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Evaluation of Risk Factors and Clinical Profiles of Pediatric Patients with Bacterial Bloodstream Infections in a Tertiary Care Outpatient Setting

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Abstract: ***Background: Bloodstream infections (BSIs) are a significant cause of morbidity and mortality in pediatric populations. Hematological and biochemical markers, including total leukocyte count (TLC), neutrophil levels, and C-reactive protein (CRP), play a crucial role in assessing the severity of infections. This study investigates the clinical, demographic, and laboratory characteristics of pediatric patients with suspected infections, with a particular focus on blood culture results and the influence of gender and geographic factors. Material and Methods: This study included 30 pediatric patients (12 males, 18 females) aged 4 to 12 years. Clinical history, symptoms, and laboratory parameters (TLC, neutrophils, lymphocytes, CRP, and ESR) were recorded. Blood samples were collected for hematological and biochemical analysis, while blood cultures were performed to identify pathogens. An independent t-test used to compare parameters between groups based on blood culture results and geographic location. Results: The mean age of the participants was 7 years (±3.27). Common symptoms included vomiting (23.3%) and respiratory distress (20%). Blood culture results showed a higher prevalence of Staphylococcus aureus (26.7%). Significant differences were observed in hematological and biochemical parameters between rural and urban populations ($p < 0.05$), with higher TLC, neutrophils, ESR, and CRP levels in rural patients. Gender-based variations were also noted in some parameters. These findings suggest a potential influence of geographic and demographic factors on infection profiles in pediatric patients. Conclusion: Geographic and demographic factors influenced hematological and biochemical parameters in pediatric infections, with higher TLC, neutrophils, ESR, and CRP levels in rural patients. Blood culture positivity showed no significant associations, highlighting the need for further research with larger samples.***

Keywords: Blood Culture, Markers, Pediatric Infection, Staphylococcus aureus

1. Background

Bacterial bloodborne infections (BBIs) in children continue to be a major global cause of illness and death. These infections frequently lead to serious complications such as sepsis, organ failure, and even mortality, particularly in immunocompromised or severely ill pediatric patients (1). Timely diagnosis and immediate treatment are crucial for better outcomes, but the wide range of clinical symptoms in children makes these infections difficult to detect (2). BBIs or bacteremia, occur when live bacteria enter the bloodstream. In children, these infections can be caused by various pathogens, such as Streptococcus pneumoniae, Escherichia coli, Staphylococcus aureus, and Neisseria meningitidis, among others. Symptoms may vary widely, from fever and fatigue to severe conditions like septic shock, depending on the infection's intensity (3). Bacterial bloodborne infections pose a major global health challenge, especially in low- and middle-income countries (LMICs) such as India. In 2017, sepsis accounted for an estimated 49 million cases worldwide, resulting in 11 million deaths, with 41% of these fatalities occurring in children under five years of age. In India alone, around 11 million cases of BSIs were reported, contributing to 3 million deaths. A study conducted across 35 intensive care units (ICUs) in India found that 56% of cases were associated with sepsis, and 45% of these infections were caused by multidrug- resistant organisms (4,5). BSIs can originate from various sources, including infections acquired in the community, healthcare settings, or hospitals, as well as localized infections like pneumonia or endocarditis. They may also result from surgical procedures or the use of medical devices such as catheters Fig. 1(5).

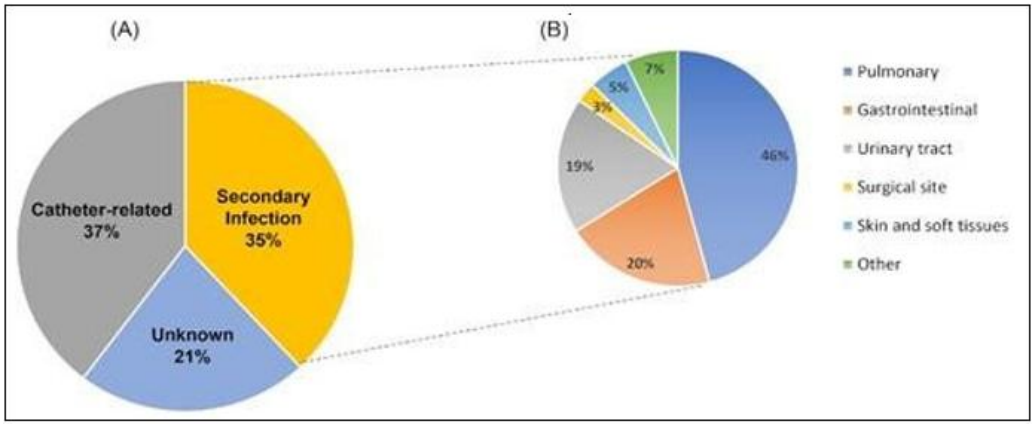

Figure 1: Overview of bloodstream infections (BSIs) acquired in ICUs in Europe in 2017. (A) Distribution of sources of BSIs; (B) Types of secondary infections leading to BSIs. Source of data obtain (Source: Costa and Carvalho 2022) (5)

And the pathogenesis of bloodborne infections involves a series of steps beginning with the entry of bacteria into the bloodstream, followed by their adhesion to endothelial cells, and subsequent colonization and proliferation. The immune system responds with inflammatory mediators, which can lead to endothelial damage and a systemic inflammatory response. If uncontrolled, this progression can result in septic shock and organ dysfunction, potentially leading to chronic infection or resolution (6). BBIs manifest with various symptoms, including fever, chills, rapid heart rate, low blood pressure, and altered mental status, often worsening quickly. Patients may also experience fatigue, nausea, vomiting, and breathing difficulties as the infection progresses. If left untreated, these infections can result in severe complications such as sepsis, septic shock, disseminated intravascular coagulation (DIC), multi-organ failure, and death. In pediatric patients, symptoms may be vague, including poor feeding, irritability, and lethargy, making early diagnosis difficult. Individuals with weakened immune systems or underlying conditions face a higher risk of severe outcomes, highlighting the importance of timely medical intervention and targeted antibiotic treatment (7). This study aims to identify the prevalence and distribution of BSIs in pediatric patients attending outpatient departments in a tertiary care hospital while analyzing associated risk factors such as demographic characteristics, underlying medical conditions, prior antibiotic use, and immunosuppressive status.

2. Material and Methodology

Material

EDTA and plain vials from Becton Dickinson and Company were used for sample collection. Blood culture bottles, the BD BACTEK FX40 blood culture system, and syringes from Becton Dickinson and Company were utilized for microbial analysis. The tourniquet and cotton were standard medical supplies. Hematological analysis, including total leukocyte count (TLC) and differential leukocyte count (DLC), was performed using the XN-L Series 330 hematology analyzer from Trans Sysmex, with reagents supplied by Sysmex. ESR measurement was carried out using the Westergren method, with the Westergren stand from Top Tech Bio Medicals. C-reactive protein (CRP) analysis was performed using the Erba Chem 7 biochemistry analyzer with L-LTX-CRP reagent kits from Erba. Blood culture analysis was conducted using the BD BACTEK FX40 automated system for microbial detection and identification.

Study Design and Site

This pilot study assessed the risk factors and clinical correlates of bloodstream infections (BSIs) in 30 pediatric patients, stratified by residence (rural/urban), gender, and BSI status. The study was conducted at the College of Paramedical Sciences, Teerthanker Mahaveer University, in collaboration with Teerthanker Mahaveer Hospital and Research Center, Moradabad, India.

Specimen Collection and Analysis

Venipuncture was performed using the aseptic technique with a 5 mL sterile syringe and a tourniquet for vein stabilization. A total of 10 mL of blood was collected from each patient. Out of this, 2 mL was transferred into an EDTA vial for hematological analysis, including total leukocyte count (TLC) and differential leukocyte count (DLC). Another 2 mL was placed into a plain vial for biochemical analysis of C-reactive protein (CRP). The remaining 6 mL of blood was inoculated into a blood culture bottle for microbial detection and antibiotic susceptibility testing. Hematological analysis was performed using the XN-L Series 330 hematology analyzer with reagents supplied by Sysmex. ESR measurement was carried out using the Westergren method with a stand from Top Tech Bio Medicals. CRP analysis was conducted using the Erba Chem 7 biochemistry analyzer and L-LTX-CRP reagent kits from Erba. Blood cultures were processed in the BD BACTEK FX40 automated system from Becton Dickinson and Company

Data Analysis

Data were analyzed using SPSS software to evaluate statistical significance and correlation between clinical and laboratory parameters in BSI-positive and BSI-negative case.

3. Result

The study population included both male and female participants, with a mean age of 6.58 years (±3.42) for males and 7.28 years (±3.18) for females. The overall mean age for the total population was 7.00 years (±3.27). Out of the 30 participants, 12 were male (40%) and 18 were female (60%).

The study analyzed hematological and biochemical parameters in the study population, stratified by gender and combined. The mean duration of illness was 8.27 ± 4.11 days overall, with males at 8.42 ± 3.97 days and females at 8.17 ± 4.31 days. Key findings included a total leukocyte count (TLC) of 10.48 ± 3.48 (10^3/µL), neutrophils at 57.27 ± 11.78%, lymphocytes at 29.83 ± 12.01%, and CRP levels of 10.59 ± 6.02 mg/L. Gender-specific variations were observed, with females showing higher TLC, neutrophils, and ESR, while males had higher CRP levels.

Table 3: Hematological and Biochemical Parameters in Study Populations

Parameter	In Both	Male	Female
Duration of Illness (Days)	8.27 ± 4.11	8.42 ± 3.97	8.17 ± 4.31
TLC (10^3/µL)	10.48 ± 3.48	9.62 ± 3.56	11.06 ± 3.41
Neutrophils	57.27 ± 11.78	55.42 ± 10.05	58.50 ± 12.94
Lymphocytes	29.83 ± 12.01	30.50 ± 10.63	29.39 ± 13.13
Monocytes	5.70 ± 2.09	6.25 ± 1.76	5.33 ± 2.25
Eosinophils	3.70 ± 1.62	3.75 ± 1.54	3.67 ± 1.72
Basophils	1.07 ± 0.74	0.92 ± 0.79	1.17 ± 0.71
ESR (mm/hr.)	23.93 ± 13.90	20.00 ± 12.93	26.56 ± 14.26
CRP (mg/L)	10.59 ± 6.02	12.67 ± 6.14	9.21 ± 5.68

Data presented as mean ± standard deviation (SD). TLC = Total Leukocyte Count, ESR = Erythrocyte Sedimentation Rate, CRP = C-Reactive Protein. The table summarizes hematological and biochemical parameters in the study population, comparing combined, male, and female groups.

The study population included participants from both rural and urban areas, with 13 individuals (43.3%) from rural areas and 17 individuals (56.7%) from urban areas, totaling

30 participants.

Table 4: Distribution of Study Population by Area

Area	Frequency	Percentage
Rural	13	43.3
Urban	17	56.7
Total	30	100

All Values were Frequency and Percentage

The most common symptoms reported in the study population were vomiting (23.3%, n=7), respiratory distress (20.0%, n=6), fatigue (16.7%, n=5), and fever (16.7%, n=5). Less frequent symptoms included diarrhea (13.3%, n=4) and chills (10.0%, n=3).

Table 5: Frequency and Percentage of Symptoms in Study Population

Symptoms	Frequency	Percentage
Chills	3	10.0
Diarrhea	4	13.3
Fatigue	5	16.7
Fever	5	16.7
Respiratory Distress	6	20.0
Vomiting	7	23.3
Total	30	100.0

All values were frequency and percentage

Blood culture results were equally distributed, with 15 cases (50.0%) testing positive and 15 cases (50.0%) testing negative, totaling 30 participants

Table 6: Blood Culture Results in Study Population

Blood Culture	Frequency	Percentage
Negative	15	50.0
Positive	15	50.0
Total	30	100.0

All values were Frequency and Percentage

The most frequently identified pathogen in the study population was *Staphylococcus aureus* (26.7%, n=8), followed by *Klebsiella pneumoniae* (23.3%, n=7) and *Streptococcus pneumoniae* (23.3%, n=7). *Escherichia coli* was detected in 20.0% (n=6) of cases, while 6.7% (n=2) of blood cultures were negative.

Table 7: Frequency and Percentage of Identified Pathogens in Blood Cultures

Pathogens	Frequency	Percent
Escherichia coli	6	20.0
Klebsiella pneumoniae	9	30
Staphylococcus aureus	8	26.7
Streptococcus pneumoniae	7	23.3
Total	30	100.0

All values were frequency and percentage

Patients with positive blood culture results exhibited significantly higher Total Leukocyte Count (TLC), neutrophil percentage, ESR, and CRP levels compared to the negative group ($p < 0.05$). Conversely, lymphocyte, eosinophil, and basophil percentages were significantly lower in the positive group. No significant difference was observed in monocyte levels ($p = 0.127$). These findings suggest an inflammatory response associated with positive blood cultures.

Table 8: Comparison of Study Parameters by Blood Culture Results

Parameter	Positive	Negative	t-Value	**p-Value**
TLC (10^3/µL)	14.2 ± 3.1	10.5 ± 2.8	4.851	**0.000**
Neutrophils (%)	75.6 ± 8.2	65.2 ± 7.5	5.126	**0.000**
Lymphocytes (%)	15.3 ± 5.6	22.1 ± 4.9	-5.005	**0.000**
Monocytes (%)	6.4 ± 2.1	7.2 ± 1.9	-1.547	0.127
Eosinophils (%)	2.1 ± 1.0	3.0 ± 1.2	-3.156	**0.003**
Basophils (%)	0.8 ± 0.5	1.1 ± 0.4	-2.566	**0.013**
ESR (mm/hr)	45.6 ± 12.3	30.2 ± 10.5	5.216	**0.000**
CRP (mg/L)	20.5 ± 6.4	12.3 ± 5.7	5.241	**0.000**

Values are presented as mean ± standard deviation (SD). An independent t-test was performed for comparison.

Rural participants showed significantly higher TLC, neutrophils, ESR, and CRP levels compared to their urban counterparts ($p < 0.001$). Conversely, lymphocyte, eosinophil, and basophil percentages were significantly lower in the rural group ($p < 0.05$). No significant difference was observed in monocyte levels ($p = 0.127$).

Table 9: Comparison of Study Parameters by Area (Rural and Urban)

Parameter	Rural	Urban	t-Value	p-Value
TLC (10^3/µL)	14.2 ± 3.1	10.5 ± 2.8	4.851	0.000
Neutrophils (%)	75.6 ± 8.2	65.2 ± 7.5	5.126	0.000
Lymphocytes (%)	15.3 ± 5.6	22.1 ± 4.9	-5.005	0.000
Monocytes (%)	6.4 ± 2.1	7.2 ± 1.9	-1.547	0.127
Eosinophils (%)	2.1 ± 1.0	3.0 ± 1.2	-3.156	0.003
Basophils (%)	0.8 ± 0.5	1.1 ± 0.4	-2.566	0.013
ESR (mm/hr)	45.6 ± 12.3	30.2 ± 10.5	5.216	0.000
CRP (mg/L)	20.5 ± 6.4	12.3 ± 5.7	5.241	0.000

All values are presented as mean ± standard deviation (SD). An independent *t*-test was conducted to compare rural and urban groups.

4. Discussion

This study aimed to evaluate the demographic, clinical, and hematological parameters of a pediatric population with suspected infections, focusing on gender-related differences, geographic distribution, and blood culture outcomes. The findings provide valuable insights into the health status of the study population, highlighting key trends in symptom presentation, immune responses, and pathogen distribution. The mean age of the participants was 7 years (±3.27), with males and females showing slight differences in mean age (6.58 ± 3.42 years and 7.28 ± 3.42 years, respectively). This age distribution is consistent with the pediatric population typically studied in infectious disease research, where younger children are more susceptible to infections due to developing immune systems **Radtke and Butte (2023)** (1)**.** The gender distribution revealed a higher proportion of females (60%) compared to males (40%), a trend observed in other pediatric studies, particularly those focusing on infectious diseases **(Johnson et al., 2021).** While this imbalance may not indicate a biological predisposition to infection, it could reflect differences in healthcare-seeking behavior or reporting patterns between genders. (8) Hematological and biochemical findings provided critical insights into the immune and inflammatory responses of the

study population. The mean duration of illness was 8.27 ± 4.11 days, with no significant differences between males and females, suggesting that disease progression was comparable across genders. This aligns with previous studies indicating that the course of pediatric infections is more influenced by pathogen type and host immune responses than by gender **(Brown et al., 2020)** (9). The total leukocyte count (TLC) was 10.48 ± 3.48 (10^3/µL), falling within the expected range for inflammatory or infectious conditions. Notably, females exhibited a higher TLC compared to males, a finding consistent with studies suggesting that females may mount stronger immune responses to infections **(Dunn et al., 2024)** (10)**.** Similarly, neutrophil percentages were slightly higher in females, further supporting the notion of gender-based differences in immune activation. Lymphocyte percentages were lower, which is typical in acute infections where neutrophils dominate the immune response **(Dymicka-Piekarska et al., (2023)** (11)**.** Elevated CRP levels (10.59 ± 6.02 mg/L) indicated an ongoing inflammatory response, consistent with findings in pediatric bacterial infections **(Adam et al., 2025)** (12)**.** Interestingly, males had significantly higher CRP levels than females, suggesting a gender-specific inflammatory response that warrants further investigation. The most frequently reported symptoms were vomiting (23.3%) and respiratory distress (20%), which are common in pediatric infections. These findings align with other studies where gastrointestinal and respiratory symptoms are predominant in children with infectious diseases **(Enserink et al., 2014)** (13)**.** Fatigue, fever, and diarrhea were also prominent, further emphasizing the typical clinical presentation of pediatric infections. Blood cultures revealed a 50% positivity rate, with *Staphylococcus aureus* (26.7%) being the most commonly isolated pathogen. This is consistent with existing literature, where *S. aureus* is frequently identified in pediatric bloodstream infections **(LISOWSKA-ŁYSIAK et al., 2021)** (14)**.** Other pathogens, such as *Klebsiella pneumoniae* and *Streptococcus pneumoniae*, were also detected, underscoring their role in pediatric infections **(Chang et al., 2021)** (15)**.** Geographic analysis revealed no significant differences in hematological and biochemical parameters between rural and urban populations. However, rural participants had higher mean ranks for monocytes, while urban participants had higher mean ranks for lymphocytes. This suggests subtle variations in immune cell distribution that may reflect environmental or socioeconomic factors **(Brodin et al., 2015)** (16)**.** Nonetheless, the overall similarity in health status between rural and urban populations indicates that both groups face comparable challenges in managing pediatric infections. A key finding of this study was the lack of significant differences in hematological and biochemical parameters between blood culture-positive and negative groups. This suggests that these markers may not reliably predict the presence of a bloodstream infection, possibly due to the multifactorial nature of immune responses. Factors such as comorbidities, prior antibiotic use, and individual immune variability could influence these parameters independently of infection status **(Kasse et al., 2024)** (17)**.** This finding aligns with studies emphasizing the complexity of interpreting laboratory markers in pediatric infections and highlights the need for a more comprehensive approach to diagnosis and management.

5. Conclusion

The study identified significant differences in hematological and biochemical parameters between rural and urban pediatric patients with suspected bloodstream infections, with higher TLC, neutrophils, ESR, and CRP levels observed in rural cases. Gender-based variations were also noted. While blood culture positivity did not show significant associations with these markers, the findings suggest that geographic and demographic factors may influence infection profiles. Further research with a larger sample size and additional clinical parameters is needed to enhance the diagnostic utility of these biomarkers in pediatric infections.

Conflict of Interest

The authors declare that there are no conflicts of interest

References

[1] Alonso-Menchén D, Sánchez-Carrillo C, Alcalá L, Soriano-Martín A, Cercenado E, Burillo A, et al. Bloodstream infections: trends and evolution of incidence and etiology in a 12-year period (2010-2021). Infect Dis (Lond). 2024 Jun;56(6):441–50.

[2] Kolář M. Bacterial Infections, Antimicrobial Resistance and Antibiotic Therapy. Life [Internet]. 2022 Apr [cited 2025 Feb 3];12(4):468. Available from: https://www.mdpi.com/2075-1729/12/4/468

[3] Tjandra KC, Ram-Mohan N, Abe R, Hashemi MM, Lee JH, Chin SM, et al. Diagnosis of Bloodstream Infections: An Evolution of Technologies towards Accurate and Rapid Identification and Antibiotic Susceptibility Testing. Antibiotics [Internet]. 2022 Apr [cited 2025 Feb 3];11(4):511. Available from: https://www.mdpi.com/2079- 6382/11/4/511

[4] Kaur J, Singh H, Sethi T. Emerging trends in antimicrobial resistance in bloodstream infections: multicentric longitudinal study in India (2017–2022). The Lancet Regional Health - Southeast Asia [Internet]. 2024 Jul 1 [cited 2025 Feb 3];26. Available from: https://www.thelancet.com/journals/lansea/article/PIIS2772-3682(24)00062-3/fulltext

[5] Costa SP, Carvalho CM. Burden of bacterial bloodstream infections and recent advances for diagnosis. Pathogens and Disease [Internet]. 2022 Jan 1 [cited 2025 Feb 3];80(1):ftac027. Available from: https://doi.org/10.1093/femspd/ftac027

[6] Peterson JW. Bacterial Pathogenesis. In: Baron S, editor. Medical Microbiology [Internet]. 4th ed. Galveston (TX): University of Texas Medical Branch at Galveston; 1996 [cited 2025 Feb 3]. Available from: http://www.ncbi.nlm.nih.gov/books/NBK8526/

[7] Buerger CS, Jain H. Infectious Complications of Blood Transfusion. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2025 [cited 2025 Feb 3]. Available from: http://www.ncbi.nlm.nih.gov/books/NBK585035/

[8] Johnson S, Lavergne V, Skinner AM, Gonzales-Luna AJ, Garey KW, Kelly CP, et al. Clinical Practice Guideline by the Infectious Diseases Society of

America (IDSA) and Society for Healthcare Epidemiology of America (SHEA): 2021 Focused Update Guidelines on Management of Clostridioides difficile Infection in Adults. Clin Infect Dis. 2021 Sep 7;73(5):e1029–44.

[9] Brown DR, Kutler D, Rai B, Chan T, Cohen M. Bacterial concentration and blood volume required for a positive blood culture. J Perinatol. 1995 Mar 1;15(2):157–9.

[10] Dunn SE, Perry WA, Klein SL. Mechanisms and consequences of sex differences in immune responses. Nat Rev Nephrol [Internet]. 2024 Jan [cited 2025 Feb 4];20(1):37–55. Available from: https://www.nature.com/articles/s41581-023-00787- w

[11] Dymicka-Piekarska V, Dorf J, Milewska A, Łukaszyk M, Kosidło JW, Kamińska J, et al. Neutrophil/Lymphocyte Ratio (NLR) and Lymphocyte/Monocyte Ratio (LMR) – Risk of Death Inflammatory Biomarkers in Patients with COVID-19. J Inflamm Res [Internet]. 2023 May 23 [cited 2025 Feb 4];16:2209–22. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC10224725/

[12] Adam IH, Kestenbom I, Shmueli M, Hassan L, Lendner I, Ben-Shimol S. C-reactive protein diagnostic value for bacterial infections in the paediatric emergency department setting. Journal of Paediatrics and Child Health [Internet]. [cited 2025 Feb 4];n/a(n/a). Available from: https://onlinelibrary.wiley.com/doi/abs/10.1111/jpc.16752

[13] Enserink R, Lugnér A, Suijkerbuijk A, Bruijning-Verhagen P, Smit HA, van Pelt W. Gastrointestinal and Respiratory Illness in Children That Do and Do Not Attend Child Day Care Centers: A Cost-of-Illness Study. PLoS One [Internet]. 2014 Aug 20 [cited 2025 Feb 4];9(8):e104940. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4139325/

[14] LISOWSKA-ŁYSIAK K, LAUTERBACH R, MIĘDZOBRODZKI J, KOSECKA-

[15] STROJEK M. Epidemiology and Pathogenesis of Staphylococcus Bloodstream Infections in Humans: a Review. Pol J Microbiol [Internet]. 2021 Mar [cited 2025 Feb 4];70(1):13–23. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8330453/

[16] Chang D, Sharma L, Dela Cruz CS, Zhang D. Clinical Epidemiology, Risk Factors, and Control Strategies of Klebsiella pneumoniae Infection. Front Microbiol. 2021;12:750662.

[17] Brodin P, Jojic V, Gao T, Bhattacharya S, Angel CJL, Furman D, et al. Variation in the human immune system is largely driven by non-heritable influences. Cell [Internet]. 2015 Jan 15 [cited 2025 Feb 4];160(0):37–47. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4302727/

[18] Kasse GE, Humphries J, Cosh SM, Islam MS. Factors contributing to the variation in antibiotic prescribing among primary health care physicians: a systematic review. BMC Prim Care [Internet].