

SJMLS - 10 (4) - 004

Risks Associated with Urinary Tract Infections Among Under Five Aged Children in Lagos StateBernice Enobong Udoh^{*1}, Toyosi Raheem^{1,2}, Bamidele Iwalokun².Department of Biological Science, Faculty of Natural & Applied Sciences, Lead City University, Ibadan¹, Molecular Biology and Biotechnology Department, Nigerian Institute of Medical Research², Yaba, Lagos.Author for Correspondence*: enobern2020@gmail.com/+234-802-356-0218.
<https://dx.doi.org/10.4314/sokjmls.v10i4.4>**Abstract**

The most common bacterial infection in childhood is urinary tract infection which usually triggers fever. There are varieties of infectious agents that triggers fever including bacterial pathogens. We aimed to identify the risks associated with urinary tract infections among febrile children attending Primary Health Care facilities in Lagos. A total of 660 venous Blood and mid-stream urine samples were collected from study participants with acute fever 37.5°C from May to November, 2024 and analyzed at the Nigerian Institute of Medical Research, Yaba, Lagos. The participants were recruited from Primary Health Centres in the 3 senatorial districts of Lagos covering Alimosho, Surulere and Ikorodu LGA. Bacterial isolates were identified using Microbact[™] gnb 24E test kit. Sociodemographic data of participants were also assessed. We tested 660 venous blood and the mid-stream urine samples of participants from Alimosho, Surulere, and Ikorodu LGA in Lagos. Equal numbers of participants of 220 in each site were enrolled with consent of their caregivers. A total of 63 Gram negative bacteria were isolated from the participants. Species of bacteria isolated were *Escherichia coli* (22), *Klebsiella spp* (20), *Acinetobacter spp* (8), *Citrobacter spp* (8), *Enterobacter spp* (3), *Stenotrophoma sp* (1), and *Averyella sp* (1). The commonest pathogen found in all sites was *Escherichia coli* (35%:22 of 63). Co-infections of bacteremia and UTIs was 65% (41 of 63) with participants from Ikorodu having the highest number (56%:23 of 41). Low haemoglobin level (< 10g/dl) was found in 51 % of participants with coinfections of bacteremia and UTIs.

Diagnosing children with febrile illness of bacterial etiology unveiled risks of UTIs among under-5aged children.

Keywords: Bacteremia, Co-infections, Haemoglobin, Febrile illness, Urinary tract infection

Introduction:

Young children with urinary tract infections usually have non-specific signs including fever which are rarely diagnosed accurately unlike adults. These children may present symptoms such as poor appetite, failure to thrive, lethargy, irritability, vomiting, or diarrhoea (Marks *et al.*, 2021). In low- and middle-income countries especially those in Africa, up to 80% of children who visit healthcare facility present with an acute febrile illness (AFI) (Von Kalckreuth *et al.*, 2016; Herlihy *et al.*, 2016 & Marks *et al.*, 2021). Malaria is mostly attributed to fever in Africa even though bacterial, fungal, and parasitic causes exist (Shrestha *et al.*, 2020 & Marks *et al.*, 2021). Due to economic constraints, most diagnosis are narrowed to exclude these possible causes (Aigheyisi & Egoro, 2019).

In Nigeria, children below the age of 14 years constituted more than 40% of the population (Emgard *et al.*, 2019) while children aged five years and below constitute the bulk of patients attending the pediatrics out-patient clinics (Iroh *et al.*, 2016, GBD, 2017 & Maze *et al.*, 2018). These age groups are particularly vulnerable to many communicable and infectious diseases, and mortality among them is usually very high (Panzner *et al.*, 2016 & Masoud, 2021).

Urinary tract infection is the most common

bacterial infection in young children (La Scola *et al.*, 2018; Kalal & Nagaraj, 2016). About 30% of infants and children experience recurrent infections after the initial UTI with varieties of symptoms (Roberts & Wald, 2018). The incidence of UTIs depends on age and gender. The prevalence is higher in males than females (4:2) in first year of life (Tullus & Shaikh, 2020). Most infections are caused by *Escherichia coli*, although in the first year of life *Klebsiella pneumoniae*, *Enterobacter spp*, *Enterococcus spp* and *Pseudomonas spp* are more frequent than later in life, and there is a higher risk of urosepsis compared with adulthood (Stein *et al.*, 2015; Tullus & Shaikh, 2020).

Urinary tract infections usually lead to cystitis and pyelonephritis. Cystitis (lower urinary tract) is inflammation of the urinary bladder mucosa with symptoms including dysuria, stranguria, frequency, urgency, malodorous urine, incontinence, haematuria, and suprapubic pain. Pyelonephritis (upper urinary tract) is diffuse pyogenic infection of the renal pelvis and parenchyma with symptoms including fever (Swerkerson *et al.*, 2016 & Shaikh *et al.*, 2020). Bacteraemia is usually associated with UTIs and can progress to sepsis when immune system is weakened (Hercik *et al.*, 2018 & Moore *et al.*, 2019).

Therefore, further diagnosis must be applied to rule out other causes of febrile illness, for improved prognosis and aversion of mortality rate among these children. In this study we investigated the presence of bacterial pathogens in blood and urine specimens collected from under 5 aged children attending selected primary health centres (PHCs) in Lagos. Identification of bacterial pathogens was done using Microbact[™] gnb 24e test kit approach with the goal of obtaining additional insights into the risks associated with urinary tract infections in little children.

Materials and Methods

Venous blood and mid-stream urine samples collected from under 5 aged children attending selected primary health care facilities in Alimosho, Surulere and Ikorodu L.G.A were analyzed at the Nigerian Institute of Medical

Research, Lagos. The recruited primary health care facilities (Meiran, Akowonjo, Ikotun, Orile-Iganmu, and Igbogbo PHCs) are public institutions providing comprehensive medical care to patients of all ages in Lagos state.

A total of 220 subjects from each L.G.A, with a total of 660 participants in all the sites, were recruited with written informed consent from their caregivers/ parents. The inclusion criteria was under 5 aged children with fever who tested negative for malaria infection and were residence in the study area. Clinical examinations and questionnaires were employed to obtain sociodemographic data and other information such as sources of drinking water. Laboratory analyses were carried out at NIMR. A clean voided midstream urine sample was collected after cleaning the external genitalia. Urinary tract infection was excluded following the guidelines of European Association of Urology (EAU)/European Society for Paediatric Urology (ESPU). Urinary tract infection was excluded if the dipstick was negative for both leukocyte esterase and nitrite or microscopic analysis was negative for both pyuria and bacteriuria (Stein *et al.*, 2015; Hay *et al.*, 2016, Tullus and Shaikh, 2020). The classical definition of >10⁵ CFU/ml of voided urine was still used to define significant UTI (Liu *et al.*, 2016; Tullus, 2016; Stocker *et al.*, 2021). Identification of bacterial isolates was done using Microbact[™] gnb24E bacterial identification test kit.

Statistical analyses were performed using SPSS version 26 and body temperature was calculated by taking the axillary temperature measurement (Crump and Kirk, 2015; Eleven *et al.*, 2020; Marks *et al.*, 2021).

Ethical approval (IRB/23/098) for this study was obtained from the Health Research, Ethics committee, of Nigerian Institute of Medical Research (NIMR), Lagos. Administrative approval and permission was further obtained from the Lagos State Primary Health Care Board.

Results

Table 1: Features of Study Participants by location

Features of participants	Alimosho Site	Surulere Site	Ikorodu Site	Total
Mean Age (Years)	3.5	3.9	3.2	
Number (%) of Males	77 (35%)	88 (40%)	106 (48%)	271 (41%)
Number(%) of Infected Males	7 (23%)	7 (23%)	16 (54%)	30 (48%)
Number (%) of Females	143 (65%)	132 (60%)	114 (52%)	389 (59%)
Number (%) of Infected Females	13 (39%)	5 (15%)	15 (46%)	33 (52%)
Source of Drinking water				
Bore-hole	166 (75%)	202 (92%)	143 (65%)	511 (77%)
Others	54 (25%)	18 (8%)	77 (35%)	149 (23%)
Participants with UTI and Bacteremia	10	7	22	39
Coinfection				
Number (%) of Co-infected participants with Hb< 10g/dl	10 (100%)	7 (100%)	19 (86%)	36 (92%)

Table 2: Bacterial Isolates and Frequency of Participants infected by Site

Bacterial Isolates	Specimen Isolated from	Freq. of Participants Infected in Alimosho	Freq. of Participants Infected in Surulere	Freq. of Participants Infected in Ikorodu	Total
Escherichia coli	Blood plus Urine	5	2	7	14
	Blood only	2	1	2	5
	Urine only	1	1	1	3
Klebsiella Oxytoca	Blood plus Urine	1	2	2	5
	Blood only	2	-	1	3
Klebsiella ozaenae	Blood plus Urine	-	1	3	4
	Blood only	-	-	1	1
Klebsiella ascorbata	Blood plus Urine	1	-	3	4
Klebsiella pneumoniae	Blood only	-	1	1	2
Citrobacter freundii	Blood plus Urine	-	-	3	3
	Blood only	1	-	-	2
Citrobacter gillenii	Blood plus Urine	-	-	1	1
	Blood only	-	1	1	2
	Urine only	1	-	-	1
Acinetobacter baumannii	Blood plus Urine	2	1	1	4
	Blood only	-	-	1	1

Acinetobacter haemolyticus	Blood plus urine	1	-	1	2
	Blood only	1	-	-	1
	Urine only	-	-	1	1
Enterobacter agglomerans	Blood plus Urine	-	1	1	2
	Blood only	-	1	-	1
Stenotrophoma maltophilia	Blood plus urine	1	-	-	1
Averyella dalhousiensis	Blood only	-	-	1	1

We tested 660 venous blood and the mid-stream urine samples of participants from Alimosho, Surulere, and Ikorodu LGA in Lagos. Equal numbers of participants of 220 in each site were enrolled with consent obtained from their caregivers. Baseline characteristics of the participants are listed in table 1. Total number of male participants were 271(41%), bacterial pathogens were isolated from 30 (48%) of them, while 389 (59%) female participants were enrolled for the study and 33 (52%) of them were found with bacterial pathogens.

The oldest participants were from Surulere with a mean age of 3.9 while the youngest were from Ikorodu with a mean age of 3.2. The majority of participants from the 3 sites used borehole as their primary source of drinking water (77%) while a reasonable number of participants (35%) from Ikorodu still used other sources of drinking water. Participants with UTI plus bacteremia coinfection were 10, 7 and 22, from Alimosho, Surulere and Ikorodu respectively. Low haemoglobin level (Hb < 10g/dl) was observed in the majority of the participants (92%) with coinfection.

In table 2, The Microbact test kit identified 63 bacterial pathogens of which the most frequent pathogen identified in all the sites were *E. coli*

(22) and *Klebsiella spp* (19). A rare pathogen, *Averyella dalhousiensis* was found only in Ikorodu site. The frequency of bacterial isolates found in each specimen were: blood (18), urine (5), both urine and blood (40). There is significant association between bacteremia and UTI in which most of the pathogens were found.

Discussion

This study provides an update on the recent spectrum of Gram-negative bacterial isolates causing febrile illness in children. Upon analyzing 660 venous blood and urine samples of under 5 aged children with febrile illness, 9.6% (63 of 660) were found to be infected (Table 1). Despite good source of drinking water (Borehole:79%) bacterial pathogens were still found in the participants enrolled for this study. Generally, Lagos residents rely on ground water as their major source of drinking water, but a reasonable number (35%) at Ikorodu still depends on other sources of natural water which surrounds the locality and could be used for various needs. There is significant lack of well-maintained public water facilities in Lagos, where urban development processes frequently take place. Previous reports by Obiora and Onwuka (2005) and recent report by Aigheyasi and Edore (2019) indicated that this may lead to contamination of water bodies with domestic waste including shallow ground water that is less than 70m deep.

The number of infected females were 52% (33 of 63) and males 48% (30 of 63). This finding is contrary with previous reports by Tullus and Shaikh (2020) who reported that males are mostly infected with UTI in their early years. This may be attributed to the higher number of female participants attending the healthcare facilities and consequently being enrolled for the study. Moreso, young children with presumptive UTIs, around 20% of cultures show lower bacterial numbers than the generally used cutoff of 10^5 CFU/mL (Ombelet *et al.*, 2019; Tullus and Shaikh, 2020). Majority of the participants with coinfection of UTI and bacteremia had low haemoglobin values (Hb<10g/dl:92%). This may be an additional risk associated with UTI, although previous report by Aigheyisi and Edo (2019) suggests that poor nutrition due to economic constraint in the country as a whole may be a contributing factor.

In Table 2, the most prevalent pathogen found in all the study sites was *E. coli* (35%: 22 of 63). This finding is consistent with previous studies by Tullus and Shaikh (2020) and Stocker *et al.*, (2021), although in the first year of life *Klebsiella pneumoniae*, *Enterobacter spp*, *Enterococcus spp*, and *Pseudomonas spp* are more frequent than later in life, and there is a higher risk of urosepsis compared with adulthood (Stocker *et al.*, 2021). Most of the bacterial isolates (64%) were found to be present in both blood and urine samples. Bacteremia is a recognized risk associated with UTIs (CDC,2019; Marks *et al.*, 2021) and it's not unique to any particular region, its occurrence in Nigerian children is not unexpected given the potential for bacterial spread especially in such communities where natural water serves as bathing site for everyone. The commonest bacteria found in all the study sites were, *E. coli*, *K. oxytoca*, *K. ozaenae*, *A. baumannii* and *C. gillenii*. *Acinetobacter baumannii* is among the WHO priority list of multi-drug resistant bacteria (Abade *et al.*, 2018; Tacconelli *et al.*, 2018; Mabrouk *et al.*, 2020; Wasfi *et al.*, 2021). A rare bacterial pathogen (*Averyella dalhousiensis*) was isolated from a participant in Ikorodu. This bacterial pathogen is capable of causing sepsis if immunity is low (Andrew *et al.*,2017; Olorukooba *et al.*, 2020). Bacteremia

can progress to sepsis when the immune system overreacts to the infection and attacks normal tissues and organs (Mostafa *et al.*, 2022, Smith and Nehring, 2023).

Conclusion and Recommendations

This study has revealed the presence of bacterial pathogens in blood and urine samples of the participants. We have noticed bacteremia and low haemoglobin to be associated with urinary tract infections among these febrile children, hence attributing febrile illness to largely malaria infection is not encouraged. It is recommended that we conduct a comprehensive medical investigation on children presenting to healthcare centers with febrile illness to rule out non-malarial causes of febrile illness. This will lead to proper management and treatment of these children and thereby reduce under 5 mortality rates in Nigeria.

Disclosure

The authors declared no conflicts of interest. No funding was received for this study.

References

- Abade, A., Eidex, R.B., Maro, A., *et al.* (2018). Use of TaqMan Array Cards to screen outbreak specimens for causes of febrile illness in Tanzania. *American Journal of Tropical Medicine and Hygiene*; **98**:1640–1642.
- Aigheyisi, O.S. and Edo, J.O. (2019). Asymmetric Effects of Money Supply Growth on Economic Growth in Nigeria: An Empirical Investigation. *Kardan Journal of Economics and Management Sciences*: Doi:10.31841/KJEMS.2021.51.
- Andrew, S., Johnson, S., Cheryl, L., Tarr B., Brown, H. Jr., Karen, M., Birkhead, J. and Farmer, J. (2017). First Case of Septicemia Due to a Strain Belonging to Enteric Group 58 (Enterobacteriaceae) and Its Designation as *Averyella dalhousiensis* gen. nov., sp. nov., Based on Analysis of Strains from 20 Additional Cases. *Journal Of Clinical Microbiology*; **43**:5195–5201.
- Crump, J.A., Kirk, M.D. (2015). Estimating the burden of febrile illnesses. *PLoS Neglected Tropical Diseases*; **9**:e0004040.
- Elven, J., Dahal, P., Ashley, E.A., *et al.* (2020). Non-malarial febrile illness: a systematic

- review of published aetiological studies and case reports from Africa, 1980-2015. *BioMed Central*; **18**:279.
- Emgard, M., Suya, S.E., Nyombi, B.M., Masha, D., Gonzales-Siles, L., Norden, R., *et al.* (2019). Carriage of penicillin-non-susceptible pneumococci among children in northern Tanzania in the 13-valent pneumococcal vaccine era. *International Journal of Infectious Diseases*; **81**:156–166.
- Global Burden of Disease (2018) Disease and Injury Incidence and Prevalence Collaborators. Global, regional, and national incidence, prevalence, and years lived with disability for 354 diseases and injuries for 195 countries and territories, 1990–2017: a systematic analysis for the Global Burden of Disease Study 2017. *Lancet*; **392(10159)**:1789–858.
- Hay, A.D., Birnie, K., Busby, J., *et al.* (2016). The Diagnosis of Urinary Tract infection in Young children (DUTY): a diagnostic prospective observational study to derive and validate a clinical algorithm for the diagnosis of urinary tract infection in children presenting to primary care with an acute illness. *Health Technology Assessment*; **20**: 1–294.
- Hercik, C., Cosmas, L., Mogeni, O.D., *et al.* (2018). A combined syndromic approach to examine viral, bacterial, and parasitic agents among febrile patients: a pilot study in Kilombero, Tanzania. *American Journal of Tropical Medicine and Hygiene*; **98**:625–632.
- Herlihy, J.M., D'Acromont, V., Hay Burgess, D.C. and Hamer, D.H. (2016) Diagnosis and treatment of the febrile child. In: Black RE, Laxminarayan R, Temmerman M, Walker N, (2016). Reproductive, maternal, newborn, and child health: disease control priorities, 3rd ed. Vol 2. *Washington (DC): The International Bank for Reconstruction and Development / The World Bank*; 2016.
- Iroh, P.Y., Obaro, S.K. and Storch, G. (2016). Challenges in the etiology and diagnosis of acute febrile illness in children in low- and middle-income countries. *Journal of the Pediatric Infectious Diseases Society*; **5**:190–205.
- Kalal, B.S. and Nagaraj, S. (2016). Urinary tract infections: a retrospective, descriptive study of causative organisms and antimicrobial pattern of samples received for culture, from a tertiary care setting. *Germs*; **6**:132-8. <https://doi.org/10.11599/germs.2016.1100>.
- Liu, J., Ochieng, C., Wiersma, S., *et al.* (2016). Development of a TaqMan array card for acute-febrile-illness outbreak investigation and surveillance of emerging pathogens, including Ebola virus. *Journal of Clinical Microbiology*; **54**:49–58.
- La Scola, C., De Shaikh, N., Hoberman, A., Hum, S.W., *et al.* (2018). Development and validation of a calculator for estimating the probability of urinary tract infection in young febrile children. *Journal of American Medical Association Pediatrics*; **172**: 550–556.
- Marks, F., Liu J., Soura A.B., Gasmelseed, N.J., Operario, D.J., Grundy, B., John Wieser, J., Gratz, J., Meyer, C.J., Justin, I., Lim, J.K., Kalckreuth, V., Espinoza, L.M., Konings, F. and Jeon, H.J (2021). Pathogens that cause acute febrile illness among children and adolescents in Burkina Faso, Madagascar and Sudan. *Clinical Infectious Diseases*. **73(8)**:1338-1345.
- Mostafa, S.H., Saleh, S.E., Hamed, S.M. and Aboshanab, K.M. (2022). Febrile illness of bacterial etiology in a public fever hospital in Egypt: High burden of multidrug resistance and WHO priority Gram negative pathogens. *Germs*; **12(1)**:75-85. doi: 10.18683/germs.2022.1308.
- Mabrouk, S.S., Abdellatif, G.R., El-Ansary, M.R., Aboshanab, K.M. and Ragab, Y.M. (2020). Carbapenemase producers among extensive drug-resistant gram-negative pathogens recovered from febrile neutrophilic patients in Egypt. *Infectious Drug Resistance*; **13**:3113-24. <https://doi.org/10.2147/IDR.S269971>.
- Masoud, S.M., Abd El-Baky, R.M., Aly, S.A and Ibrahim, R.A. (2021). Coexistence of certain ESBLs, MBLs and plasmid mediated quinolone resistance genes among MDR *E. coli* isolated from different clinical specimens in Egypt. *Antibiotics (Basel)*; **10**: 835.
- Maze, M.J., Bassat, Q., Feasey, N.A., Mandomando, I., Musicha, P. and Crump, J.A. (2018). The epidemiology of febrile illness in sub-Saharan Africa: implications for diagnosis and management. *Clinical*

- Microbiology and Infection*; **24**:808–814.
- Moore, C.C., Jacob, S.T. and Banura, P., *et al.* (2019). Etiology of sepsis in Uganda using a quantitative polymerase chain reaction-based TaqMan Array Card. *Clinical Infectious Diseases*; **68**:266–272.
- Ombelet, S., Barbé, B., Affolabi, D., *et al.* (2019) Best practices of blood cultures in low- and middle-income countries. *Frontiers of Medicine (Lausanne)*; **6**:131.
- Stein, R., Dogan, H.S., Hoebeke, P., Koċvara, R., Nijman, R.J., Serdar, C. and Tekgu, S. (2015). Urinary Tract Infections in Children: EAU/ESPU Guidelines 0302-2838/ European Association of Urology. *Published by Elsevier B.V.A. European Urology* **67**:546–558. <http://dx.doi.org/10.1016/j.eururo.2014.11.007>.
- Olorukooba, A.A., Ifusemu, W.R., Ibrahim, M.S., Jibril, M.B., Amadu, L. and Lawal, B. (2020). Prevalence and Factors associated with Neonatal Sepsis in a Tertiary Hospital, North West Nigeria. *Nigerian Journal of Medicine*; **61**:60-66.
- Panzner, U., Pak, G.D., Aaby, P., *et al.* (2016). Utilization of healthcare in the Typhoid Fever Surveillance in Africa Program. *Clinical Infectious Diseases*; **62** Suppl 1: S56–68.
- Roberts, K.B. and Wald, E.R. (2018). The diagnosis of UTI: colony count criteria revisited. *Pediatrics*; **141**: e20173239.
- Stocker, M., van Herk, W., El Helou, S., *et al.* (2021). C-reactive protein, procalcitonin, and white blood count to rule out neonatal early-onset sepsis within 36 hours: A secondary analysis of the neonatal procalcitonin intervention study. *Clinical Infectious Diseases* **73**(2): e383–e390. doi: 10.1093/cid/ciaa876.
- Smith, D.A. and Nehring, S.M. (2023). Bacteremia. *National Institute of Health (NIH)*. <https://www.ncbi.nih.gov>.
- Tacconelli, E., Carrara, E., Savoldi, A., *et al.* (2018). Discovery, research, and development of new antibiotics: the WHO priority list of antibiotic-resistant bacteria and tuberculosis. *Lancet Infectious Diseases*; **18**:318-327. [https://doi.org/10.1016/S1473-3099\(17\)30753-3](https://doi.org/10.1016/S1473-3099(17)30753-3).
- Tullus, K. and Shaikh, N. (2020). Urinary tract infections in children. *The Lancet*; **395**:112-127.
- Shaikh, N., Osio, V.A., Wessel, C.B. and Jeong, J.H. (2020). Prevalence of asymptomatic bacteriuria in children: a meta-analysis. *Journal of Pediatrics*; **217**: 110–117.
- Shane, A.L., Mody, R.K., Crump, J.A., *et al.* (2017). Infectious Diseases Society of America Clinical practice guidelines for the diagnosis and management of infectious diarrhea. *Clinical Infectious Diseases*; **65**:1963-73. <https://doi.org/10.1093/cid/cix959>.
- Shrestha, P., Dahal, P., Ogbonnaa-Njoku, C., *et al.* (2020). Non-malarial febrile illness: a systematic review of published aetiological studies and case reports from Southern Asia and South-eastern Asia, 1980-2015. *BMC Medicine*; **18**:299. <https://doi.org/10.1186/s12916-020-01745-0>.
- Swerkersson, S., Jodal, U., Åhrén, C., Sixt, R., Stokland, E. and Hansson, S. (2016). Urinary tract infection in infants: the significance of low bacterial count. *Journal of Pediatric Nephrology*; **31**: 239–245.
- Wasfi, R., Rasslan, F., Hassan, S.S., Ashour, H.M. and Abd ElRahman, O.A. (2021). Co-existence of carbapenemase-encoding genes in *Acinetobacter baumannii* from cancer patients. *Infectious Diseases and Therapies*; **10**:291-305. <https://doi.org/10.1007/s40121-020-00369-4>.
- Von Kalckreuth, V., Konings, F., Aaby, P., *et al.* (2016). The typhoid fever surveillance in Africa Program (TSAP): clinical, diagnostic, and epidemiological methodologies. *Clinical Infectious Diseases*; **62**(1):S9–S16.

Citation: Bernice Enobong Udoh, Toyosi Raheem, Bamidele Iwalokun. Risks Associated with Urinary Tract Infections Among Under Five Aged Children in Lagos State. *Sokoto Journal of Medical Laboratory Science*; **10**(4): 40–47. <https://dx.doi.org/10.4314/sokjmls.v10i4.4>

Copyright: This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.