EUROPEAN ACADEMIC RESEARCH
Vol. VI, Issue 5/ August 2018

Impact Factor: 3.4546 (UIF)
DRJI Value: 5.9 (B+)

ISSN 2286-4822
www.euacademic.org

Significant bilharzia associated bacteriuria in Abu Rukba Sudanese Village

HUSAMELDIN ABDALLA BAKHIT
Dr. PhD, Assistant Professor, Dean of the faculty
White Nile University, Faculty of Medical Laboratory Sciences
White Nile State, Kosti City, Sudan
SAMAH SID AHMED MOHAMED SALIH ELSAFI
MSc, PhD student, Head, Department of Microbiology Laboratory
National Health Insurance, Microbiology Laboratory
White Nile State, Kosti city, Sudan
MOHAMMED BAHA ELDIN AHMED SAAD
PhD, Professor
Omdurman Ahlia Univesity, Faculty of Medical Laboratory Science
Omdurman, Sudan
FARID KOUSEIBATI
Dr, PhD in Medical Biochemistry, Laboratory Director
AL-Mujtahed Medical Laboratory, Bab Mussala Square
Damascus, Syria
Head of Laboratories in Tcshreen Teaching Hospital (1980-2000)
HADI ABD
Dr., Honorary Assistant Professor
Medicine Doctor PhD in Clinical Laboratory Sciences-parasitology
Senior Researcher
University of Medical Sciences and Technology
Faculty of Medical Laboratory Sciences, Department of Parasitology
Khartoum, Sudan
EYAD MOHAMMAD ALSHAMMARI
Dr., PhD., Professor, previous Dean the college
University of Hail, College of Applied Medical Sciences
Department of Clinical Nutrition, Hail, Saudi Arabia

Abstract:

Bilharzia or Schistosomiasis is a parasitic disease affects 200 million people worldwide and is considered one of the most serious infections. Schistosoma haematobium is pathogenic to humans and causes blood in the urine and sometimes in the stool. However,

haematuria may enhance bacterial growth in bilharzia patients' urinary tract, but studies on the relationship between bilharzia and urinary tract infection from different regions are conflicting. We aimed to study association between urinary tract bacterial infections and schistosomiasis, and antibiotic susceptibility pattern of isolated bacteria, in Abu Rukba village in the White Nile State, Sudan. Microscopy, cultivation, biomedical analysis and antibiotic susceptibility were utilised to identify S. haematobium and isolated bacteria. Both gram-positive and gram-negative bacteria were isolated from the samples. The gram-positive bacteria were Staphylococcus aureus and Enterococcus faecalis compared the gram-negative bacteria that were Escherichia coli, Klebsiella pneumoniae and Proteus species. The most frequent bacteria in S. haematobium positive and S. haematobium negative samples were S. aureus, E. faecalis, E. coli, K. pneumonia, respectively. Prevalence of bilharzia associated bacteriuria (29%) differed significantly from that of bacteriuria alone (21%) since p value of $\chi 2$ was 0.04. The isolated bacteria were susceptible to most antibiotics utilised in this study. Number of growing bacteria in the S. haematobium positive samples was significantly more than number of growing bacteria in the S. haematobium negative samples. Thus schistosomiasis might enhance Bilharzia associated bacteriuria due to biology of schistosomes.

Key words: Bilharzia, Urinary Tract Bacterial infections, Significant Association, Antibiotic susceptibility.

INTRODUCTION

Schistosomiasis is a parasitic disease caused by digenetic blood trematodes. The three main species infecting humans are *Schistosoma haematobium, S. japonicum,* and *S. mansoni.* Two other species, more localized geographically, are *S. mekongi* and *S. intercalatum*[1]. *S. haematobium* is the causative agent of Bilharzia disease (schistosomiasis).The disease affects 200 million people worldwide and is considered one the most serious infections today[2, 3]. *S. haematobium* has a very complex life

cycle that is distinct from many trematodes in that the sexes are separate in this species. Adult males are around 10 mm and females are 15 mm in length. Both sexes of *S. haematobium* have a strong oral sucker and a smaller posterior ventral sucker. Males have a gynecophoral canal where females are usually located. Both male and females must remain together for long periods of time in order for the males to fertilize the females having uterus can contain 20-200 eggs[1, 4, 5]. *S. haematobium* is pathogenic to humans and causes blood in the urine and sometimes in the stool. Persons affected by *S. haematobium* may also develop cough, fever, skin inflammation, and tenderness of the liver because the spined eggs attach to vital organs and cause tissue degeneration. Later stages of the disease may be characterized by the swelling and damaging of the bladder, liver, and other organs. The eggs of *S. haematobium* can clog the bladder neck and cause infection. Many researchers have also observed damage on other body structures. Chronic schistosomiasis raises the incidence of bladder cancer in many Middle Eastern countries[2], [3]. Bilharzia is a common public health problem in the world[1]. Individuals may acquire the disease during contact with water containing cercariae of the parasite[2]. *S. haematobium* is responsible for majority of deaths due to schistosomiasis in the world[3]. Schistosomiasis is a major tropical and subtropical disease commonly found widespread in many African countries and other developing countries in Asia and South America. It is the second most prevalent tropical disease after malaria[4]. Association between schistosomiasis and bacteriuria is not clear yet since Pugh and Gilles (1979) and Eyong et al. (2008), found no association between bacteriuria and schistosomiasis in Mahufashi area in Northern Nigeria[6, 7].While, Adeyeba and Ojeaga (2002) found 920 out of 1600 (57.5%) were infected with *S. haematobium* and the frequency of bacteremia was 75.4%[8]. We examined 1029 urine samples for schistosomiasis and

bacteriuria and published an article about the result of schistosomiasis only[9] and kept result of bacteriuria to this study that aimed to investigate prevalence of bacteriuria in 594 *S. haematobium* positive and 435 *S. haematobium* negative urine samples collected from the 1029 individuals in Abu Rukba village in the White Nile State of Sudan, in order to clarify the association between urinary tract bacterial infections and schistosomiasis, in addition to estimate antibiotic susceptibility pattern of isolated bacteria.

MATERIAL AND METHODS

Study design, area, and sample collection

A longitudinal case control study was conducted in Abu Rukba village in the White Nile State that is situated 94 Km south west of Kosti, Sudan. The study was carried out on a population of 1029 individuals (513 males and 516 females) including pupils, house wives, farmers and workers that subdivided into 5 age groups. The study commenced in November 2011 and ended in November 2013.

Midstream urine samples were collected aseptically as possible, in a sterile wide mouth container in the morning. Each individual was asked to do some exercise before taking the urine specimen. All samples were processed by the laboratory within 2 hours of collection, or were kept refrigerated at 4º C until delivery to the laboratory and were processed no longer than 4 hours after collection.

Cultivation of urine samples, identification of growing bacteria and susceptibility to antibiotics

The urine samples were cultured on Cysteine Lactose Electrolyte Deficient (CLED) agar plates and incubated aerobically at 37°C overnight[10]. Identification of growing bacteria was performed according to standard bacteriological

methods. Sensitivity of bacteria to each antibiotic was carried out by measuring the diameter of inhibition zone of bacterial growth around the disc, and compared with a standard table[10].

Statistical analyses

Chi-2 test was used for comparison between numbers of growing bacteria in the *S. haematobium* positive samples and numbers of growing bacteria in the *S. haematobium* negative samples. A p value of ≤ 0.05 was considered statistically significant.

RESULTS

An elevated number of urinary tract bacterial infections in *S. haematobium* positive urine samples

Out of 594 positive urine samples for *S. haematobium*, 294 samples were positive for bacteria. The 435 negative urine samples for *S. haematobium* exhibited bacterial growth in 215 samples (Figure 1).

Prevalence of bilharzia associated bacteriuria was 29% and that of bacteriuria alone was 21%. The statistical analysis showed that number of growing bacteria in the *S. haematobium* positive samples was significantly more than number of growing bacteria in the *S. haematobium* negative samples (P of $\chi 2$ was 0.04).

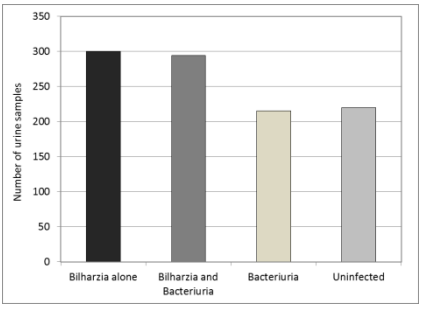

Figure 1: Number of urine samples positive for bilharzia alone, both bilharzia and bacteriuria, bacteriuria alone and uninfected urine samples.

Distribution of bilharzia alone, bilharzia associated bacteriuria and bacteriuria alone in the population according age groups

Numbers of bilharzia alone, bilharzia associated bacteriuria and bacteriuria alone in age groups 1-10, 11-20, 21-30, 31-40 and over 40 year for the examined population were 146, 143 and 89; 120, 118 and 70; 13, 14 and 13; 11, 10 and 10; 10, 9 and 33, respectively (Tab le 1). Group 1-10 year was the most infected group with bilharzia alone, bilharzia associated bacteriuria and bacteriuria alone. Group 31-40 was the less infected. Each group did not show significant difference between bacteriuria alone and bilharzia associated bacteriuria. But the difference between total numbers of bilharzia alone, bilharzia associated bacteriuria and bacteriuria alone (300, 294 and 215) was significant since p of $\chi 2$ was 0.04 (Table 1).

Table 1: Numbers of bilharzia alone, bilharzia associated bacteriuria and bacteriuria alone in the population

Age in year	Bilharzia only	Bilharzia associated bacteriuria	Bactiruria only	Uninfected samples	Total	P of $\chi 2$
1-10	146	143	89	90	468	> 0.05
11-20	120	118	70	72	380	> 0.05
21-30	13	14	13	14	54	> 0.05
31-40	11	10	10	11	42	> 0.05
Over 40	10	9	33	33	85	> 0.05
Total	300	294	215	220	1029	< 0.05

Distribution of bilharzia associated bacteruria and bacteruria alone in the population according gender

Bakhit et al. 2014 studied bilharzia distribution between 513 males and 516 females out of 1029 population and found 317/513 of the males compared to 277/516 of the females had bilharzia. Here, we studied distribution of bacteriuria in bilharzia positive and negative urine samples and found 157/317 of the males compared to 137/277 of the females who had bilharzia also had bacteriuria (Table 2).

Table 2: Bilharzia associated bacteriuria in gender groups

Gender	Examined	Bilharzia associated Bacteriuria	Frequency %	*P* of $\chi 2$
Males	317	157	27	> 0.05
Females	277	137	23	
Total	594	294	49.5	

Distribution of bacteriuria in bilharzia negative urine samples showed that 115/232 of males and 100/202 of the females had bacteriuria (Table 3).

Table 3: Bacteriuria in bilharzia negative samples in gender groups

Gender	Examined	Bacteriuria	Frequency %	*P* of $\chi 2$
Males	232	115	26	> 0.05
Females	202	100	23	
Total	435	215	49	

Growth of bacteria in *S. haematobium* positive and *S. haematobium* negative urine samples

Bacterial culture of the *S. haematobium* positive urine samples revealed growth of *Staphylococcus aureus* in 116 urine samples, *Enterococcus faecalis* in 57, *Escherichia coli* in 28, *Klebsiella pneumonia* in 20, *Proteus species* in 2 and mixed infection in 71(Table 4). Moreover, bacterial culture of the *S. haematobium* negative urine samples revealed growth of *S. aureus* in 63 urine samples, *E. faecalis* in 57, *E. coli* in 21, *K. pneumonia* in 12, *Proteus species* in 4 and mixed infection in 58 (Table 4). The most frequent bacteria in *S. haematobium* positive and *S. haematobium* negative samples were *S. aureus*, *E. faecalis*, *E. coli* and *K. pneumoniae*, respectively.

Table 4: Number and frequency rates of bacteria isolated from *S. haematobium* positive and *S. haematobium* negative urine samples.

Examined urine samples	*S. haematobium* positive		*S. haematobium* negative	
Isolated Bacteria	Positive	Frequency %	Positive	Frequency %
Staphylococcus aureus	116	39.5	63	29.2
Enterococcus faecalis	57	19.4	57	26.5
Eschrichia coli	28	9.5	21	9.8
Klepseialla pneumoniae	20	6.8	12	5.6
Proteus spp	2	0.7	4	1.9
Mixed infection	71	24.1	58	27
Total	294	100	215	100

Antimicrobial susceptibility and treatment of the isolated bacteria from S. haematobium positive and S. haematobium negative urine samples

100% of the isolated bacteria species were found sensitive to ceftriaxone and amoxyclav. Moreover, 90% of isolated organisms were found sensitive to norofloxacin and ciprofloxacin. However, all the isolated bacteria were found resistant to amoxicillin (Table 5). All urinary tract bacterial infections were treated with antibiotics.

Table 5: Antibiotic susceptibility rates (%) of sensitive (S) and resistant (R) isolated bacteria from *S. haematobium* positive and *S. haematobium* negative urine samples.

Isolated bacteria	Antibiotics and their susceptibility rates (%)									
	Amoxyclav		Ceftriaxone		Ciprofloxacin		Norofloxacin		Amoxicillin	
	S	R	S	R	S	R	S	R	S	R
S. aureus	100	0	100	0	90	10	90	10	0	100
E. faecalis	100	0	100	0	90	10	90	10	0	100
E. coli	100	0	100	0	90	10	90	10	0	100
K.pneumoniae	100	0	100	0	90	10	90	10	0	100
Proteus spps	100	0	100	0	90	10	90	10	0	100

DISCUSSION

Our study investigated prevalence of bacteriuria in 594 *S. haematobium* positive and 435 *S. haematobium* negative urine samples collected from the population of Abu Rukba village in the White Nile State of Sudan. Both gram-positive and gram-negative bacteria were isolated in this study. The gram-positive bacteria were *S. aureus* and *E. faecalis* and the gram-negative bacteria were *E. coli*, *K. pneumoniae* and Proteus species were isolated from *S. haematobium* positive versus *S. haematobium* negative urine samples. The most frequent bacteria in *S. haematobium* positive and *S. haematobium* negative samples were *S. aureus*, *E. faecalis*, *E. coli* and *K. pneumoniae*, respectively.

All the isolated bacterial species were susceptible to ceftriaxone, amoxyclav, norofloxacin and ciprofloxacin. However, all the isolated bacteria were found resistant to amoxicillin. In this context, Ossai reported that nitrofurantoin, gentamicin and oframax were the most effective drugs for the management of bacterial infections among his student population. He found also that all the bacterial isolates were resistant to oxacillin and augmentin[11]. Very limited number of studies assumed that no association was found between bacteriuria and *S. haematobium* infection in the Malumfashi area. The lack of association between urinary bacterial infection and schistosomiasis probably reflects the low intensity of *S. haematobium* infection in the Malumfashi area of northern Nigeria[6]. Whatever, despite an elevated prevalence rate of urinary schistosomiasis in this community to be 51% there was no significant difference in the prevalence of bacteriuria among children with and without urinary schistosomiasis[7].

We found bacterial growth in 294 out of 594 samples of the *S. haematobium* positive samples showing a significant

difference than the bacterial growth in 215 out of 435 *S. haematobium* negative samples (*P* of $\chi 2$ was 0.04). Thus, our findings disclosed that the presence of *S. haematobium* was significantly associated with high prevalence of bacteriuria. In agreement with other researchers who also isolated bacteria from *S. haematobium* positive urine samples and emphasized this significant association [8, 12, 13, 14, 15, 16, 17, 18, 19]. It was assumed that the difference in bacteriuria prevalence among schistosomiasis infected and uninfected populations in urinary schistosomiasis endemic areas might be higher than in non-endemic areas. In this context, a field study in an area of intense *S. haematobium* infection in a Gambian community was reported that the prevalence of bacteruria was significantly greater than in non-endemic areas[12] Moreover, a survey in Egypt found that the prevalence of bacteriuria between school children was 10 times higher in areas endemic for urinary schistosomiasis[13]. In this paper, we try to discuss the following question: Why prevalence of bacteriuria in bilharzia patients was higher than that bacteriuria in bilharzia negative patients? We think that there are many factors related to *S. haematobium* biology enhancing urinary tract bacterial growth in schistosomiasis patients. This parasitic flatworm *S. haematobium* called blood fluke which typically lives inside the veins having suckers and hooks for attachment to blood veins of the host. The eggs have spines to attach the wall of urinary bladder leading to haematuria that enhances bacterial growth and causes urinary tract infection. Schistosoma species feed on patient blood during their long lifespan (5-10 year) [20]. Moreover, it was demonstrated the parasite-bacteria interaction of Salmonella species was on the surface of adult Schistosomes. Salmonella species were bounded to the surface tegument of Schistosoma species and the bacterial pili are the appendages necessary for bacteria-parasite surface interaction [21, 22]. Unfortunately, *S. mansoni* infects together with *S.*

haematobium same patients and increase severity of schistosomiasis[23].

It is known also that life cycle of the schistosome consists of egg, larvae (miracidia and cercaria), and adult worm. The cercariae will feed on blood in the vessels until they reach their adult parasites. Unusual among parasitic helminths, the long-lived adult worms, continuously bathed in blood, take up nutrients directly across the body surface and also by ingestion of blood into the gut. The amount of blood ingested into the gut per day is considerable about 100 nl for males and for the more actively feeding females about 900 nl that volume is 4 times more than body volume of the worm[20]. Moreover, eggs of adult *S. haematobium* and *S. mansoni* are characterized by terminal verses lateral spins that injured urogenital and intestinal veins during the eggs passage with urine or with faeces resulting in haematuria and presence of blood in faeces, which will lead to anaemia. Double infection with *S. haematobium* and *S. mansoni* might be occurred, since both *S. mansoni* and *S. haematobium* eggs characterized by lateral and terminal spines were detected in the same urine of the patient at a private laboratory in Khartoum as described and published by Tongu *et al.,* 1990 and others[23].

In addition, textbooks of parasites describe that eggs of *S. mansoni* are found in the urine[24, 25]. The eggs of *S. mansoni* may be found in the bladder in 7% of the patients when they are found in the rectum[26]. In Sudan 3 to 5% of the patients of mixed schistosomiasis discharge eggs of both *S. haematobium* and *S. mansoni* in the urine[23]. In this context, Cunin *et al.,* 2003 and others examined a total of 1118 pupils and found an infection prevalence of 70.5% for *S. haematobium* and 30.8% for *S. mansoni*. Unfortunately, *S. mansoni* eggs were found in 14.5% of the urine samples and *S. haematobium* eggs in 3% of the stool samples[27]. Cercariae and adult worms live in the veins and feed on blood during their long life span and the terminal

verses lateral spins injure urogenital and intestinal veins during the eggs passage with urine or with faeces resulting in haematuria and presence of blood in faeces. The blood is a potential culturing medium for bacteria in the urinary tract and may enhance bacterial growth in bilharzia patients. This co-infection has been documented as potential risk factor in the incidence of squamous cancer of the bladder in later years and recent studies have implicated bacteriuria in bladder cancer since bacteria accelerate the multi-stage process of bladder carcinogenesis [28, 29, 30, 31, 32].

S. haematobium related haematuria, renal failure and bladder cancer lead to anaemia[33] in addition to the natural lifespan of blood feeding adult schistosome that takes around 5-10 years[20], the schistosomiasis becomes an aetiological factor of anaemia and malnutrition[34].

The consequent effects of anaemia and malnutrition on bilharzia patient health has uncovered that infection and malnutrition have always been intricately linked. There are extensive, synergistic, antagonistic, and cyclical interactions between malnutrition and infection [35, 36]. Malnutrition is the primary cause of immunodeficiency worldwide and the worldwide magnitude of parasite infection is enormous[37]. All studies about schistosomiasis showed that the schistosomiasis were associated with morbidities that relate to malnutrition and chronic inflammation[38]. Schistosoma species can cause non-specific systemic morbidities with anaemia, malnutrition, and reduced childhood development[39] as a consequence of the effect of continued inflammation on normal growth, iron absorption, physical fitness, and cognitive occupation[40]. Furthermost anaemia in patients with schistosomiasis is anaemia of inflammation, associated with blood loss (and high parasitic loads), that leads to total-body iron deficiency[41]. The anaemia of inflammation is affected by iron trapping within the body, facilitated by the hepatic

hormone hepcidin the relief of which is encouraged by infection-related making of the pro-inflammatory cytokine interleukin[42]. As a consequence of chronic anaemia, declined aerobic capacity negatively affects physical work production in regions prevalent for schistosomiasis[40]. Reduced function marks and undernutrition in children are also significantly related with schistosomiasis[43].

CONCLUSIONS

Our result showed that number of growing bacteria in the *S. haematobium* positive samples was significantly more than number of growing bacteria in the *S. haematobium* negative samples. Schistosomiasis might enhance Bilharzia associated bacteriuria due to biology of Schistosoma species.

REFERENCES

1. Schistosomiasis Biology. http://www.cdc.gov/parasites/schistosomiasis/biology.html.
2. Liese B. The Organization of Schistosomiasis Control Programs. Parasitol Today. 1986; 2: 339-340.
3. Roberts L, Janovy J. Foundations of Parasitology, Sixth Edition. Boston: McGraw Hill Companies Inc. 2000
4. Agnew A, Lucas S, Doenhoff M. The host-parasite relationship of *Schistosoma haematobium* in CBA mice. London School of Hygiene and Tropical Medicine. 1988; 3: 403-424.
5. Basch P. Schistosomes. New York: Oxford University Press. 1991.
6. Pugh RN, Gilles HM. Malumfashi Endemic Diseases Research Project, X. *Schistosoma haematobium* and Bacteriuria in the Malumfashi Area. Ann Trop Med Parasitol. 1979; 73: 349-354.
7. Eyong ME, Ikepeme EE, Ekanem EE. Relationship between Schistosoma haematobium infection and urinary tract

infection among children in South Eastern, Nigeria. Niger Postgrad Med J. 2008; 15: 89-93.

8. Adeyeba OA, Ojeaga SGT. Urinary schistosomiasis and concomitant urinary tract pathogens among school children in Metropolitan Ibadan, Nigeria. Afr J Biomed Res. 2002; 5:103-107.
9. Bakhit HA, Saad MB, Elsadig AA, Satti AB, Abosalif KO. 2014. Prevalence and incidence of urinary schistosomiasis infection among the population of Abo Rukba village in white Nile State, Sudan. J Sci. 2014; 12:725-731.
10. Theodore M. Prevalence and Antibiogram of Urinary Tract Infections among Prison Inmates in Nigeria. Intern J Microbiol. 2006; 2:1-5.
11. Nmorsi OP, Egwanyenga OA, Ukwandu NC, Nwokolo NQ. Urinary schistosomiasis in a rural community in Edo State Nigeria eosinophiluria as a diagnostic marker. Afr J Biotechnol. 2005;4:183-186.
12. Lehman JS, Farid Z, Bassily S, Kent DC. Renal Function in urinary schistosomiasis. Am J Trop Med Hyg. 1970; 19: 1001-1006.
13. Wilkins HA. *Schistosoma haematobium* in a Gambian Community .III. The prevalence of bacteriuria and of hypertension. Ann Trop Med Parasitol. 1977; 71: 179-186.
14. Laughlin LW, Farid Jnr Z, Mansour N, Edman DC, Higashi GI. Bacteriuria in urinary schistosomiasis in Egypt a prevalence survey. Am J Trop Med Hyg. 1978; 27: 916-918.
15. Uneke CJ, Ugwuoru CDC, Ngwu BAF, Ogbu O, Agala CU. Public health implication of bacteriuria and antibiotic susceptibility of bacteria isolates in Schistosoma haematobium infected school pupils in South-Eastern Nigeria. World Health Pop 2006; 1-11.
16. Nmorsi OP, Kwandu UN, Ebiaguanye LM. Schistosoma haematobium and urinary tract pathogens co-infection in a rural community of Edo State, Nigeria. J Commun Dis. 2007; 39: 85-90.
17. Uneke CJ, Ugwuoke-Adibuah S, Nwakpu KO, Ngwu BAF. An Assessment of Schistosoma haematobium infection and

urinary tract bacterial infection amongst school children in rural eastern Nigeria - ISPUB. intern J Lab Med. 2009; 4:1

18. Bakhit HA, Shanan S, Saad MB. The prevalence of Schistosoma haematobium among the population of Keryab village, Sharg el Nil, Khartoum North with emphasis on secondary bacterial infection. Sudan Med Lab J. 2011; 1: 36-46.
19. Ossai OP, Dankolil R, Nwodo C, Tukur D, Nsubuga P, Ogbuabor D, et al. Bacteriuria and urinary schistosomiasis in primary school children in rural communities in Enugu State, Nigeria. Pan Afr Med J. 2014; 18:15.
20. Patrick J. Skelly, Akram A. Da'dara, Xiao-Hong Li, William Castro-Borges, and R. Alan Wilson Schistosome Feeding and Regurgitation. PLoS Pathog. 2014; 10 (8): e1004246.
21. LoVerde PT, Amento C, Higashi G.I Parasite-parasite interaction of Salmonella typhimurim and Schistosoma. J Infect Dis. 1980; 141: 177-185.
22. Melhem RF, LoVerde PT. Mechanism of interaction of Salmonella and Schistosoma species. Infect Immun. 1984; 44: 274-281.
23. Tongu Y, Bayoumi M, Saida H. A Rare case of Schistosoma mansoni ova found in the urine of a Sudanese. Bull Sch Health Sci.1990; 1:7-9.
24. Ash LR, Orihe I. Parasites: a guide to laboratory procedures and identification, American Society of Clinical Pathologists, Chicago, p263, 1987.
25. Garcia LS, Bruckner DA. Diagnostic medical parasitology, Elsevier, New York, Amsterdam, London, p271. 1988
26. Belding DL. Textbook of Parasitology, third edition, Appleton Century-Crofts, NewYork, p786, 1965
27. Cunin p, Tchuem Tchuente LA, Poste B, Djibrilla K, Martin PMV. Interactions between Schistosoma haematobium and Schistosoma mansoni in humans in north Cameroon. Trop Med & Intern Health. 2003; 8:1110–1117.
28. Mostafa MH, Sheweita SA, O'connor PJ. Relationship between schistosomiasis and bladder cancer. Clin Microbiol Rev 1999; 12: 97-111.

29. Latif AS. Urogenital infections in the tropic. The Australasian college of Tropical Medicine. 2004 chapter 8. Available at http://www.troped.org/primer/chapter.
30. El-Mawla NG, el-Bolkainy MN, Khaled HM. Bladder cancer in Africa: update. Semin Oncol. 2001;28:174-8.
31. Bedwani R, Renganathan E, El Kwhsky F, et al. Schistosomiasis and the risk of bladder cancer in Alexandria, Egypt. Br J Cancer. 1998; 77:1186-9.
32. IARC Working Group on the evaluation of carcinogenic risks to human schistosomes, liver flukes and *Helicobacter pylori*. 1994; 61:1-241.
33. Van der Werf MJ, de Vlas SJ, Brooker S, Looman CW Nagelkerke NJ, Habbema JD, Engels D. Quantification of clinical morbidity associated with schistosome infection in sun-saharan Africa. Acta Trop.2003; 86:125-139.
34. King CH, Dickman K, Tisch DJ. Reassessment of the cost of chronic helmintic infection: a meta-analysis of disability-related outcomes in endemic schistosomiasis. *Lance*t. 2005; 365:1561-9.
35. Keusch G. The history of nutrition: malnutrition, infection and immunity. J Nutr. 2003; 133:336S- 40S.
36. Scrimshaw N, Taylor C, Gordon J. Interactions of nutrition and infection. Monograph series no. 37. Geneva, Switzerland: WHO, 1968.
37. Katona P, Katona-Apte J. The interaction between nutrition and infection. Clin Infect Dis. 2008;46:1582-8..
38. Weerakoon KG., Gobert GN, Cai P, McManus DP. Advances in the Diagnosis of Human Schistosomiasis. Clin Microbiol Rev. 2015; 28: 939-967.
39. King CH, Dangerfield-Cha M. The unacknowledged impact of chronic schistosomiasis. Chronic Illn.2008; 4: 65-79.
40. Bustinduy AL, Thomas CL, Fiutem JJ, Parraga IM, Mungai PL, Muchiri EM, Mutuku F, Kitron U, King CH. Measuring fitness of Kenyan children with polyparasitic infections using the 20-meter shuttle run test as a morbidity metric."PLoS Negl Trop Dis. 2011; 5: e1213.

41. Bustinduy AL, Parraga IM, Thomas CL, Mungai PL, Mutuku F, Muchiri EM, Kitron U, King CH. (2013). "Impact of polyparasitic infections on anemia and undernutrition among Kenyan children living in a Schistosoma haematobium-endemic area. Am J Trop Med Hyg. 2013; 88: 433-440.
42. Nemeth E, Rivera S, Gabayan V, Keller C, Taudorf S, Pedersen BK, Ganz T. IL-6 mediates hypoferremia of inflammation by inducing the synthesis of the iron regulatory hormone hepcidin. J Clin Invest. 2004; 113: 1271-1276.
43. Friedman JF, Kanzaria HK, McGarvey ST. Human schistosomiasis and anemia: the relationship and potential mechanisms. Trends Parasitol. 2005; 21: 386-392.