance of droplets water, hemolysis as clear zone. Microscopically *S. pyogenes* was found to be Gram positive, spherical or ovoid, and arranged in chains with different long as in figure 1 A, B .

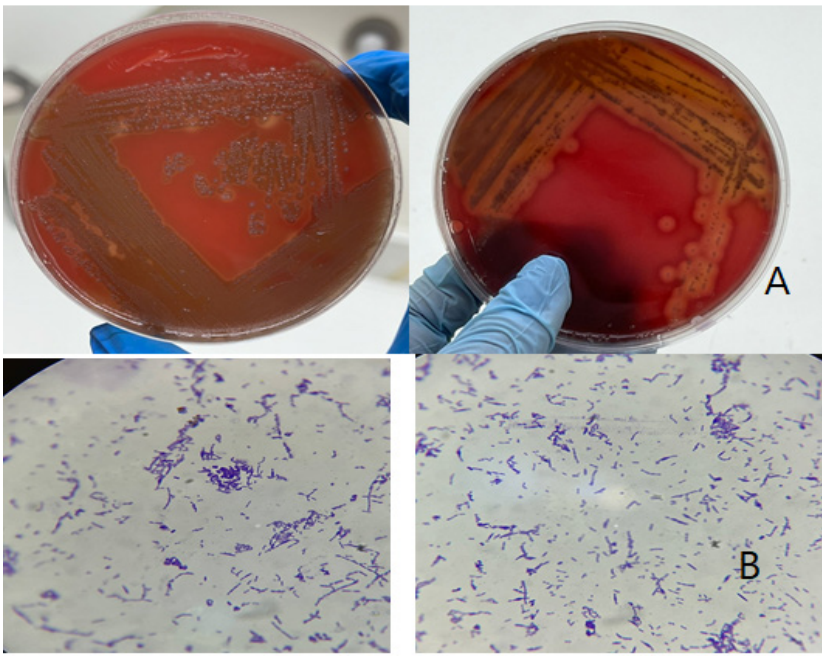

Figure 1 A *S. pyogenes* on blood agar.
B. Gram stain of *S. pyogenes*

The results in table 2 showed the morphological and biochemical tests that performed on isolates under study.

Table 2 Biochemical tests used to diagnose isolates.

Bacteria	Shape	Gve	Hly	Cat.	Ox	Baci.	Op.	**R-test**
S. pyogenes	Streptococci	+	β	-	-	S	R	+
Non GABHS	Streptococci	+	B, α, γ	-	-	R	R	-
S..aureus	Staphylococci	+	β	+	-	R	R	-
Coagulase -	Streptococci	+	α	+	-	R	R	-
S. pneumoniae	Streptococci	+	γ	+	-	R	S	-
Viridians	Streptococci	+	α	-	-	R	R	-
Other bacteria	Bacilli	-	V	+	V	R	R	-

* V: variable, Gve: Gram stain, Hly: Hemolysin, Cat: Catalase, Baci: Bacitracin, Ox: Oxidase, Op.: Optechin, R-test: Strep A rapid test

The bacteriological examination of throat swabs from 82 patients showed a varied array of microbial isolates, with Staphylococci being the most prevalent group 25.61%, succeeded by *S.pyogenes* 19.51% and Viridians groups 15.85%, the identification of *S. pyogenes* in approximately 20% of cases underscores its persistent significance as a pathogen in pharyngeal infections, especially due to its correlation with acute tonsillitis, pharyngitis, and possible post-infectious sequelae like rheumatic fever and glomerulonephritis.

The detection of Non-group A β-hemolytic streptococci (Non-GABHS) in 14.63% of samples indicates that additional streptococcal groups, including groups C and G, may also play a role in pharyngeal inflammation, but often with reduced clinical severity compared to *S. pyogenes*. Viridans streptococci, normally regarded as components of the normal oropharyngeal flora, were identified in a significant proportion (15.85%), however their pathogenic significance is context-dependent and frequently opportunistic.

The detection of coagulase-negative staphylococci (CoNS) in 8.54% of patients and *S. pneumoniae* in 6.10% indicates the polymicrobial composition of the oropharynx, since some isolates may signify colonisation rather than genuine illness.

Nonetheless, 8 isolates (9.76%) were categorized as "other bacteria," perhaps encompassing gram-negative rods or uncommon pathogens.

These findings underscore the diversity of bacterial flora in pharyngeal infections, although *S. pyogenes* is a primary concern, empirical treatment decisions should consider a wider array of potential species, particularly in recurring or unusual cases. The results of the study were consistent with a previous study [12] where 4,062 samples were collected, 471 were positive for *S. pyogenes* 11.5%, which supports the isolation rate of this bacteria in the current study. The isolation results of the current study were similar to those achieved [13], with the isolation rate being 24%, and the percentages of males and females being 45% and 55%, respectively, this confirms the results of our current study. The study also showed a discrepancy in the isolation rate of *S. pyogenes* compared to

studies conducted in other governorates, such as Baghdad [14], where the isolation rate was 34%, and Hillah [15] (59.57%).

Table 3 types of bacteria isolated from throat swab (n= 82)

Bacterial types	No.	%
S. pyogenes	16	19.51%
Non GABHS	12	14.63%
Staphylococci	21	25.61%
Coagulase -	7	8.54%
S. pneumoniae	5	6.10%
Viridians	13	15.85%
Other bacteria	8	9.76%
Total	82	100%

The distribution of Patients According to Age Groups

This study's age-stratified distribution of bacterial isolates reveals significant epidemiological tendencies, the 5–15 years represented the largest proportion of positive throat swabs 41.46%, with *S.pyogenes* identified as the predominant pathogen in this group. this corresponds with recognized clinical information that school-aged children constitute the principal risk group for *S. pyogenes* pharyngitis due to proximity, underdeveloped immunity, and elevated colonization rates.

Conversely, older age groups exhibited a progressive decrease in *S. pyogenes* isolation, with just one case identified in the 45–55 years category, notably, other bacteria, including *S.aureus*, coagulase-negative staphylococci (CoNS), and gram-negative organisms, were more frequently isolated in adults, particularly within the 25–55 age demographic, suggesting a potential alteration in the aetiology of pharyngitis with age or heightened colonization by opportunistic pathogens in adults.

The viridans streptococci, typically regarded as components of the normal

flora, were detected in all age demographics, with a higher prevalence in younger and middle-aged individuals, indicating enduring colonization that may not consistently be harmful, the prevalence of *S. pneumoniae* in older adults, particularly those aged 45–55 years, may indicate a trend of colonization or the possibility for subsequent infections in persons with preexisting respiratory or systemic ailments as in table 4.

These data substantiate the concept that bacterial pharyngitis exhibits age-related variations in pathogen profiles, hence endorsing focused diagnostic and therapeutic strategies. Prioritization of *S. pyogenes* screening and therapy is essential in pediatric populations, but a more comprehensive microbiological evaluation may be required for adult patients exhibiting chronic or unusual symptoms.

The results of the current study were consistent with the findings of a number of previous studies [13, 16] as they showed similarity in the percentages of bacterial isolates, especially *S.pyogenes*, in the age group (5–15 years).

As for the high percentage of *S.aureus* isolation in adults, the results do not consistent with the study of [17] but similar to [18] who found that the percentage of *S.aureus* isolation was 29% and 20%, respectively, these percentages were consistent with the percentages in the current study.

Table 4 shows the distribution of patients by age in the first ages group 5-15 years ,where the age of 5 years is the ideal age to start taking tonsil swabs, the tonsils begin to grow after birth, but they do not reach their full anatomical and functional size until the ages of 4 to 10 years, at this stage, they become more immunologically active and more susceptible to an inflammatory response to antigens, increasing the likelihood of acute bacterial infection caused by *S. pyogenes*, before this age, the tonsils are small and immunologically incomplete, which reduces the appearance of swelling, redness, or exudate that clinical examination and screening require, therefore, taking swabs before this age may not be of high diagnostic value, especially since most cases of tonsillitis in young children (<3–4 years) are caused by non-specific viral infections.

Table 4 number of bacteria isolated from throat swab according to age categories.

Bacteria / Age group	*S. pyogenes*	Non GABHS	*S. aureus*	CoNS	*S. pneumoniae*	viridians	G- ve	Total (%)
5-15 years	**9**	**6**	**12**	**1**	**1**	**5**	**-**	**34 (41.46%)**
15-25 years	**4**	**2**	**4**	**2**	**1**	**2**	**-**	**15 (18.3%)**
25-35 years	**2**	**3**	**5**	**1**	**-**	**3**	**3**	**17 (20.73%)**
35-45 years	**-**	**1**	**-**	**1**	**-**	**1**	**2**	**5 (6.1%)**
45-55 years	**1**	**-**	**-**	**2**	**3**	**2**	**3**	**11 (13.41%)**
Total (%)	**16 (19.51%)**	**12 (14.63%)**	**21 (25.6%)**	**7 (8.54%)**	**5 (6.1%)**	**13 (15.85%)**	**8 (9.77%)**	**82**

Antibiotic susceptibility

As shown in table 5 , *S. pyogenes* showed resistance to Azithromycin 76.5%, Clindamycin 43.8% and Ciprofloxacin 75% While highly sensitive to Amoxicillin 100%, Levofloxacin 100%, Vancomycin 95.5%, Cefotaxime 87.5%.

Based on the findings of this study 90% of the *S. pyogenes* isolates were sensitive to penicillin, which is consistent with other studies conducted in Iraq [19, 20, 21]

This may be due to a deficiency or absence of beta-lactamase production in *S. pyogenes*, However, only some isolates demonstrated resistance to penicillin, Penicillin resistance in *S. pyogenes* may occur through evasion of penicillin treatment by entering epithelial cells, which are poorly penetrated by penicillin, by forming a biofilm, and by protection of *S. pyogenes* by other beta-lactamase-producing bacteria [19].

In the current study, the sensitivity of *S. pyogenes* to antibiotics, erythromycin and cefotaxime, were 87.5%, these results were similar to those in recent studies [22].

The study showed that *S. pyogenes* isolates were sensitivity percentage to Augmentin, vancomycin and azithromycin were 100%, 95.5% and 22.5% respectively, a result somewhat similar to those found in the study of Ali and Wadi [13] who reported that sensitive to vancomycin was 100% but in regarding to Augmentin and azithromycin their results were 75%, and 40% respectively.

A study conducted in Kirkuk Governorate Iraq, showed that a large percentage of *S.pyogenes* isolates obtained from children with throat infections were sensitive to various antibiotics with ampicillin, ceftriaxone, and clindamycin showing sensitivity rates of 95.8%, 81.25%, and 68.75% respectively [23].

Another study reported that *S.pyogenes* sensitive to penicillin and clindamycin with percentage 100% and 95.7%, respectively.

In a study by [24], a total of 2,123 samples were received from patients with respiratory tract infections, of which 50 *S.pyogenes* isolates were obtained, among these strains, 8% were not susceptible to penicillin, the prevalence of resistance to clindamycin and ceftriaxone was 40% and 5.3%, respectively, a result consistent with current findings for clindamycin and penicillin.

Although penicillin's susceptibility rates were good, the worrisome rise in MIC values was concerning, the preferred medication for *S.pyogenes* infections was, penicillin, therefore, was important to reevaluate the penicillin susceptibility patterns, the preferred treatment for penicillin-resistant GAS infections was clindamycin; however, in several investigations, it was also shown that 40% of strains were becoming more resistant to the antibiotic, this emphasizes the necessity of using antibiotics sparingly in order to avoid treatment failures [25], due to its longer half-life amoxicillin was frequently chosen despite being equally effective [26].

Table 5 Antibiotic susceptibility of *Streptococcus pyogenes*

Antibiotics	Interpretation	
	Resistance	Sensitives
	(%)	
Penicillin	10%	90%
Augmentin	0%	100%
Azithromycin	76.5%	22.5%
Amoxicillin	10.5%	88.5%
Cefotaxime	11.5%	87.5%
Ciprofloxacin	75%	25%
Clindamycin	43.8%	56.2%
Erythromycin	11.5%	87.5%
Levofloxacin	0%	100%
Vancomycin	4.5%	95.5%

- For **Ciprofloxacin**, *Streptococcus pyogenes* is generally considered **resistant** even if zone is large.
- For **Vancomycin**, the CLSI does **not recommend disk diffusion** testing; MIC testing is required.
- **Penicillin and Amoxicillin**: *S. pyogenes* is predictably susceptible, so zone size >26 mm = Susceptible.

hematological test

CBC parameters

The analysis of complete blood count (CBC) parameters revealed distinct patterns between patients infected with *S.pyogenes*, those with other bacterial infections, and healthy controls as seen in table 6.

Table 6 levels of CBC parameters between studies groups

CBC parameters	***S.pyogenes*** **16**	**Other patients** **84**	**Control** **25**
Lymphocyte	1.756± 0.3	3.556± 1.6	2.342± 0.56
RBC	4.408± 0.5	4.458± 0.4560	4.452± 0.57
WBC	12.49± 5.16	10.28± 3.41	6.820± 1.4
Granulocytes	9.213± 1.2	6.534± 1.5	4.704± 1.8

The mean lymphocyte count of the *S. pyogenes* are 1.76 $\times 10^9$/L, in other bacteria 3.556$\times 10^9$/L and in control Group are 2.342 $\times 10^9$/L as in table 6.

Tukey's multiple comparisons tests showed in figure 2 mean difference between the groups. These findings suggest that lymphopenia (low lymphocyte count) may be more prominent in *S. pyogenes* infections compared to infections caused by other bacterial agents, One possible explanation is that *S. pyogenes* produces a variety of virulence factors and superantigens, such as streptococcal pyrogenic exotoxins, which may induce lymphocyte apoptosis or redistribution, thereby reducing the circulating lymphocyte count.

The results of the study were consistent with the results reached by [27] who confirmed that some strains of GAS are associated with severity of lymphopenia.

On the other hand, Anderson *et al* [28] found a decrease in B cells (a type of lymphocyte) in patients with *S. pyogenes* induced pharyngitis, as well as a decrease in NK cells, they also found a decrease in the frequency of type 1 helper T cells (Th1), type 17 regulatory T cells (Treg), and T follicular helper cells (TFH) 72 hours after infection, suggesting T cell migration toward the site of infection [29].

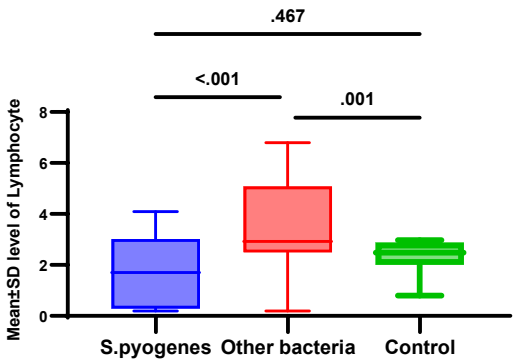

Figure 2 Lymphocytes analysis, *S. pyogenes* vs other bacteria (mean difference = -1.80; 95% CI = -2.82 to -0.78; p < 0.001) *S. pyogenes* vs control (mean difference = -0.59; p = 0.467) other bacteria group vs control (mean difference = 1.21; p = 0.001).

The mean of RBC count of the *S. pyogenes* are 4.408, in other bacteria 4.458and in control Group are 4.452 as in table 6.

The statistical analysis of RBC confirmed that there are no significant differences between the groups as shown in figure 3.

RBC levels remained stable across all groups and were not affected by bacterial infection status in this study, this stability is expected, as RBC count is

not typically altered in acute upper respiratory tract infections, unless there is concurrent anemia, chronic disease, or hemolytic activity, none of which were present or observed in the study population.

The results of this study were identical to the results obtained by [30], who reported that there is no significant differences in the number of RBC.

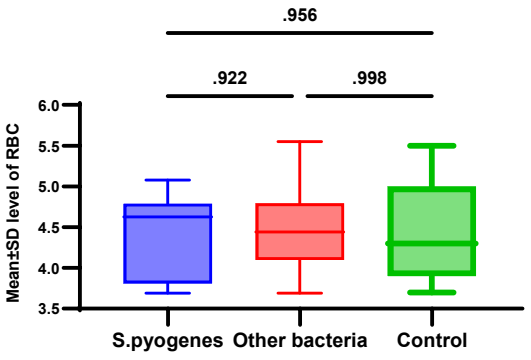

Figure 3,RBS analysis, the mean difference *S. pyogenes* vs other bacteria (mean difference = -0.05083, CI -0.3654 to 0.2637, P=.922) and *S. pyogenes* vs controls was (-0.04450, CI -0.4137 to 0.3247 P=.956) other bacteria vs control (0.006333, CI -0.2564 to 0.2691 P=.998).

The mean counts of WBC in patients infected with *S. pyogenes* , other bacteria and control Group are 12.49, 10.28, 6.820 respectively as in table 6.

WBC results are a consistent feature of bacterial infections in general, but are not uniquely specific to *S. pyogenes*. The elevated WBC count in both *S. pyogenes* and other bacterial groups reflects the expected leukocytosis associated with acute inflammatory responses, particularly driven by neutrophilia, which is commonly triggered by bacterial pathogens.

However, statistical comparisons showed in figure 4, that while the difference between *S. pyogenes* and the control group was highly significant (mean diff = 5.666, $p < 0.001$), the difference between *S. pyogenes* and the other bacteria group was not statistically significant (mean diff = 2.206, $p = 0.126$). In contrast, the difference between the other bacteria and control groups was statistically significant (mean diff = 3.460, $p < 0.001$).

The reviews conducted by [31, 32, 33], on some cases matched, all cases where they infected by *S.pyogenes* had a severe elevation of WBC, which is very consistent with the results of the patients' serum tests taken in this study.

In another study conducted by [34], the WBC count in patients with streptococcal acute tonsillitis reached (12.77±4.85) with a statistical signif-

icance of (P value= 0.001), which is completely consistent with the results of this study (12.49±5.16) with a statistical significance of (P value= 0.001).

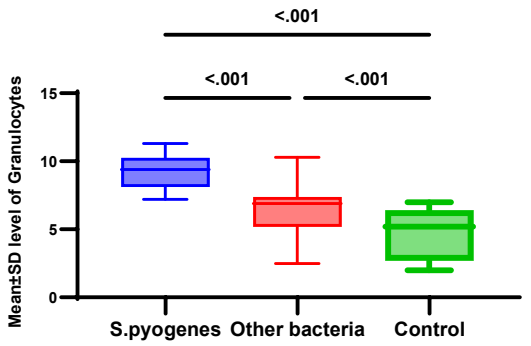

Figure 4- WBC analysis, the mean difference *S. pyogenes* vs other bacteria (5.666, CI 2.537 to 8.796 <.001) and *S. pyogenes* vs controls was (2.206, CI -0.4599 to 4.873, P=. .126) other bacteria vs control (3.460, CI 1.233 to 5.687, <.001).

While Statistical analysis of granulocyte shows the mean counts are 9.213 while other bacteria and control are 6.534 and 4.704 respectively.

The mean difference between *S. pyogenes* and other bacteria was 2.68 ($p < 0.001$), and between *S. pyogenes* and controls was 4.51 ($p < 0.001$) as shown in the figure 5.

The results of the current study were identical to what was reached by [34] as the results of the current study showed a significant increase in the rate of Granulocytes (9.213±1.2) and the other recorded a significant increase measuring (9.076±4.68) with statistical significance ($p < 0.001$).

In another study conducted by [30] who confirmed a significant increase in the number of granulocytes in patients with chronic and acute tonsillitis infected by *S.pyogenes*.

Granulocytes, which include neutrophils, are the first responders in the innate immune system and are significantly elevated in bacterial infections, the markedly increased granulocyte count in *S. pyogenes* infections likely reflects a strong systemic inflammatory response triggered by streptococcal virulence factors, such as M protein and streptolysins [35] this aligns with previous findings where granulocytosis is a common feature in acute streptococcal pharyngitis, serving as an important hematological marker of bacterial etiology and immune activation.

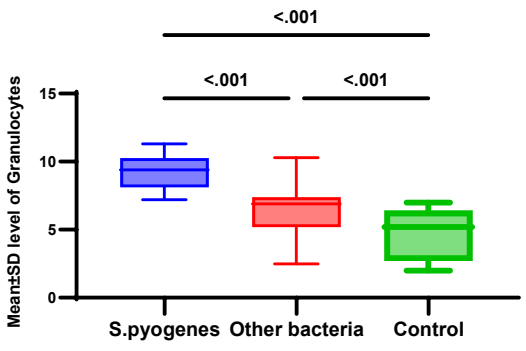

Figure 5 GRA analysis, the mean difference *S. pyogenes* vs other bacteria (2.679, CI 1.661 to 3.696 <.001) and *S. pyogenes* vs controls was (4.509, CI 3.314 to 5.703, <.001) other bacteria vs control (1.830, CI 0.9801 to 2.680, <.001).

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