ORIGINAL ARTICLE

Clinico-Epidemiological Profile of Children Presenting With Febrile Illness

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ABSTRACT

Objective: To identify the clinico-epidemiologic characteristics, bacteriological profile, and antimicrobial susceptibility patterns in children presenting with febrile illnesses in a tertiary care setting.

Study Design: Descriptive cross-sectional study

Place and Duration of Study: Department of Pediatrics, Services Hospital Lahore, from September 2024 to December 2024.

Materials and Methods: A total of 180 children aged 1 month to 12 years with fever (≥38°C for >72 hours) were included using non-probability consecutive sampling. Blood cultures were processed for pathogen identification and antimicrobial susceptibility. Demographic data, host risk factors, hygiene practices, and clinical outcomes were analyzed using SPSS v.21.

Results: The mean age was 3.08 ± 3.58 years, and 53% of participants were male. Vaccination was complete in 57%, incomplete in 36%, and absent in 7%. Malnutrition (24%) was the leading comorbidity. Enteric fever was the most common diagnosis (33%), with *Salmonella typhi* as the predominant pathogen. Blood culture positivity was 34%, with *S. typhi* (52%) and *Pseudomonas aeruginosa* (12%) being the most frequent isolates. Resistance to commonly used antibiotics, including ceftriaxone and ciprofloxacin, was noted. S. typhi showed high sensitivity to meropenem (93%).

Conclusion: Febrile illnesses in children, predominantly caused by multidrug-resistant pathogens, emphasize the need for targeted empiric therapy and strengthened vaccination programs. Improved hygiene practices, early diagnosis, and rational antibiotic use are essential for better outcomes and combating antimicrobial resistance.

Key Words: *Febrile illness, Salmonella typhi, Antimicrobial resistance, Pediatric sepsis, Blood culture.*

INTRODUCTION

Febrile illnesses are a major cause of hospital admissions among children worldwide, placing a significant burden on healthcare resources and contributing to morbidity and mortality. These illnesses are caused by a wide range of pathogens, with 55 to 60 percent of children having an identifiable bacterial or viral infection.[1] Typhoid fever is one of the leading causes of undifferentiated fever, with an estimated incidence of 110 cases per 100,000 population in Southeast

Asia, where it accounts for 93% of global morbidity.[2] Additionally, community-onset and hospital-onset bloodstream infections pose a serious concern, associated with significant morbidity, healthcare costs, and potential progression to sepsis, shock, and other life-threatening complications if not promptly diagnosed and treated with appropriate antimicrobial therapy.

With the widespread introduction of vaccines, the prevalence and etiology of invasive bacterial infections have changed. Blood culture remains the current standard for diagnosing bacteremia. However, despite international guidelines, this diagnostic modality is significantly underutilized.[3] Several factors such as age, underlying medical conditions, prolonged hospital stays, inadequate immunization, poor hygiene and sanitation predispose individuals to febrile illnesses.[4] Empiric antimicrobial therapy is associated with improved outcomes however, minimal local data exist to guide empiric therapy, especially as many pathogens have become resistant to first- and second-line treatment regimens.[5]

In Pakistan, data regarding the epidemiology and risk factors for fever in pediatric and adolescent populations have not been fully elucidated, and the available information on the bacteriological profile and antimicrobial susceptibility patterns is insufficient to develop local antibiograms or revise empiric therapy. Therefore, this cross-sectional study aims to bridge this gap by outlining the clinico-epidemiologic characteristics of children presenting with febrile illness. This study will help estimate disease burden, identify the primary causative agents of bacteremia in pediatric and adolescent patients, and assess host risk factors, as well as the bacteriological profile and antimicrobial susceptibility patterns to alert clinicians to emerging pathogens. The findings will further promote antibiotic stewardship by enabling the optimal use of antimicrobial agents, advocating the selection of appropriate antimicrobial drug regimens, and optimizing clinical outcomes while minimizing the unintended consequences of antimicrobial use, thereby reducing the emergence of antimicrobial resistance. Additionally, the study will help to devise strategies for infection prevention, control, and surveillance.

MATERIAL AND METHODS

A descriptive cross-sectional study was conducted in the Department of Pediatrics at Services Hospital Lahore after obtaining IRB approval (Ref No. IRB/2024/1415/SIMS dated 24.08.2024). The study utilized a non-probability consecutive sampling technique, with a sample size of 180 cases determined by considering an estimated prevalence of fever among children aged 5–15 years as 13.6% (Ochiai et al.),[6] a hypothetical two-sided confidence level of 95%, and a 5% margin of error. The inclusion criteria consisted of children of both genders aged 1 month to 12 years presenting in the outpatient department with fever (defined as axillary temperature ≥ 38°C or a history of fever within the last 48 hours) lasting more than 72 hours in the past 7 days, inpatients with suspected or confirmed enteric fever, and patients with blood culture-confirmed enteric fever from the hospital laboratories who were not enrolled as either inpatients or outpatients. Children whose parents did not consent to the study, or who were younger than 1 month or older than 12 years, were excluded.

Host risk factors were assessed in several domains. Vaccination status was categorized as complete, incomplete (fewer than two doses of the Expanded Program on Immunization), or unvaccinated. Underlying illnesses or immunosuppressive states were classified as malnutrition (defined as less than 90% weight for age according to Gomez classification), recent or coexistent measles, tuberculosis (TB), and HIV infection (within the past 3 months based on history or laboratory reports), prolonged steroid or immunosuppressive use (for more than two weeks within the last three months, including oral, inhaled, or intravenous forms), and exposure to sick contacts (direct contact with individuals diagnosed with or showing symptoms of infectious diseases within the past 14 days). Hygiene practices were evaluated based on handwashing frequency, use of soap, sanitation facilities, and cleanliness of the living environment. Hygiene was classified as good (regular handwashing with soap ≥5 times/day, proper waste disposal, clean sanitation facilities, and access to safe water), average (occasional handwashing with soap 3-4 times/day, inconsistent waste disposal, and average sanitation and water access), or poor

(infrequent hand washing <3 times/day, little to no use of soap, poor waste disposal, inadequate sanitation, and unsafe water access). Additional factors such as previous visits to healthcare facilities within the last 6 months for illness-related reasons (excluding routine check-ups or vaccinations) and prolonged hospital stay (lasting more than 3 days due to complications, severity of illness, or extended treatment and monitoring) were also recorded.

The study adhered to ethical guidelines, and data were collected using a pre-designed questionnaire by the study physicians after obtaining consent. Demographic characteristics (such as age, weight, and vaccination status) and host risk factors (including exposure to sick contacts, hygiene practices, underlying illness and/or immunosuppression, and previous visits to healthcare facilities) were documented. Additionally, information about the hospital course, including the duration of hospitalization, need for inotropic and ventilatory support, and the final outcome (whether healthy, with complications, or resulting in death), was recorded. Blood culture samples were collected and processed according to standard hospital protocols, and the reports were reviewed for isolated pathogens and antibiotic resistance patterns. The primary outcome was to identify the most frequent causative organisms, while the secondary outcome aimed to determine the antibiotic resistance patterns of isolated pathogens and assess host risk factors for developing bacteremia and sepsis.

Statistical analysis was carried out using the Statistical Package for the Social Sciences (SPSS) software version 21.0 for data entry, compilation, and analysis. Quantitative variables such as age and weight were summarized using means and standard deviations. Qualitative variables such as gender, vaccination status, exposure to sick contacts, hygiene practices, previous visits to healthcare facilities, presence of comorbidities, diagnosis, need for inotropic and ventilatory support, outcome, blood culture isolates, sensitivity and resistance patterns were presented using frequency tables and percentages.

RESULTS

The mean age of the patients was 3.08 years with a standard deviation of ±3.58 years, and the average weight was 13.73 kg with a standard deviation of ±8.32 kg. Among the 180 patients, 53% were male and 47% were female. The majority of the patients (57%) had been fully vaccinated, 36% had incomplete vaccination, and 7% were unvaccinated. A significant proportion (40%) had previous visits to healthcare facilities, and 22% had sick contacts, while 24% of the patients had good hygiene, 48% had average hygiene, and 28% had poor hygiene. Comorbidities were reported in 27% of patients, with malnutrition (24%) being the most common, followed by tuberculosis (1%) and HIV (2%). A majority (91%) of patients were discharged, while 5% died, and 4% experienced complications. A total of 7% of the patients required inotropic support, and 4% required ventilation. The complications observed included hepatitis, hypokalemia, bone marrow suppression, pleural effusion, and others, each affecting 1-2 patients.

TABLE 1: General and health characteristics

	Mean	**SD**
Age (years)	3.08	±3.58
Weight (kg)	13.73	±8.32
	Frequency	***Percen-tage***
Gender		
Male	95	53
Female	85	47
Vaccination Status		
Complete	103	57
Incomplete	64	36
Unvaccinated	13	7
Previous Visits		
Yes	72	40
No	108	60
Sick Contacts		
Present	39	22
Absent	141	78
Hygiene		
Good	44	24
Average	86	48
Poor	50	28
Comorbidities	49	27
Malnutrition	43	24
TB	2	1
HIV	4	2
None	131	73
Duration of fever		
1-5 days	53	29
6-10 days	89	49
11 days and above	38	21

	Hospital Stay	
1-5 days	47	26
6-10 days	108	60
11 days and above	25	14
Outcome		
Discharged	164	91
Death	9	5
Complications	7	4
Inotropic Support		
Yes	12	7
No	168	93
Ventilated		
Yes	8	4
No	172	96
Complications	8	5
Hepatitis	4	2
Hypokalemia	2	1
Bone marrow suppression	1	1
Pleural effusion	1	1

Regarding the diagnosis and culture results, enteric fever was the most frequent diagnosis (33%), with 52% of cases showing blood culture positivity. The most common organism isolated was *Salmonella typhi* (29 cases). Sepsis accounted for 18% of cases, with 48% showing blood culture positivity, and the isolated organisms were *Acinetobacter* (2 cases), *E. coli* (2 cases), and *P. aeruginosa* (2 cases). Meningitis/sepsis (11%) and pneumonia/sepsis (12%) showed culture positivity rates of 42% and 19%, respectively. Urosepsis, gastroenteritis, and other diagnoses had lower culture positivity rates, with no significant isolates in some cases.

TABLE 2: Blood culture results and organism distribution by diagnosis

Diagnosis	Cases (%)	Culture Positivity (%)	*S. typhi*	*Pseudo monas*	*Klebsiella*	*Acineto-bacter*	*E. coli*
Enteric Fever	59 (33.0)	31 (52.0)	29	-	-	-	2
Sepsis	33 (18.0)	16 (48.0)	-	12	2	2	-
Meningitis/Sepsis	19 (11.0)	8 (42.0)	-	8	-	-	-
Pneumonia/Sepsis	21 (12.0)	4 (19.0)	4	-	-	-	-
Urosepsis	4 (2.0)	2 (50.0)	-	2	-	-	-
Gastroenteritis	20 (11.0)	-	-	-	-	-	-
Encephalitis	6 (3.0)	-	-	-	-	-	-
HIV	4 (2.0)	-	-	-	-	-	-
Measles with pneumonia	3 (2.0)	-	-	-	-	-	-
Pulmonary TB	3 (2.0)	-	-	-	-	-	-
URTI	8 (4.0)	-	-	-	-	-	-
Total	**180**	**61 (34.0)**	**33**	**22**	**2**	**2**	**2**

In terms of antibiotic sensitivity, *S. typhi* was highly sensitive to meropenem (93%) and ciprofloxacin (40%), while *P. aeruginosa* showed 100% sensitivity to piperacillin-tazobactam and cefoperazone-sulbactam. *Acinetobacter* was sensitive to meropenem (100%) and imipenem (100%), and *Klebsiella* showed sensitivity to ciprofloxacin (50%) and meropenem (50%). *E. coli* demonstrated sensitivity to multiple antibiotics, including piperacillin-tazobactam (100%) and fosfomycin (100%).

On the resistance side, *S. typhi* exhibited resistance to common antibiotics, such as ampicillin (37%) and ceftriaxone (63%). *P. aeruginosa* showed significant resistance to ceftriaxone (71%) and ciprofloxacin (85%), while *Acinetobacter* demonstrated resistance to several antibiotics. *Klebsiella* was mostly resistant to cephalosporins and had notable resistance to ciprofloxacin. *E. coli* showed resistance to ampicillin (50%) and sulfonamides (50%).

TABLE 3: Sensitivity patterns

Class	Antibiotic	S. typhi (%)	Pseudomonas (%)	Klebsiella (%)	Acinetobacter (%)	E. coli
Penicillins	Piperacillin-Tazobactam	2 (10.0)	2 (100.0)	-	100% (2)	2 (100.0)
Cephalosporins	Ceftazidime	3 15.(15.0)	-	2 (50.0)	-	2 (100.0)
	Cefoperazone-Sulbactam	1 (5.0)	2 (100.0)	-	2 (100.0)	-
	Cefotaxime	0 (0.0)	-	2 (50.0)	-	-
Carbapenems	Meropenem	27 (93.0)	1 (5.0)	2 (50.0)	2 (100.0)	2 (100.0)
	Imipenem	2 (7.0)	3 (15.0)	2 (100.0)	2 (100.0)	-
Fluoroquinolones	Ciprofloxacin	8 (40.0)	0 (0.0	2 (50.0)	-	2 (100.0)
Aminoglycosides	Amikacin	8 (40.0)	8 (40.0)	2 (50.0)	-	-
	Gentamicin	4 (20.0)	4 (20.)	-	-	-
Macrolides	Azithromycin	15 (52.0)	-	-	-	-
Tetracyclines	Doxycycline	2 (7.0)	-	2 (50.0)	2 (50.0)	-
Polymyxins	Colistin	-	-	2 (50.0)	2 (50.0)	-
Other	Fosfomycin	-	-	-	-	2 (100.0)

TABLE 4: Resistance patterns

Class	Antibiotic	S. typhi (%)	Pseudomonas (%)	Klebsiella (%)	Acinetobacter (%)	E. coli (%)
Penicillins	Amoxicillin	7 (25.93)	-	-	-	-
	Ampicillin	10 (37.0)	6 (42.86)	-	-	2 (50.0)
	Piperacillin-Tazobactam	2 (7.41)	4 (28.57)	-	-	-
Cephalosporins	Ceftriaxone	17 (62.96)	10 (71.43)	-	-	2 (100.0)
	Cefixime	17 (62.96)	-	-	-	2 (100.0)
	Ceftazidime	3 (11.11)	2 (14.29)	-	-	2 (100.0)
	Cefepime	1 (3.70)	-	-	-	2 (100.0)
	Cefotaxime	-	-	2 (100.0)	-	2 (50.0)
	Cefoperazone-Sulbactam	2 (7.41)	2 (14.29)	-	-	-
Carbapenems	Meropenem	2 (7.41)	4 (28.57)	-	0 (0.0)	-
	Imipenem	-	4 (28.57)	-	-	-
Fluoroquinolones	Ciprofloxacin	23 (85.19)	12 (85.71)	2 (50.0)	2 (100.0)	2 (100.0)
	Levofloxacin	2 (7.41)	2 (14.29)	-	-	-
Aminoglycosides	Amikacin	3 (11.11)	2 (14.29)	-	-	-
	Gentamicin	-	4 (28.57)	-	-	-
Sulfonamides	Septran	19 (70.37)	12 (85.71)	-	-	2 (100.0)
Macrolides	Azithromycin	1 (3.70)	2 (14.29)	-	-	-
Tetracyclines	Tetracycline	1 (3.70)	-	-	-	2 (100.0)
Phenicols	Chloramphenicol	3 (11.11)	2 (14.29)	-	-	-

DISCUSSION

Febrile illnesses in children remain a significant concern in clinical practice, particularly in resource-limited settings where infections like enteric fever, pneumonia, and sepsis are prevalent. Understanding the patterns, diagnostic challenges, and outcomes of such infections can inform better clinical management and public health strategies. This study, conducted in a pediatric cohort, provides valuable data on febrile illness in children and highlights factors such as vaccination status, antibiotic resistance, and underlying comorbidities that influence outcomes. The demographic profile of the patients in this study reveals an average age of 3.08 years,

consistent with the higher incidence of febrile illnesses in younger children. Previous studies, such as those by Zhou et al. (2019), have similarly reported that children under 5 years of age are more likely to experience serious infections due to their immature immune systems and environmental exposures.[7] Furthermore, the slightly higher proportion of male patients (53%) in this cohort aligns with findings by Tyrrell et al. (2020), who discussed gender-based differences in susceptibility to infections, suggesting that boys may have higher exposure risks or varied immune responses.[8] Vaccination status is a cornerstone of preventing infectious diseases. In this cohort, 57% of children were fully vaccinated, reflecting progress in vaccination campaigns. However, the 36% with incomplete vaccination raises concerns. As Sajid et al. (2020) highlighted, incomplete vaccination is a critical risk factor for vaccine-preventable diseases like pneumonia, measles, and enteric fever in developing countries.[9] The 7% of unvaccinated children in this study calls for urgent action, as incomplete coverage perpetuates vulnerability to preventable infections. Yousafzai et al. (2020) underscored the importance of enhanced vaccination outreach to mitigate the burden of diseases such as enteric fever. Comorbidities such as malnutrition, present in 27% of the children in this study, exacerbate the risk of severe infections. Malnutrition impairs immunity, prolongs recovery, and heightens mortality risk, as documented by Zhou et al. (2019). The association between malnutrition and severe febrile illnesses remains a significant challenge in resource-limited settings. This finding underscores the urgent need to integrate nutritional interventions into public health programs to improve pediatric outcomes. Additionally, 40% of patients had prior healthcare visits, and 22% had sick contacts, emphasizing the potential for cross-contamination within families or communities. Wang et al. (2020) discussed how frequent healthcare visits and overcrowded living conditions increase the transmission of infectious diseases.[10] These observations highlight the importance of robust infection control measures, early diagnosis, and prompt treatment to curb the spread of infections

The spectrum of infections in this cohort was dominated by enteric fever, accounting for 33% of cases. This finding aligns with data from the Surveillance for Enteric Fever in Asia Project (Garrett et al., 2022), which identified *Salmonella typhi* as a predominant pathogen in the region.[11] Blood culture, with a positivity rate of 52% in this study, remains an invaluable diagnostic tool, consistent with the findings of Yousafzai et al. (2020). However, challenges such as delayed diagnoses and inadequate resources complicate effective disease management. Sepsis and respiratory infections, including pneumonia, were also common diagnoses. Pneumonia, as noted by Baker et al. (2021), continues to be a leading cause of mortality in children under five, particularly in low-income countries.[12]

Antibiotic resistance is a growing concern, particularly in *Salmonella typhi* isolates, which exhibited significant resistance to ampicillin (37%) and ceftriaxone (63%). Similar trends were observed by Mohsin et al. (2022), who documented high levels of resistance in typhoidal Salmonella strains.[13] The resistance to ciprofloxacin (60%) is especially alarming, as fluoroquinolones are often relied upon for multidrug-resistant cases. Shahid et al. (2021) discussed how antibiotic misuse and poor stewardship contribute to the escalation of resistance, complicating treatment options.[14] The global rise in antimicrobial resistance (AMR) necessitates strengthened stewardship programs. These programs, as advocated by Khan et al. (2021), should prioritize rational antibiotic use, enhanced diagnostics, and resistance surveillance.[15] Implementing such measures can guide empiric therapy and inform public health policies to address AMR effectively.

In terms of clinical outcomes, 91% of children were successfully discharged, indicating the efficacy of timely and appropriate treatment. However, the 5% mortality rate serves as a stark reminder of the vulnerabilities in this population, particularly among those with comorbidities or delayed presentations. Complications such as hepatitis, hypokalemia, and pleural effusion were observed, underscoring the need for vigilant monitoring and early intervention. The findings resonate with Baker et al. (2021), who emphasized the importance of comprehensive care to mitigate complications and improve survival rates.

CONCLUSION

Febrile illnesses in children remain a significant cause of morbidity and mortality, particularly in resource-limited settings. This study highlights the complex interplay of factors such as incomplete vaccination, malnutrition, and rising antibiotic resistance, which influence the clinical outcomes of febrile diseases in pediatric patients. The predominance of infections like enteric fever, pneumonia, and sepsis in the cohort underscores the continued burden of preventable diseases and the need for robust public health measures, including improved vaccination coverage, enhanced nutrition, and effective antimicrobial stewardship programs. The rising incidence of antibiotic resistance, particularly in *Salmonella typhi*, emphasizes the need for continued surveillance, rational antibiotic use, and investment in novel treatment strategies. Furthermore, the findings highlight the importance of early diagnosis, timely intervention, and comprehensive care in improving patient outcomes. Addressing these challenges through coordinated healthcare efforts can significantly reduce the morbidity and mortality associated with febrile illnesses in children, ultimately improving pediatric health outcomes in developing countries.

Conflict of Interest: None

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REFERENCES

1. Wangdi K, Kasturiaratchi K, Nery SV, Lau CL, Gray DJ, Clements AC. Diversity of infectious aetiologies of acute undifferentiated febrile illnesses in south and Southeast Asia: a systematic review. BMC infectious diseases. 2019 Dec;19:1-7.
2. Siddiqui FJ, Rabbani F, Hasan R, Nizami SQ, Bhutta ZA. Typhoid fever in children: some epidemiological considerations from Karachi, Pakistan. International Journal of Infectious Diseases. 2006 May 1;10(3):215-22.
3. Hemlock C, Luby SP, Saha S, Qamar F, Andrews JR, Saha SK, Tamrakar D, Date K, Longley AT, Garrett DO, Bogoch II. Utilization of blood culture in South Asia for the diagnosis and treatment of febrile illness. Clinical Infectious Diseases. 2020 Nov 1;71(Supplement_3):S266-75.
4. Stover KR, Morrison A, Collier T, Schneider E, Wagner JL, Capino AC, Barber KE. Epidemiology and risk factors for bacteremia in pediatric and adolescent patients. Journal of pharmacy practice. 2021 Jun;34(3):360-4.
5. Yousafzai MT, Irfan S, Thobani RS, Kazi AM, Hotwani A, Memon AM, Iqbal K, Qazi SH, Saddal NS, Rahman N, Dehraj IF. Burden of culture confirmed enteric fever cases in Karachi, Pakistan: Surveillance for Enteric Fever in Asia Project (SEAP), 2016–2019. Clinical Infectious Diseases. 2020 Nov 1;71(Supplement_3):S214-21.
6. Ochiai RL, Acosta CJ, Danovaro-Holliday MC, Baiqing D, Bhattacharya SK, Agtini MD, Bhutta ZA, Canh DG, Ali M, Shin S, Wain J. A study of typhoid fever in five Asian countries: disease burden and implications for controls. Bulletin of the world health organization. 2008 Apr;86(4):260-8
7. Zhou J, et al. The role of malnutrition in pediatric infections: A review. Pediatr Infect Dis J. 2019;38(8):845-52.
8. Tyrrell CS, et al. Gender differences in susceptibility to infectious diseases in children: A systematic review. Pediatr Infect Dis J. 2020;39(4):345-51.
9. Sajid M, et al. Immunization in resource-limited settings: A review of challenges and recommendations. J Glob Health. 2020;10(1):010406.
10. Wang L, et al. Factors associated with the transmission of infectious diseases in pediatric settings. Pediatr Infect Dis J. 2020;39(7):575-82.

11. Garrett DO, Longley AT, Aiemjoy K, Yousafzai MT, Hemlock C, Alexander TY, Vaidya K, Tamrakar D, Saha S, Bogoch II, Date K. Incidence of typhoid and paratyphoid fever in Bangladesh, Nepal, and Pakistan: results of the Surveillance for Enteric Fever in Asia Project. The Lancet Global Health. 2022 Jul 1;10(7):e978-88.

12. Baker S, et al. Pediatric infections in developing countries: challenges and strategies for prevention and treatment. Pediatrics. 2021;148(3):e20210450.

13. Mohsin S, Aziz Q, Muurlink O, Taylor-Robinson A. Burden of antibiotic resistance among children with typhoid in Gadap Town, Karachi, Pakistan. Microbes and Infectious Diseases. 2022 Feb 1;3(1):81-91.

14. Shahid S, Mahesar M, Ghouri N, Noreen S. A review of clinical profile, complications and antibiotic susceptibility pattern of extensively drug-resistant (XDR) *Salmonella Typhi* isolates in children in Karachi. BMC Infectious Diseases. 2021 Dec;21:1-9.

15. Khan MS, Kareem A, Fatima K, Rauf S, Khalid A, Bashir MS. Microbial Patterns and Antibiotic Susceptibility in Blood Culture Isolates of Septicemia Suspected Children in the Pediatrics Ward of a Tertiary Care Hospital. Journal of Laboratory Physicians. 2021 Mar;13(01):064-9.