

## Research Article

# Seroprevalence and Associated Sociodemographic Risk Factors of *Chlamydia trachomatis* in Owerri, Nigeria

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## Abstract

**Background:** *Chlamydia trachomatis* is the most common bacterial sexually transmitted infection globally, contributing significantly to reproductive health complications, particularly due to its largely asymptomatic nature. Despite its widespread impact, comprehensive epidemiological data, especially from regions like Nigeria, remain limited.

**Objective:** This study aimed to determine the seroprevalence of *C. trachomatis* infection and its association with sociodemographic characteristics and risk factors in Owerri, Imo State, Nigeria.

**Methods:** A cross-sectional study was conducted on 518 participants (318 symptomatic, 200 asymptomatic) recruited from the Federal Medical Center, Owerri, between September 2018 and September 2019. Serum samples were collected and analyzed for *C. trachomatis* IgG antibodies using the Enzyme-Linked Immunosorbent Assay (ELISA). A structured questionnaire collected data on socio-demographic factors and risk behaviors. Data were analyzed using SPSS version 2.0, with the Chi-square test to determine associations, and  $P < 0.05$  considered statistically significant.

**Results:** The overall seroprevalence of *C. trachomatis* IgG antibodies was 6.8%. Prevalence was 5.4% in symptomatic subjects and 8.0% in asymptomatic subjects, with no statistically significant difference ( $P > 0.05$ ). Females showed a higher prevalence (8.3%) than males (5.0%), though this difference was not statistically significant ( $P = 0.238$ ). While age group trends were observed (e.g., highest prevalence in 15-20 symptomatic and 21-25 asymptomatic groups), age was not significantly associated with infection ( $P = 0.805$ ). A statistically significant association was found between Chlamydia infection and age at first sexual intercourse ( $P < 0.05$ ), with 89.5% of symptomatic positive participants having their first sexual encounter at or before 20 years. Socioeconomic factors (education, occupation, income), condom use, number of sexual partners, marital status, and history of STIs did not show statistically significant associations with Chlamydia infection in this study ( $P > 0.05$  for all).

**Conclusion:** The study revealed a *C. trachomatis* seroprevalence of 6.8% in Owerri, with a notable asymptomatic burden. The significant association between infection and early age at first sexual intercourse highlights a critical risk factor. These findings underscore the need for targeted public health interventions, focusing on awareness, early detection, and prevention strategies, particularly for young, sexually active populations in resource-limited settings.

## 1. Introduction

*Chlamydia trachomatis* stands as the most prevalent bacterial sexually transmitted infection (STI) globally, affecting millions annually and imposing a substantial public health and economic burden worldwide [1]. This obligate intracellular bacterium is responsible for a diverse array of clinical manifestations, ranging from severe ocular diseases like trachoma, which can lead to blindness, to a spectrum of

urogenital infections [2]. In women, untreated *C. trachomatis* infections are a leading cause of severe reproductive health complications, including pelvic inflammatory disease (PID), ectopic pregnancy, and tubal factor infertility, often necessitating costly medical interventions such as tubal surgery and in vitro fertilization [3, 4]. Men can also experience complications such as urethritis and epididymitis, which may contribute to male infertility [5]. The insidious nature of *C. trachomatis* infection is largely due to its predominantly asymptomatic presentation; a significant majority of infected individuals—approximately 80% of infected females and 50% of infected males—remain unaware of their infection [2, 5]. This silent progression facilitates widespread transmission within communities and allows the infection to advance to more severe, often irreversible, sequelae without timely diagnosis and treatment [6].

The World Health Organization (WHO) has consistently highlighted the alarming global incidence of *C. trachomatis*, with estimates indicating nearly one hundred million new cases occurring annually [7]. The impact is particularly profound in low-income countries, where the burden of STIs is disproportionately high [6]. In sub-Saharan Africa, *C. trachomatis* infection contributes significantly to maternal and child morbidity and mortality, affecting more women (50 million) than men (42 million) [8, 9]. Despite this critical public health challenge, comprehensive epidemiological data on *C. trachomatis* prevalence and its associated risk factors remain notably scarce across many parts of the region, including Nigeria. Previous studies conducted in various Nigerian cities have yielded widely divergent prevalence rates, often attributed to variations in specific geographic locations, demographic profiles of the study populations, and the diagnostic methodologies employed [10–16]. This inconsistency underscores a critical data gap that hinders the development and implementation of targeted and effective public health interventions.

In Owerri, Imo State, Nigeria, a vibrant urban center characterized by high social activities, numerous higher educational institutions, and a thriving hospitality industry, there is a substantial youth population (Federal Republic of Nigeria Official Gazette, 2006). This demographic landscape, coupled with potential increases in sexual activity, creates a heightened risk for the transmission and spread of sexually transmitted diseases like *C. trachomatis*. The escalating rates of reproductive health issues and infertility observed in Nigeria are frequently linked to undiagnosed and untreated STIs [10]. The absence of routine, widespread screening programs for asymptomatic STIs in Nigerian healthcare facilities further exacerbates this problem, leading to an underestimation of the true prevalence and a delay in addressing the long-term health consequences [7, 17]. Understanding the precise magnitude of *C. trachomatis* infection in such a dynamic and populous setting is therefore paramount for public health planning.

This study is meticulously designed to bridge this critical knowledge gap by systematically determining the seroprevalence rates of *Chlamydia trachomatis* infection. Utilizing the Enzyme-Linked Immunosorbent Assay (ELISA) technique, the research will assess infection rates in both symptomatic individuals seeking medical care and apparently healthy asymptomatic individuals within Owerri, Imo State. Beyond mere prevalence, a key objective is to meticulously identify and analyze the sociodemographic characteristics (such as age, educational status, occupation, and income) and behavioral risk factors (including number of sexual partners, condom use, and age at first sexual intercourse) that are significantly associated with *C. trachomatis* infection within this specific population. The comprehensive findings derived from this research are anticipated to provide invaluable baseline data for local health planning authorities. This evidence-based insight will be instrumental in formulating and implementing more effective, context-specific strategies for the control, prevention, and ultimately, the reduction of the burden of *Chlamydia trachomatis* infections in Owerri and serve as a model for similar resource-limited settings across Nigeria and beyond.

## 2. Materials and Methods

### 2.1. Study Design

This study employed a cross-sectional design to investigate the sero-epidemiological prevalence of *Chlamydia trachomatis* infection in Owerri, Imo State, Nigeria.

### 2.2. Study Area and Population

The study was conducted in Owerri, Imo State, located in the South-eastern geopolitical zone of Nigeria. Owerri is the capital of Imo State, with an estimated population of 3,927,563 inhabitants [18]. The city is characterized by high social activities, a concentration of higher educational institutions, and numerous hospitality industries, attracting a diverse population including a significant youth demographic.

Symptomatic participants were recruited from out-patients attending the sexually transmitted infections (STI) and HIV clinics at the Federal Medical Center (FMC), Owerri. Asymptomatic participants comprised healthy individuals from the general population within the same age range. The laboratory investigations were primarily conducted in the Medical Microbiology unit of the Laboratory Department, FMC, Owerri, from September 2018 to September 2019.

Inclusion criteria for the study comprised symptomatic men and women presenting with clinical symptoms such as discharge (vaginal or urethral), dysuria, pruritis, abdominal/pelvic pain, testicular pain, inguinal adenopathy, pelvic inflammatory disease, cervicitis, or salpingitis. Additionally, asymptomatic healthy men and women with no clinical symptoms were included. All subjects were aged 15 to 45 years and above, provided informed consent to participate, and had not received any antibiotic treatment in the previous four weeks. Exclusion criteria included subjects below 15 years of age, those unwilling to provide consent, and individuals who had received antibiotic treatment within the previous four weeks.

### 2.3. Sample Size Determination

A total of 518 participants were recruited for the study, exceeding the calculated minimum sample size of 318, which was determined using a formula described by [19] based on a previous prevalence rate of 29.4% in the South-East [10] at a 95% confidence level and a 5% margin of error. The recruited participants comprised 318 symptomatic subjects (test group) and 200 asymptomatic subjects (control group).

## 2.4. Ethical Approval and Informed Consent

Ethical approval for the study was obtained from the Federal Medical Center (FMC), Owerri Ethical Research Committee. Written informed consent was obtained from all participants prior to their enrollment in the study. For participants who were minors, assent was obtained along with informed consent from their parents or legal guardians.

## 2.5. Administration of Questionnaire

A structured questionnaire was administered to all consenting participants. The questionnaire collected data on socio-demographic characteristics including age, sex, marital status, educational status, occupation, and income. It also gathered information on risk factors related to *Chlamydia trachomatis* infection such as the number of sexual partners, history of STIs, age at first sexual intercourse, and condom use, as well as participants' knowledge about Chlamydia infection and its prevention.

## 2.6. Collection and Processing of Specimens

Blood samples were collected from all 518 participants. A 3-5 ml volume of blood was collected from each subject by venepuncture under aseptic conditions. Serum was separated from the clotted blood samples by centrifugation and stored at  $-20^{\circ}\text{C}$  until ready for serological analysis.

## 2.7. IgG Detection by ELISA Assay

The presence of *Chlamydia trachomatis* IgG antibodies in serum samples was detected using a commercially available Enzyme-Linked Immunosorbent Assay (ELISA) kit (Bio-check, as per thesis Appendix II). The assay was performed strictly according to the manufacturer's instructions. Microtiter wells were selected, and controls, including positive, negative, and cut-off calibrator, were run in duplicate. Test samples, controls, and cut-off calibrator were diluted 1:40 by adding  $5\mu\text{l}$  of sample to  $200\mu\text{l}$  of sample diluent. One hundred microliters ( $100\mu\text{l}$ ) of each diluted sample or control was then dispensed into appropriate wells. The wells were incubated at  $37^{\circ}\text{C}$  for 30 minutes, then emptied, rinsed five times with wash buffer, and tapped dry. One hundred microliters ( $100\mu\text{l}$ ) of enzyme conjugate was subsequently added to each well, mixed, and incubated at  $37^{\circ}\text{C}$  for another 30 minutes. After washing five times,  $100\mu\text{l}$  of Tetramethyl benzidine (TMB) reagent was added, mixed, and incubated at  $37^{\circ}\text{C}$  for 15 minutes. The reaction was stopped by adding  $100\mu\text{l}$  of stop solution (1N-HCL), and the optical density (OD) was read at 450nm using a microtiter plate reader within 15 minutes.

Interpretation of results was based on the *Chlamydia trachomatis* IgG index, as per thesis Appendix III: an index less than 0.901 was considered negative, an index between 0.91 to 0.99 was equivocal, and an index of 1.00 or greater was positive for IgG antibody to Chlamydia.

## 2.8. Data Analysis

Data generated from the questionnaires and laboratory assays were analyzed using SPSS version 2.0. The Chi-square ( $\chi^2$ ) test was employed to determine statistical associations between sociodemographic characteristics, risk factors, and *Chlamydia trachomatis* infection status. A p-value of less than 0.05 ( $P < 0.05$ ) was considered statistically significant.

## 3. Results

A total of 518 participants were recruited, with 318 (61.4%) symptomatic and 200 (38.6%) asymptomatic Figure 1. The overall seroprevalence of IgG antibodies to *Chlamydia trachomatis* was 6.8% (35/518) Table 1.

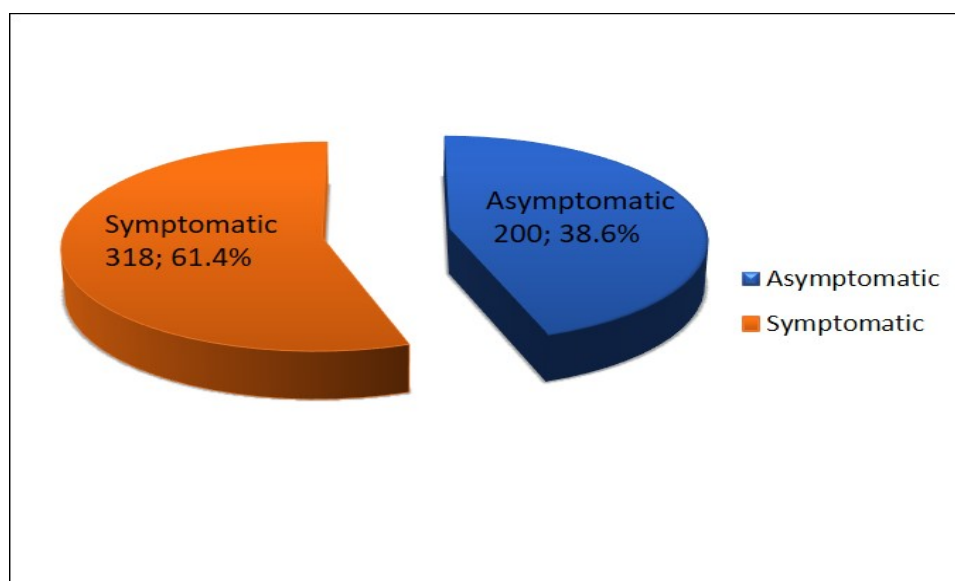


Figure 1: Distribution of participants according to symptomatic status

**Table 1:** The Sero – Prevalence of IgG in *Chlamydia trachomatis* Infection among Participants

Subjects	Total No. Examined	No. Positive (%)
Symptomatic and Asymptomatic	518	35 (6.8)
<b>Total</b>	<b>518</b>	<b>35 (6.8)</b>

### 3.1. Demographics of Participants in Relation to Symptomatic Status and *Chlamydia trachomatis* Infection

Table 2 of the result showed *Chlamydia trachomatis* prevalence in symptomatic males at 5.1% (8/154) and symptomatic females at 6.7% (11/164). Among asymptomatic participants, males had a prevalence of 4.6% (4/88) and females 10.7% (12/112). Overall seroprevalence was 5.0% (12/242) in males and 8.3% (23/276) in females. Gender showed no significant association with Chlamydia infection (P=0.238).

**Table 2:** The Sero-prevalence of *Chlamydia trachomatis* infections in both Symptomatic and asymptomatic male and female subjects

Subjects	Total No. Examined	No. Positive (%)
<b>Males</b>		
Symptomatic	154	8 (5.1%)
Asymptomatic	88	4 (4.6%)
<b>Total</b>	<b>242</b>	<b>12 (5.0%)</b>
<b>Females</b>		
Symptomatic	164	11 (6.7%)
Asymptomatic	112	12 (10.7%)
<b>Total</b>	<b>276</b>	<b>23 (8.3%)</b>

$\chi^2=1.128$ , df=1, P=0.288

Table 3 of the result indicated that symptomatic participants were most represented in the 21-25 age group (92; 28.9%), while asymptomatic participants were most numerous in the 26-30 age group (39; 19.5%).

**Table 3:** Age distribution of Symptomatic and Asymptomatic Participants

Age (yrs)	No. Screened	No. (%) Symptomatic	No. (%) Asymptomatic
15-20	74	44 (13.9)	30(15.0)
21-25	124	92 (28.9)	32 (16.0)
26-30	113	74 (23.3)	39 (19.5)
31- 35	96	63 (19.8)	33 (16.5)
36-40	40	21 (6.6)	19 (9.5)
41-45	42	10 (3.1)	32 (16.0)
>45	29	14 (4.4)	15 (7.5)
<b>Total</b>	<b>518</b>	<b>318(100)</b>	<b>200(100)</b>

Table 4 of the result detailed age-specific seroprevalence. Among symptomatic subjects, the 15-20 age group had the highest infection rate (18.2%; 8/44), with no infection in the > 45 age group. For asymptomatic subjects, the 21-25 age group showed the highest rate (18.8%; 6/32). Overall, age group differences in infection rates were not statistically significant (P=0.805).

**Table 4:** The Sero – Prevalence *Chlamydia trachomatis* infection in subject by age

Age group (yrs)	Symptomatic No. screened	No. of positive(%)	Asymptomatic No. of screened	No. of positive(%)
15-20	44	8(18.2)	30	4(13.3)
21-25	92	4(4.3)	32	6(18.8)
26-30	74	3(4.3)	39	2(5.1)
31-35	63	2(3.2)	33	1(3.0)
36-40	21	1(4.8)	19	1(5.1)
41-45	10	1(10.0)	32	1(3.1)
>45	14	0 (0.0)	15	1(6.7)
<b>Total</b>	<b>318</b>	<b>19(5.9)</b>	<b>200</b>	<b>16(8.0)</b>

$\chi^2=3.032$ , df=6, P=0.805

### 3.2. Socio-economic Status and Risk Factors Associated with *Chlamydia trachomatis* Infection

Table 5 of the result presented socio-demographic characteristics. Symptomatic participants with no formal education had the highest infection rate (14.3%; 5/35), while those with tertiary education had the lowest (3.0%; 4/134). Asymptomatic participants with no formal education also showed the highest rate (21.4%; 3/14). Educational level was not statistically significant (P=0.379).

Students recorded the highest prevalence by occupation in both symptomatic (8.1%; 8/99) and asymptomatic (12.5%; 4/32) groups. Civil servants had the lowest prevalence in both groups. Occupational status was not statistically significant (P=0.222).

Regarding income, symptomatic participants earning less than ₦20,000 per month had the highest infection rate (16.7%; 9/54), with the lowest (2.2%; 2/91) in those earning above ₦30,000. Asymptomatic participants earning less than ₦20,000 also showed the highest prevalence (8.6%; 8/43). Income level was not statistically significant ( $P=0.612$ ).

**Table 5:** Socio – demographic characteristic associated with *Chlamydia trachomatis* Infection among symptomatic and asymptomatic subjects

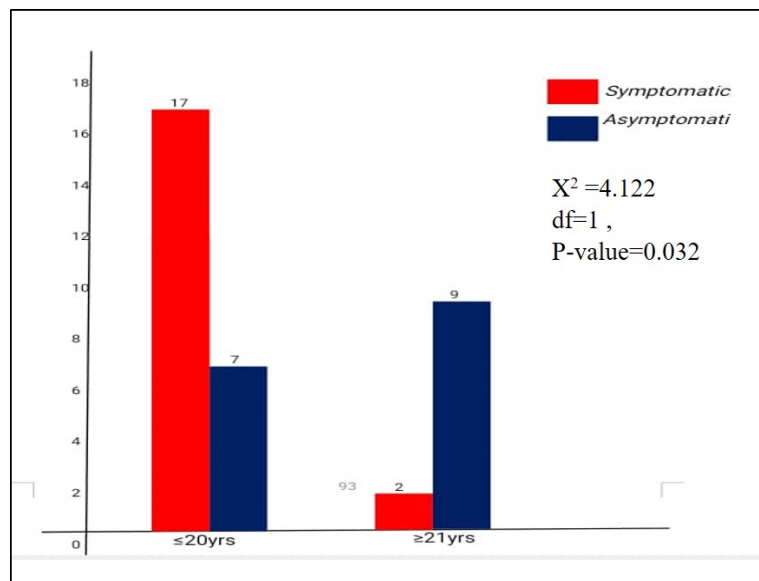
Variables	Symptomatic		Asymptomatic	
	No. Enrolled	No. of positives%	No. Enrolled	No. of positives%
<b>Education Status</b>				
No Formal Education	35	5(14.3)	14	3(21.4)
Primary	63	4(6.3)	36	4(11.1)
Secondary	86	6(6.9)	48	2(4.2)
Tertiary	134	4(3.0)	102	7(6.8)
<b>Total</b>	<b>318</b>	<b>19 (5.9)</b>	<b>200</b>	<b>16 (8.0)</b>
<b>P Value=0.379</b>				
<b>Occupational status</b>				
Unemployed	96	5(5.2)	78	9(11.5)
Student	99	8(8.1)	32	4(12.5)
Civil servant	51	2(3.9)	50	0(0.0)
Business	64	4(6.3)	40	3(7.5)
<b>Total</b>	<b>318</b>	<b>19(5.9)</b>	<b>200</b>	<b>16(8.0)</b>
<b>P Value=0.222</b>				
<b>Income Status (Thousand Naira)</b>				
Nil	73	4(5.5)	56	4(7.1)
<20	54	9(16.7)	43	8(18.6)
20-30	100	4(4.0)	32	1(3.1)
>30	91	2(2.2)	69	3(4.3)
<b>Total</b>	<b>318</b>	<b>19(5.9)</b>	<b>200</b>	<b>16(8.0)</b>
<b>P Value=0.612</b>				

Table 6 of the result outlined risk factors. Condom use, number of sexual partners, marital status, and history of STIs showed no statistically significant association with *Chlamydia* infection ( $P>0.05$  for all).

**Table 6:** Risk factors related to *Chlamydia trachomatis* infection among symptomatic and asymptomatic participants

Variables	Symptomatic		Asymptomatic	
	No. Enrolled	No of positives%	No. Enrolled	No of positives%
<b>Condoms Use</b>				
Yes	145	4(2.8)	74	4(5.4)
No	173	15(8.7)	126	12(9.5)
<b>P&gt;0.05</b>				
<b>Sexual partners</b>				
1	166	7(4.2)	37	2(5.4)
2	50	3(6.0)	63	4(6.4)
>3	102	9(8.8)	100	10(10.0)
<b>P&gt;0.05</b>				
<b>Marital Status</b>				
Single	148	12(8.1)	83	11 (13.3)
Married	110	3(2.7)	97	1 (1.0)
Divorced	60	5(8.3)	40	4 (10.0)
<b>P&gt;0.05</b>				
<b>History of STI</b>				
Yes	204	11(5.4)	164	12(7.3)
No	114	8(7.0)	38	4(11.1)
<b>P&gt;0.05</b>				

Figure 2 of the result indicated a statistically significant difference in *Chlamydia trachomatis* infection based on age at first sexual intercourse ( $P<0.05$ ). Among symptomatic positive participants, 89.5% (17/19) had their first sexual intercourse at or before 20 years. In contrast, among asymptomatic positive participants, 43.8% (7/16) had their first sexual intercourse at or before 20 years, while 56.3% (9/16) had it at 21 years and above.



**Figure 2:** Distribution of *Chlamydia trachomatis* infection by age at first sexual intercourse among symptomatic and asymptomatic participants

#### 4. Discussion

This study aimed to determine the seroprevalence of *Chlamydia trachomatis* infection and its association with sociodemographic characteristics and risk factors among symptomatic and asymptomatic individuals in Owerri, Imo State, Nigeria. The overall seroprevalence of *C. trachomatis* IgG antibodies in the study population was found to be 6.8% Table 1. This finding is comparable to some studies, such as that by [20] in asymptomatic young adults also in Owerri, but it contrasts with several other reports from different parts of Nigeria and globally that have indicated higher prevalence rates [10, 21, 22]. This observed variation in prevalence rates across studies is likely attributable to differences in study populations, geographical locations, and the diagnostic methods employed [23, 24]. The relatively lower prevalence observed in this study, compared to some others, might also reflect improved diagnostic methods or specific characteristics of the study subjects, which can influence reported rates [25].

The study revealed a *C. trachomatis* seroprevalence of 5.4% in symptomatic subjects and 8.0% in asymptomatic subjects. Although the prevalence was apparently higher in asymptomatic individuals, this difference was not statistically significant ( $P > 0.05$ ). This trend aligns with the known asymptomatic nature of Chlamydia infection, where a large proportion of infected individuals remain undiagnosed [26]. The overall prevalence of 6.8% is notably lower than figures reported from other Nigerian cities, such as Lagos (51% and 18.2%), Jos (56.1%), Zaria (38.3%), and Benin City (20%) [12, 13, 27–29]. These discrepancies could be due to variations in study settings, socioeconomic status, hygiene levels, study duration, and sample size. For instance, this study utilized ELISA for detection, while some comparative studies used culture methods, which, though sensitive, can be technically demanding and costly for routine diagnosis [30].

Gender-specific analysis indicated a higher prevalence of *C. trachomatis* infection in females (8.3%) compared to males (5.0%) Table 2. This observation is consistent with numerous global reports demonstrating a higher burden of *C. trachomatis* among women [31]. This disparity may be partly explained by women generally seeking more reproductive and gynecological healthcare services, leading to increased detection opportunities. Despite the difference in prevalence, gender was not statistically associated with Chlamydia infection in this study ( $P = 0.238$ ), which is in line with findings from other studies [3, 32–34].

Regarding age, symptomatic subjects in the 15–20 age group exhibited the highest seroprevalence (18.2%), while among asymptomatic subjects, the 21–25 age group showed the highest rate (18.8%) Table 4. These age groups fall within the sexually active population, which is a known risk factor for STIs [13, 24, 35]. The observed decrease in susceptibility to Chlamydia infection with increasing age is often attributed to cervical epithelial changes, where the columnar epithelial cells (a primary host target for *C. trachomatis*) present in young women are replaced by squamous epithelium through metaplasia in older age groups [36, 37]. Despite these trends, age was not significantly associated with Chlamydia infection in both symptomatic and asymptomatic subjects in this study ( $P = 0.805$ ), contrasting with some international studies [38, 39].

A statistically significant association was found between Chlamydia infection and age at first sexual intercourse ( $P < 0.05$ ) Figure 2. A substantial majority (89.5%) of symptomatic Chlamydia-positive participants had their first sexual encounter at or before 20 years of age. This finding supports the notion that earlier sexual debut increases the risk of *C. trachomatis* infection, aligning with previous research [13, 40]. The vulnerability of younger women to Chlamydia infection is linked to the persistence of columnar epithelium in their cervixes [3].

In terms of socioeconomic status, the highest infection rates were observed among participants with no formal education in both symptomatic (14.3%) and asymptomatic (21.4%) groups, although this difference was not statistically significant ( $P = 0.379$ ) Table 5. This finding, while not significant, suggests a potential link between lower educational attainment and increased vulnerability, possibly due to limited awareness and practice of safe sex. Similarly, participants with lower monthly incomes (less than ₦20,000) showed higher infection rates in both symptomatic (16.7%) and asymptomatic (8.6%) groups, though this was also not statistically significant ( $P = 0.612$ ). While some studies have reported a significant association between income and Chlamydia infection [34, 41], found no such link. The higher prevalence in low-income groups may be attributed to factors such as poor sex education, inadequate personal hygiene, and social structures that promote risky sexual behaviors.

Occupational status also showed no statistically significant association with Chlamydia infection ( $P = 0.222$ ). However, students recorded the highest prevalence in both symptomatic (8.1%) and asymptomatic (12.5%) groups Table 5. This aligns with the understanding that young

age is a key risk factor for chlamydial infection, as many students fall within the highly sexually active age demographic [10].

Finally, the study found no statistically significant association between Chlamydia infection and other common risk factors such as condom use, number of sexual partners, marital status, and history of STIs ( $P > 0.05$  for all) Table 6. This contrasts with numerous epidemiological studies that have identified these as significant risk factors [13, 34, 42]. The lack of association in this study might be explained by specific population characteristics or reporting biases.

## 5. Conclusion

While the overall seroprevalence of *C. trachomatis* in Owerri appears relatively lower than some national figures, the persistent asymptomatic nature of the infection, coupled with a significant association with early age at first sexual intercourse, signals the ongoing public health challenge. The findings show the need for targeted interventions, particularly focusing on young, sexually active populations, to improve awareness and promote early detection and treatment of *Chlamydia trachomatis* infections in this region.

## Article Information

**Disclaimer (Artificial Intelligence):** The author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.), and text-to-image generators have been used during writing or editing of manuscripts.

**Competing Interests:** Authors have declared that no competing interests exist.

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