

Detection of Antibodies to Human T Cell Lymphotropic Virus-I/II and *Strongyloides Stercoralis* Among Pregnant Women on Antenatal Visits to Selected Hospitals in Jos, Nigeria

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Abstract

Human T cell Lymphotropic Virus (HTLV-I/II) is an oncogenic retrovirus known to cause adult T cell leukemia which is transmitted vertically from mother to child and sexually by infected lymphocytes. Studies suggest that the onset of adult T-cell leukemia/lymphoma (ATL) in patients infected with HTLV-I/II occurs significantly earlier when the subjects are coinfecting with *S. stercoralis*. This study was aimed at detecting antibodies to HTLV-I/II and *Strongyloides stercoralis* larvae among pregnant women on antenatal visits to selected hospitals in Jos, Nigeria. A total of 188 blood samples and 136 stool samples were collected for study. Five milliliters (5ml) of venous blood was collected and transferred into a screw capped plastic tube without anticoagulant and sera extracted from each participant's sample and later analyzed for antibodies to HTLV-I/II using double-antigen sandwich enzyme linked immunosorbent assay (ELISA) kit. Stool samples were also analyzed using direct stool microscopy and Baemanns technique. Questionnaires were administered for participants' demographics and assessment of risk factors. Data obtained were then analyzed using SPSS version 17. Human T cell Lymphotropic Virus –I/II prevalence of 2.13% (4/188) was detected following the ELISA procedures with 1.06% (2/188) indeterminate results. Risk factors assessed had no statistical association with HTLV-I/II infection except for history of cancer in a family. Five parasite species were detected on stool examination with 2.2% prevalence of *Strongyloides stercoralis*. Keeping of pet dogs and having itching around legs were statistically associated with Strongyloidiasis ($P < 0.05$). Routine monitoring of HTLV-I/II and deworming of pregnant women on antenatal should be a matter of priority.

Keywords: Human T cell Lymphotropic Virus, *Strongyloides stercoralis*, Pregnant women, Antenatal, Jos.

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INTRODUCTION

Human T cell lymphotropic/leukemia virus I/II (HTLV-I/II) are re-emerging blood-borne oncogenic viruses infecting millions of individuals worldwide. The human T-lymphotropic virus type I (HTLV-I) and type II (HTLV-II), although closely related, have different clinical manifestations, pathogenesis, and geographical distributions [1]. The etiologic importance of HTLV-1 in the occurrence of certain diseases such as adult T cell leukemia (ATL) [2], neurological diseases; Human T cell Lymphotropic Virus Associated Myelopathy (HAM) or Tropical Spastic Paraparesis (TSP) and autoimmune-like diseases including uveitis, arthritis have been

extensively documented [3] and it is known to be endemic in many parts of the world, including southwestern Japan, some parts of the Caribbean islands, South America, and foci in western and central Africa and Australo-Melanesia [1]. Human T cell Lymphotropic Virus II on the other hand, despite there being no clear indications associating it with well-defined clinical manifestations, has been associated with sporadic cases of neurological disorders similar to HAM/TSP [4, 5], and has been observed as prevalent in native populations, such as the indigenous peoples of the Americas, certain tribes of pygmies in Africa [5], and injection drug users (IDUs) in urban areas of the United States, Europe, and Latin America [6, 7]. Both HTLV- I/II are transmitted mainly through blood

transfusion [8], sex [9] and mother to child infection via breast milk [10].

Human T-cell lymphotropic virus type I/II (HTLV-I/II) are known to have epidemiologic overlap and an immunologic relationship with *Strongyloides stercoralis* [11]; coinfection is associated with higher likelihood of severe strongyloidiasis and more advanced HTLV infection [12]. HTLV trigger a predominant T_H-1 cytokine immune response which causes down regulation of the T_H-2- dependent immune responses against *Strongyloides* including degranulation of mast cells, activation of eosinophils, and production of IgE, placing the host at increased risk of more severe strongyloidiasis [13].

Strongyloidiasis is caused by *S. stercoralis*, an emerging pathogen in the developed world due to increase in global migration and travel. It is estimated that 50–100 million individuals are infected with *Strongyloides stercoralis* world wide with a high prevalence in tropical regions of Africa, Asia and South America (particularly Brazil and Colombia) [14]. Studies have documented a surprisingly high level of *Strongyloides stercoralis* among HTLV carriers and of HTLV in *Strongyloides stercoralis* carriers [15]. Although the relationship between these taxonomically distant agents is yet to be elucidated and still remains controversial, it was proposed that the onset of adult T-cell leukemia/lymphoma (ATL) in patients infected with HTLV occurs significantly earlier when the subjects are coinfecting with *S. stercoralis* [16]. [11] reported that in Japan, *S. Stercoralis* carriers were found to have a significantly higher seroprevalence for HTLV-I/II than non-*S. Stercoralis* carriers.

Strongyloides stercoralis is an active geohelminth that usually produces chronic intestinal infection especially in the tropics and subtropical countries of the world. This opportunistic agent can pose a life threatening systemic invasion on immunosuppressed patients including pregnant women. The life cycle of *Strongyloides stercoralis* is complex. *Strongyloides stercoralis* infection is acquired by infective filariform larvae (L₃), from contaminated soil, directly penetrating uncovered skin [17] and spread haematogenously through capillaries into the lungs. At the lungs, they cross the alveolar membrane, migrating into the alveolar space, reach the epiglottis and are swallowed down into the mucosa of the small intestine where they become adult worms. The parthenogenetic female lays eggs that release the rhabditiform larvae that migrate to the intestinal lumen and, in stages L₁ and L₂, are excreted in stool. However, the L₂ larvae may become infective larvae. In this form, the filariform larvae enter the bloodstream by penetrating the colonic mucosa [14]. This is termed autoinfection, and is responsible for the perpetuation of the parasite even after a long period without infestation [18].

Conditions such as malnutrition, malignancies, corticosteroid, immunosuppressive therapy as well as pregnancy impair host resistance and are recognized as risk factors for development of severe strongyloidiasis. Currently, HTLV infection has been identified as the major factor related to disseminated strongyloidiasis [19]. Pregnant women play an important role in the transmission cycle of HTLV-I/II infection and represent an important epidemiological link in the study of *Strongyloides stercoralis* infection, hence, this study aimed to detect HTLV-I/II antibodies and *Strongyloides stercoralis* larvae among pregnant women on antenatal visits to selected hospitals in Jos, Nigeria.

MATERIALS AND METHODS

Study Area

This study was conducted among pregnant women on antenatal visits to four selected hospitals in Jos (Plateau Specialist Hospital Jos, Bingham University Teaching Hospital Jos, Ola Hospital Jos, and Vom Christian Hospital Jos) Plateau State, Nigeria which serve as reference hospitals for high risk obstetric patients. Plateau state is located in the middle belt area of Nigeria with an area of 26,899 Km² and an estimated population of 3,000,000 people (National Population Census, (NPC), 2006). It is located between latitude 08°24'N and Longitude 008°32' and 010°38' East. Plateau state shares boundaries with Kaduna state to the North West, Bauchi state to the North East, Nasarawa state to the South West and Taraba state to the East.

Study Design and Study Population

This study was a hospital-based cross-sectional study conducted among consented pregnant women at various stages of their gestation period and of all age categories.

Inclusion and Exclusion Criteria

All consented pregnant women without any pregnancy complications on antenatal visits to the selected hospitals were included in this study while non-pregnant female, not giving informed consent and women with acute complications of pregnancy were excluded.

Ethical Approval and Consent

Approval was obtained from the Health Research and Ethics Committee of Bingham University Teaching Hospital Jos, Plateau State (NHREC/23/05/00534) and Vom Christian Hospital Committee on Research and Ethics (VCH/ADM/48/Vol.II/) to detect antibodies to Human T Cell Lymphotropic Virus I/II and larvae of *Strongyloides stercoralis* among pregnant women attending selected Hospitals in Jos.

Sample Size Determination

The minimum sample size for this study was obtained using sample size-determination formula adopted from [20], which gave a sample size of 63

using HTLV-I/II antibodies prevalence of 4.3% in pregnant women [21]. However, statistical credence was given to the study by increasing the sample size to 188 pregnant women.

Similarly, the same formula was adopted for the detection of *Strongyloides stercoralis* larvae in stool; however, a prevalence of 2.3% reported by [22] was used. The calculated sample size was 35 which is the least number of stool samples to be used for the study. However, 136 samples were collected for study which corresponds to the number of consented pregnant women that submitted their stool samples.

Data Collection using Structured Questionnaires

Relevant information on demographic and risk factors were obtained from the participants with the aid of standardized questionnaire which were filled by the researcher and a trained assistant.

Blood Collection and Serology

About 5 ml of venous blood was collected into clean screw capped plastic tube without anticoagulant and allowed to clot at room temperature for 30minutes. The clotted samples were then centrifuged at 2500 rpm for 10 minutes. Sera were tested with commercially available Enzyme Linked Immunosorbent Assay (ELISA) kit (manufactured by Diagnostic Automation, Inc., Calabasas, CA, USA). The plates were read with spectrophotometer at a wavelength of 450 nm. Interpretation of the results was then carried out according to the kit's manufacturer's instruction.

Stool Collection and Analysis

The pregnant women were given wide-mouthed containers for stool sample collection and

requested to be submitted 1 hour after collection. A total of 136 stool samples were collected and examined immediately by direct microscopy as adopted from [22], and Baermanns method for the presence of motile *S. stercoralis* rhabditiform larvae. Briefly, a drop of fresh physiological saline was placed on one end of a clean slide and a drop of iodine placed on the other end of the slide. Using an applicator stick, a small amount of stool specimen was emulsified in the saline and another in the iodine solution. Each preparation was covered with cover slip and examined under the microscope for the presence or absence of the rhabditiform larvae under the microscope using $\times 10$ and $\times 40$ objectives respectively. Baermanns technique employed followed descriptions by [23] for the detection of larvae of *Strongyloides stercoralis* in stool samples.

Statistical Data Analysis

Data were analyzed using the software SPSS version 17 (SPSS Inc., Chicago, IL, USA). Pearson's Chi-square test was performed at 95% confidence interval and P values < 0.05 were considered statistically significant.

RESULTS

A total of 188 blood samples from pregnant women on antenatal visits to selected hospitals in Jos were assayed for Human T cell Lymphotropic Virus (HTLV-I/II) IgG antibodies. Of the 188 pregnant women tested for HTLV-I/II antibodies, 4 were found to be seropositive for HTLV-I/II antibodies giving a prevalence of 2.13%, with 2 (1.06%) indeterminate results and the remaining 182 tested negative for HTLV-I/II antibodies (Figure 1).

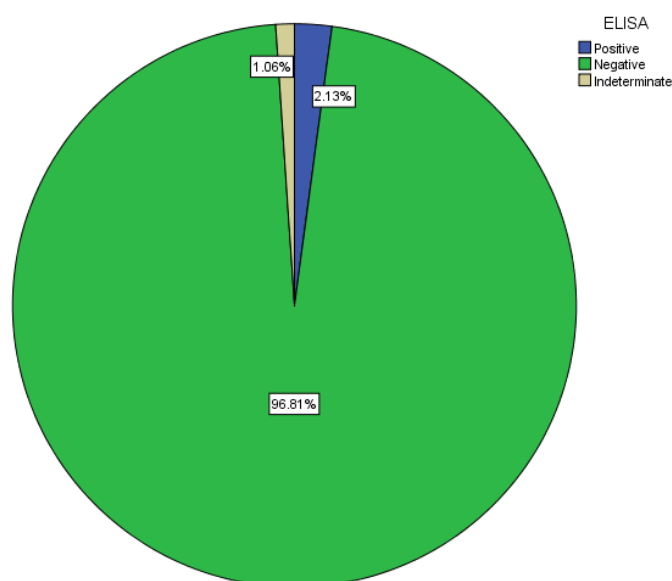


Fig 1: Seroprevalence of Human T cell Lymphotropic Virus IgG Antibodies among Pregnant Women in Jos, Nigeria

Women's socio-demographic variables were assessed in relation to HTLV-I/II infection. All pregnant women were married with age ranged from 14-45years (mean age; 27 ± 5.9). The distribution of antibodies to HTLV-I/II in relation to age showed that women in the age group 36-40years had the highest prevalence of 10.00% (2/20) followed by age group 26-30years with prevalence of 7.02% (4/57). However, there was no statistically significant association between age and HTLV-I/II infection ($\chi^2 = 14.619$ df= 6

$P = 0.263$). Pregnant women from polygamous families had the highest HTLV-I/II antibodies prevalence of 5.00% (1/20) ($\chi^2 = 1.178$, df= 1 $P = 0.555$) with majority having attended secondary school. However, those who had tertiary education had the highest HTLV-I/II antibodies prevalence of 6.12% (3/49) though not statistically significant ($\chi^2 = 7.730$ df= 6 $P = 0.259$). In terms of occupation, majority of the women studied were into businesses, but HTLV-I/II antibodies prevalence was highest among civil servants (13.04%).

Table 1: Seroprevalence of Human T cell Lymphotropic Virus I/II (HTLV-I/II) Antibodies in Relation to Socio-demographic Variables among Pregnant Women in Jos, Nigeria

Variables	No. Examined	No. Positive (%)	χ^2 (P-value)
Age			
11-15	1(0.5%)	0(0.00)	14.619(0.263)
16-20	21(11.2%)	0(0.00)	
21-25	60(31.9%)	0(0.00)	
26-30	57(30.3%)	4(7.02)	
31-35	28(14.9%)	0(0.00)	
36-40	20(10.6%)	2(10.00)	
41-45	1(0.5%)	0(0.00)	
Type of Family			
Monogamy	168(89.4%)	5(2.98)	1.178(0.555)
Polygamy	20(10.6%)	1(5.00)	
Total	188	6(3.19)	
Education Level			
Non-formal	5(2.7%)	0(0.00)	17.323(0.027*)
Primary	30(15.9%)	0(0.00)	
Secondary	104(55.3%)	3(2.88)	
Tertiary	49(26.1%)	3(6.12)	
Total	188(100%)	6(3.19)	
Occupation			
Business	85(45.2%)	2(2.35)	17.323(0.027*)
Civil Servant	23(12.2%)	3(13.04)	
Farming	40(21.3%)	1(2.50)	
House wife	25(13.3%)	0(0.00)	
Student	15(7.9%)	0(0.00)	
Total	188	6(3.19)	

Information on the risk factors to Human T cell Lymphotropic Virus (HTLV-I/II) were also collected and presented in Table 2. On assessment of the risk factors such as history of blood transfusion, sharing of needles and syringes, use of condom, history of surgery, and history of sexually transmitted diseases showed no statistically significant association with

HTLV-I/II infection, however, association was established between history of cancer in the family and infection with the virus ($\chi^2 = 9.948$ df =2 $P = 0.007$). About 8(4.26%) of the women who had history of cancer in their family reported prevalence of 12.50% to HTLV-I/II antibodies.

Table 2: Seroprevalence of Human T cell Lymphotropic Virus (HTLV-I/II) Antibodies in Relation to some Risk Factors among Pregnant Women in Jos

Factors	No. Examined	No. Positive (%)	χ^2 (P-Value)
History of Blood Transfusion			
Yes	9(4.8%)	0(0.00)	0.302(0.751)
No	179(95.2%)	6(3.35)	
Sharing of needles and syringes			
Yes	15(7.98%)	0(0.00)	0.576(0.584)
No	173(92.02%)	6(3.47)	
Condom Use			
Yes	17(9.04%)	3(17.65)	1.135(0.287)
No	171(90.95%)	3(1.75)	

Factors	No. Examined	No. Positive (%)	χ^2 (P-Value)
Previous Surgery			0.552(0.759)
Yes	16(8.51%)	0(0.00)	
No	172(91.49%)	6(3.49)	
Itravenous Drug use			0.290(0.865)
Yes	8(4.26%)	0(0.00)	
No	180(95.74%)	6(3.33)	
History of Sexually Transmitted Disease			0.390(0.823)
Yes	61(32.45%)	2(3.28)	
No	127(67.55%)	4(3.15)	
History of Cancer in Family			9.948(0.007**)
Yes	8(4.26%)	1(12.50)	
No	180(95.74%)	5(2.78)	

A total of 31(22.79%) parasites belonging to four helminthic genuses were detected in stool samples of pregnant women in Jos. *Strongyloides stercoralis*

was detected in 3 of the 136 pregnant women who participated in this study giving the prevalence of 2.21% (Figure 2).

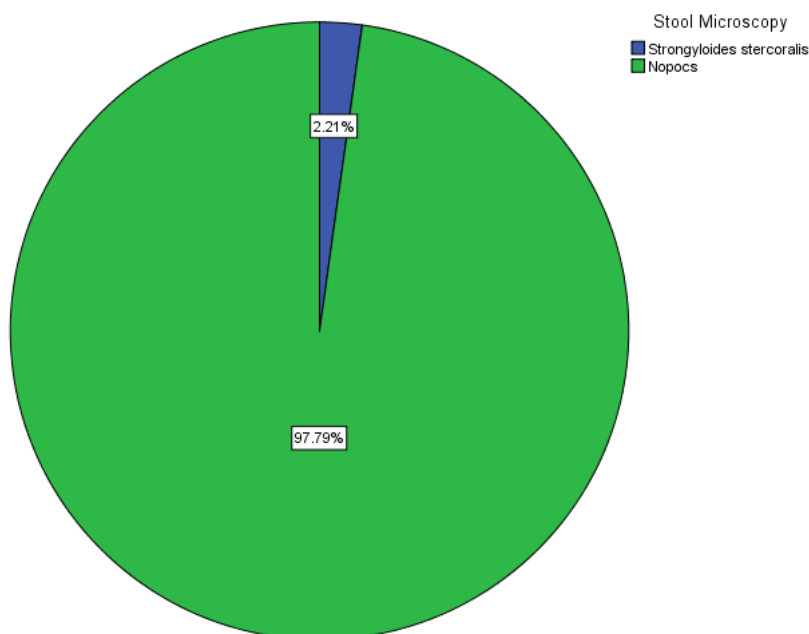


Fig 2: Prevalence of *Strongyloides stercoralis* in Pregnant Women in Jos, Nigeria

The frequency of *Strongyloides stercoralis* infection among pregnant women positive for HTLV-I/II IgG antibodies is presented in Table 3. The result showed that none of the HTLV-I/II carriers had *Strongyloides stercoralis* and there was no significant association between infection with HTLV-I/II and having *Strongyloides stercoralis* within the study population ($\chi^2= 0.591$, $df = 2$, P-value =0.744.).

Analysis of symptoms and environmental factors of the pregnant women revealed that those who had itching around the legs, seen worms in stool, coughed out worm and abdominal pain were significantly associated with parasite in infection (Table 4).

Table 3: Frequency of Infection with *Strongyloides stercoralis* among Pregnant Women Positive for HTLV I/II IgG antibodies in Jos

<i>S. stercoralis</i>		Positive	Negative	Total	χ^2 (P-Value)
HTLV-I/II	Positive	0(0.00%)	6(100.00%)	6	0.142(0.707)
	Negative	3(2.31%)	127(97.69%)	130	
	Total	3(2.21%)	133(97.79%)	136	

Table 4: Prevalence of Parasites Detected in Stools of Pregnant Women in Relation to some Risk Factors

Factors	No. Examined (%)	No. Positive (%)	(P-Value)	O R (95% CI)
Toilet at Home			0.594	0.764(0.288-2.028)
Yes	109	24(22.02)		
No	27	7(25.93)		
You Defecate in Toilet			0.518	1.358(0.528-3.490)
Yes	98	24(24.49)		
No	38	7(18.42)		
Keep Pet Dogs			0.024	2.577(1.123-5.911)
Yes	57	18(31.58)		
No	79	13(16.46)		
Are You a Farmer			0.052	3.557(0.810-16.588)
Yes	112	28(25.00)		
No	24	3(12.50)		
Do You Have Itching around the Leg			0.033	2.813(1.113-7.106)
Yes	26	11(42.31)		
No	110	20(18.18)		
Have You Seen Worms in Stool			0.000	14.000(5.056-38.700)
Yes	24	16(66.67)		
No	112	15(13.39)		
Coughed Out Worms			0.004	10.400(1.906-56.755)
Yes	7	5(71.43)		
No	129	26(20.16)		
Abdominal Pain			0.098	1.993(0.877-4.526)
Yes	59	18(30.51)		
No	77	13(16.88)		
Diarrhoea			0.835	1.125(0.375-3.372)
Yes	21	5(23.81)		
No	115	26(22.61)		

DISCUSSION

Considering their strategic importance in the chain of transmission of HTLV-I/II, pregnant women are better population group in estimating the true burden of HTLV infection in a region deemed endemic like Nigeria. This cross-sectional study has confirmed the presence of antibodies to HTLV-I/II among pregnant women and to the best of our knowledge, the first study on HTLV-I/II coinfection with *Strongyloides stercoralis* among pregnant women in Nigeria.

In this study, 2.13% prevalence of HTLV-I/II antibodies was reported among pregnant women on antenatal visits to selected hospitals in Jos. This prevalence is not surprising considering that Jos is a cosmopolitan city characterized by high level of ethno-cultural and social activities especially among youths. The result agrees well with the categorization of the study area as HTLV-I/II endemic location in Nigeria as the virus is considered endemic in areas where the prevalence ranges from 0.5 to 20% in the population [24]. The prevalence is relatively higher compared to similar studies in Ilorin, North Central Nigeria where [25] reported a prevalence of 1.1% and the 0.5% prevalence documented by [26] in Enugu, South Eastern Nigeria among pregnant women. The result of the present study is similar to the 2.1% reported by [27]

in Accra, Ghana; however, it is lower compared to the reported prevalence from South Western part of the Nigeria. [28] reported a prevalence of 22.9% among Commercial Sex Workers (CSWs) and 16.7% among pregnant women in South Western Nigeria. Similarly [21], examined the prevalence in mother-child pair; a prevalence of 4.3% was reported among mothers, while 1.1% was reported among children. This disparity in results with some reports from South Western part of the country indicates somewhat different epidemiology of the virus in North Central Nigeria. Ethnic, social, cultural and other differences have been noted to affect the distribution of the virus [25]. Although it is not yet established how these factors affect the distribution of the virus, but a relationship between these factors and progression of the proviral load in infected individuals have been established [29]. In addition, differences in sample size could also be attributable to the disparity in results.

Studies in different parts of the world have identified socio demographic variables like age, gender, socio-economic status and environmental conditions as factors for acquisition of HTLV-I/II [30]. In relation to family type, the highest prevalence of 5.0% was observed among women from polygamous families compared to 2.9% observed among women from monogamous families. The high prevalence observed

among women in polygamous family may be attributed to multiple sexual partners of the spouse, given transmission from husband to wife to be 60% and from wife to husband to be 0.4% over a 10 year period [1]. This study shows that the seropositivity of HTLV-I/II increases with age in pregnant women, with the highest prevalence found in age group 36-40 years, although there was no statistical association between age and HTLV-I/II. This finding agrees with the submissions of [25] and [31] who reported higher prevalence among older participants (26 years and above). The result is also consistent with the studies of [32] which showed that HTLV infection increases with age from 20 to 40 years in Nigeria as well as other endemic countries [33]. The result in this study may not be surprising and could indicate greater sexual involvement which is known to be a major mode of transmission of the virus. Differences in the number of pregnant women examined within each age group could also be attributed to the observed prevalence.

Tests of association between the women's level of education and occupation with seroprevalence of HTLV-I/II showed that women with tertiary education had the highest prevalence of 6.1% and 13.0% among civil servants. This result is slightly higher than studies of [30] who reported prevalence of 2.7% among students and 0.0% among civil servants in Osun state, Nigeria. The observed prevalence could be true of increase sexual activities on campus and could translate into the status of the work force in a country. The limited literatures for comparison in these areas highlight the need for further studies.

Risk factors for HTLV-I/II infection include multiple sexual partners, a history of STD [34], intravenous drug use [35] and previous blood transfusion [8]. However, the present study shows no association between history of blood transfusion, sharing of needles, condom use, history of previous surgery, intravenous drug use, history of sexually transmitted diseases and HTLV-I/II infection ($p > 0.05$). A significant association was observed between history of cancer in the family and seropositivity to HTLV-I/II among women ($\chi^2 = 9.948$ P-Value = 0.007). HTLV-I/II associated diseases in family members have been reported [36], however, does having a relative with an HTLV-I/II associated disease increase an HTLV carrier's risk to develop an associated disease as well? There is limited knowledge of the factors implicated in the development of HTLV-I/II-associated diseases and, in consequence, the lack of measures to prevent them, it remains difficult to answer such questions [37]. This calls for further studies on the risk of cancer in family and infection with HTLV.

Coinfection of *Strongyloides stercoralis* with HTLV-I/II is known increase the chances of early onset and development of HTLV-I/II-associated diseases. Moreso, parasitic infection among different population

is a function of many different factors. Most importantly the environmental factors, parasitic factors and host factors [38]. This study recorded *Strongyloides stercoralis* prevalence of 2.2% among pregnant women on antenatal visits to selected hospitals in Jos, Nigeria. This helminth generally has low prevalence as observed in most studies. This reason for low prevalence may not be unconnected to its vulnerability to adverse environmental conditions hence its alternate mode of infection, auto-infection [39]. The low prevalence could also be associated to climate and weather at the time of study. The study was conducted during the dry season where the ground was so dry which may have contributed to the unlivable infective stage making penetration of the unbroken skin difficult. Comparatively, this finding is similar to reports of [22] and close to the 2.5% reported by [40].

Infection with HTLV-I/II, even in asymptomatic carriers, is usually associated with immunologic alterations resulting in decreased levels of serum IgE [41, 42] predisposing a host to parasitic infections including *Strongyloides stercoralis*. In this study, *Strongyloides stercoralis* prevalence of 2.2% was recorded; however, the prevalence of the parasite in HTLV-I/II positive pregnant women was 0.0%. This agrees with the findings of [43] from Japan and [44] in Jamaica which revealed that there was no serologic relation between *Strongyloides stercoralis* infection and HTLV-I/II. The study however disagrees with the report of [15] who documented higher prevalence (31.6%) of *Strongyloides stercoralis* among HTLV-I/II carriers than those without HTLV-I/II infection in Okinawa, Japan. Results from this study suggest that infection with HTLV-I/II does not predispose people to *Strongyloides stercoralis* infection since acquisition of the parasite is dependent on exposure to infective larvae, whether or not immune status of the host is altered by HTLV-I/II.

Factors such as poor environmental conditions, insufficient health care education, lack of toilet facilities, as well as lack of public health hygiene, coupled with the complete absence of pipe-borne water could predispose individuals to parasitic infection. In this study, having itching of legs, keeping of pet dog, seeing worms in stool and coughing out of worms have been noted to have significant association with worm burden while other risk factors such having toilet facility, abdominal pain, diarrhea and being a farmer were as well assessed. Studies on the risk factors for *Strongyloides stercoralis* were scarce making comparisons difficult, however, [45] made similar emphasis that absence of footwear, other household members already being infected, and poor sanitation facilities as well keeping dogs which are reservoir of *S. stercoralis* are potential risk factors.

Study on antibodies to HTLV-I/II and infection with *Strongyloides stercoralis* among

pregnant women on antenatal visits to selected hospitals in Jos, Nigeria shows no coinfection with HTLV-I/II and *Strongyloides stercoralis* among the pregnant women, however, 2.13% of the women have antibodies to HTLV-I/II and 2.21% were found to be infected with larvae of *S. stercoralis*. We strongly recommend the incorporation of routine screening for HTLV-I/II among all pregnant women during antenatal visits as this will go a long way in proper management of HTLV-I/II infections and slow the spread of the viruses. Observing personal hygiene and deworming of all pregnant women infected with *Strongyloides stercoralis* to prevent disseminated strongyloidiasis is also recommended.

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