

Research Article

Seroprevalence of *Treponema Pallidum* Infection among Blood Donors in Emezaka General Hospital, Abakaliki Ebonyi State

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Abstract

This study aimed to assess the prevalence of *Treponema pallidum* (TP) infection among blood donors in Emezaka General Hospital. A cross-sectional study design was employed, involving the collection of blood samples from individuals who provided informed consent. Serological tests were conducted using ELISA for Antibody detection of TP. The collected samples were processed, and results were systematically recorded. The study focused on understanding the rate of *Treponema* Infections among blood donors, and identifying demographic factors associated with these infections. Out of the 150 samples that were analyzed, 18 were shown to be positive for TP. The results also reveal significant gender differences: among 135 male participants, only 16 (10.7%) were positive for TP, while out of 15 female participants, only 2 (1.3%) tested positive. This incongruity implies that males in this population may be more likely to be exposed to TP infection, potentially due to the risk factors associated such as male to sexual intercourse, etc. The analysis of risk factors showed that multiple sexual partners were strongly associated with TP infection, with 6 out of 45 participants testing positive. Statistical analyses were performed to evaluate the data, revealing important insights into the health implications of TP infection within the study population. Findings from this research highlight the public health significance of *Treponema pallidum* infection, emphasizing the need for enhanced screening and prevention strategies in healthcare settings. This study highlights the need for increased educational efforts to raise awareness about TP infections and also provides valuable insights to inform policy direction and public health initiatives for combating *Treponema pallidum* Infections.

Keywords

Infections, Donors, Intercourse, Antibody, Blood

1. Introduction

Treponema pallidum, the causative agent of syphilis, remains a significant transfusion transmissible infection (TTI) [1, 2]. Syphilis, an infectious disease with a long history, is still a severe challenge to public health worldwide [3]. The

World Health Organization (WHO) estimates that there are 12 million new cases of syphilis each year, with more than 90% occurring in developing nations. Six million new cases of syphilis were determined annually among persons aged 15 to

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49 years worldwide with high prevalence of fetal and neonatal deaths [3]. Furthermore, there has been a resurgence of syphilis both in developed and developing countries since the late 1990s [4].

From the very beginning, syphilis has been a stigmatized, disgraceful disease; each country whose population was affected by the infection blamed the neighboring (and sometimes enemy) countries for the outbreak [5].

In Fracastoro's tale, Syphilus, mad at Apollo for parching the trees and consuming the springs that fed the shepherd's flocks, vowed not to worship Apollo, but his King. Apollo gets offended and curses people with a hideous disease named syphilis, after the shepherd's name [6]. The precise data for syphilis seroprevalence in the populations will help to develop a strategy for prevention and treatment of it.

Treponema pallidum (TP), a member of the treponema genus of the spirochetes family in the broad category of bacteria, is the causative agent of syphilis, is a sexually transmitted microorganism that exhibits remarkable motility capabilities, allowing it to affect various systems [7]. Despite its structural resemblance to gram-negative bacteria due to its dual-membrane, *T. pallidum* possesses a lower abundance of outer membrane proteins (OMPs), which enables it to effectively cause infections. common form of syphilis transmission is through sexual intercourse, as well as through mother-to-infant, and blood transfusion. Treponemes are helically coiled, corkscrew-shaped organisms 6 to 15 µm long and 0.1 to 0.2 µm wide [8]. The organisms stain poorly with aniline dyes. Treponemes in tissues can be visualized by silver impregnation methods. In order to prevent and reduce the risk of transfusion infectious syphilis disease, screening for TP antibodies in blood donors is routinely carried out [9]. The positive of TP antibody test not only means that the blood donated has a possibility to transmit syphilis through transfusion but also implies that the donor may have other kinds of STDs, such as human immunodeficiency virus (HIV), which may pose a severe threat to blood safety [10].

Untreated syphilis is a slowly evolving chronic disease that transpires in stages separated by asymptomatic intervals. Humans are the only natural host for *T pallidum* subsp *pallidum*, and infection occurs through sexual contact. The organisms penetrate mucous membranes or enter minuscule breaks in the skin [11].

Blood from a patient with incubating syphilis may be infectious long before the appearance of a chancre, as transfused blood from patients with incubating syphilis has transmitted the infection. Although neurological symptoms may not become apparent until years after infection, invasion of the central nervous system by *T pallidum* occurs relatively early [12]. A high proportion of patients with early syphilis have CSF abnormalities, despite a lack of neurological symptoms and treponemes often can be recovered by rabbit inoculation with either normal or abnormal spinal fluids during this period. Conversely, a normal spinal fluid examination two or more years after infection indicates a low risk of

subsequent development of neurosyphilis. Other target tissues include lymph nodes, skin, mucous membranes, liver, spleen, kidneys, heart, bones, joints, larynx, and eyes. It is generally believed that the motility of the organisms contributes to the invasiveness of these bacteria. Studies with cultured human endothelial cells have demonstrated that *T pallidum* rapidly penetrates between tight endothelial cell junctions, and this may be the mode of invasion at the various sites of dissemination [13]. The most prominent and widespread histopathologic feature of syphilitic infection is perivascular inflammation. This typically consists of proliferation of adventitial cells; perivascular cuffing with lymphocytes, monocytes and plasma cells; and swelling and proliferation of endothelial cells. Occasionally these changes progress to frank vasculitis with ischemic necrosis of tissues. Granulomatous changes are characteristic of tertiary disease but may be seen in secondary syphilis as well. *Treponema pallidum* subsp *pallidum* appears to lack potent toxins, and it is believed that tissue damage results from the host's cellular inflammatory response [14]. Treponemal lipoproteins have been shown to be capable of activating relevant immune effector cells, most notably macrophages and endothelial cells. While evasion of host cellular and humoral immune responses is presumably prerequisite to establishment of persistent infection, the mechanisms responsible for this are poorly understood. It is known, however, that the surface of the organism reacts poorly with specific antibodies; the paucity of surface-exposed proteins is believed to explain this phenomenon. Circulating immune complexes containing treponemal antigens are regularly present in secondary syphilis and may contribute to clinical manifestations, most notably the nephrotic syndrome occasionally seen in the secondary stage of the disease [15].

Venereal syphilis is the prototype treponemal disease and the only treponematoses of significance in developed countries. Clinical manifestations of syphilis are complex and the periods associated with each stage vary greatly. After an incubation period of 10 to 90 days, extensive multiplication of treponemes at the site of entry produces erythema and induration [16]. The resultant papule eventually progresses to a superficial ulcer with a firm base called a hard chancre. (*Haemophilus ducreyi* causes soft chancre, which differs in that it is flat, centrally umbilicate, tender, and painful.) [17].

Treponemal infections are unique in that they are characterized by distinct clinical stages. Multiplication of the organisms at the initial site of entry produces the primary stage. The dissemination of treponemes to other tissues results in the secondary stage [18, 19]. After a relatively prolonged period, in some cases 20 to 30 years, the tertiary or late stage evolves. *Treponema pallidum* subsp *pallidum*, the most invasive of the pathogenic treponemes, produces highly destructive lesions in almost any tissue of the body, including the central nervous system. *Treponema carateum* is the least invasive and causes only cutaneous disease. *Treponema pallidum* subsp *pertenue*

and endemicum are intermediate in invasiveness and cause destructive lesions in bones and soft tissues [20, 21].

Numerous treponemes are present in this highly contagious, open lesion. Regional lymph nodes enlarge, causing regional lymphadenopathy. After 2 to 6 weeks of symptoms, this primary lesion heals, leaving only remnants of scar tissue [22].

After an asymptomatic period of 2 to 24 weeks, the secondary or disseminated stage begins.

Organisms multiply in many different tissues. Clinical manifestations include:

- 1) Slight fever,
- 2) Generalized lymphadenopathy
- 3) Malaise, and
- 4) A mucocutaneous rash. The rash initially appears on the palms and soles and eventually spreads to other areas. The rash may be macular, papular, follicular, papulosquamous, or pustular.
- 5) Superficial sores (mucous patches) may occur on mucous membranes of the mouth, vagina, or anus

While a wart-like lesion called condylomata lata may form in moist areas. All of these lesions teem with treponemes and are highly contagious. Deposition of immune complexes consisting of treponemal antigens and host antibodies in glomerular basement membranes may produce nephrotic syndrome. Two to six weeks after the onset of secondary syphilis, host defenses bring about healing. About 25 percent of untreated patients experience recurrences of this secondary stage in the first several years following infection [23, 24]. The period between secondary and tertiary syphilis, termed latency, can last for many years. Early latency refers to the first 4 years when secondary relapses may occur; late latency is the asymptomatic period beyond 4 years. During this latter period, the patient harbors infectious organisms, especially in the spleen and lymph nodes and blood serology remains positive [25-27].

2. Methodology

2.1. Study Area

The study was conducted at Emezaka in Abakaliki, the capital of Ebonyi State, Nigeria, which is one of the thirteen Local Governments in Ebonyi State. Abakaliki has boundaries with Izzi to the north, Enugu to the East, Ikwo to the South and Ezza to the West. It serves a diverse population from both urban and rural areas across Ebonyi State and neighboring regions. Abakaliki, positioned at latitude 6.3165 °N and longitude 8.1000 °E, is a significant hub for healthcare services.

2.2. Study Design

A cross-sectional study among the blood donors was conducted employing a random sampling technique. Data on demographic, social, and behavioural indicators were collected using questionnaires and blood samples tested for *Treponema pallidum* seromarkers.

2.3. Study Population

The study population consisted of male and female patients accessing medical care. Blood donors were selected randomly for the study.

2.4. Ethical Approval

Ethical approval was obtained from the Institutional Based Committee, Ebonyi State Ministry of Health before the commencement of the study. Informed consent was sought from each participant before sampling.

2.5. Inclusion and Exclusion Criteria

The inclusion criterion was consenting male and female of 20 years and above, who were chosen randomly. Non consenting individuals were excluded from the study.

2.6. Sample Collection and Processing

The sample collection process for assessing the prevalence of *Treponema pallidum*-infection was an essential component of this research study. Approximately 5 ml of blood was drawn into a sterile tube, care was taken to minimize discomfort during the procedure. After the samples were collected, they were gently mixed and labeled with unique identifiers for proper tracking. Timely transport of the samples to the laboratory was critical to ensure their integrity; however, in instances where immediate processing was not feasible, samples were stored at 2-8 °C to prevent degradation.

2.7. Data Collection

Data related to socio-demographic factors and probable risk factors associated with *Treponema pallidum* infections were collected.

2.8. Sample Size

A total of 150 blood specimens were collected randomly from consenting 150 donors (135 males and 15 females).

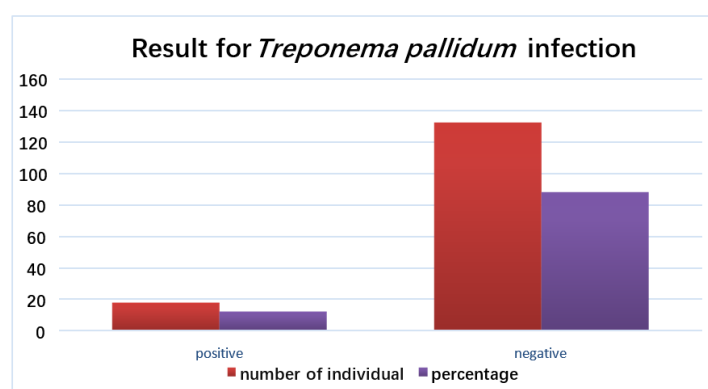
3. Results

Results for the seroprevalence of Treponema pallidum Infection among blood donors in Emezaka General Hospital.

Out of the 150 samples tested for *Treponema pallidum* infection, 18 donors were found to be positive giving prevalence of 12% while the remaining 136 donors tested negative with 88. The prevalence of *Treponema pallidum* infection among blood donors is 12%, indicating a moderate public concern as shown in Table 1 below.

Table 1. Result for *Treponema pallidum* infection among donors in Emezaka General Hospital.

Category	Number positive	Positive percentage (%)
Positive	18	12%
Negative	132	88%
Total	150	100%

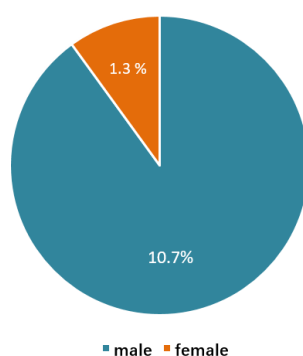
**Figure 1.** Bar chart showing the distribution of *Treponema pallidum* infection among donors in Emezaka General Hospital.

From the table below, 150 individuals were involved which showed that 135 males were examined, only 16 appeared positive of syphilis with a percentage of 10.7% while 15 females

were examined, only 2 appeared positive with a positive of 1.3%.

Table 2. Distribution of *Treponema pallidum* Infection Based on Gender.

Gender	Total	Positive	Percentage of Positive (%)
Male	135	16	10.7%
Female	15	2	1.3%
Total	150	18	12%

Distribution of T. pallidum based on gender**Figure 2.** Pie chart showing the distribution of *Treponema pallidum* infection based on gender.

From the table below, seroprevalence rate of 0.7% was obtained among 45 age 20-24 donors tested, while 2.0% seroprevalence rate was obtained among the 55 age 25-29 donors tested, 6.0% seroprevalence rate was obtained among the 35

age 30-34 donors tested, and 3.3% seroprevalence rate was obtained among the 15 ages >35 donors tested. There is no significant relationship between the age group and the *Treponema pallidum* status of the study participants.

Table 3. Distribution of *Treponema pallidum* infection among blood donors in Emezaka General Hospital based on age Range.

Age Range	Number of blood donors	Number of positive (n)	Prevalence of the donors (%)
20-24	45	1	25.0%
25-29	55	3	33.3%
30-34	35	9	16.7%
Above 35	15	5	25%
Total	150	18	100%

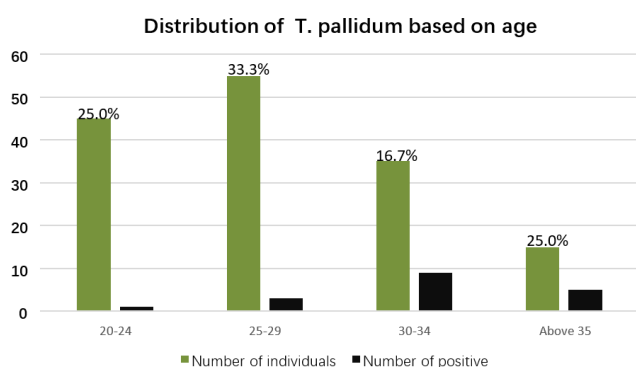


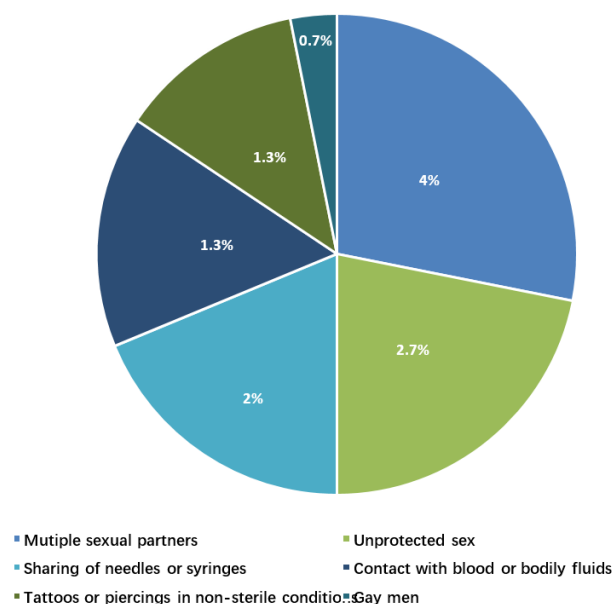
Figure 3. Bar chart showing the distribution of *Treponema pallidum* infection based on age.

Based on the risk factors, results obtained from donors who tested positive showed that out of the 25 donors who indicated to have multiple sexual partners had the highest prevalence and they had the highest positivity of 4.0% prevalence of TP infection. This is followed by those who indicated unprotected sex with 2.7% prevalence, while those who indicated sharing of needles or syringes had 2.0%, followed by those who indicated contact with blood or non-sterile fluids and Tattoos or piercings in non-sterile conditions had 2.0% prevalence, while others had the lowest prevalence with a positive of 1%.

Table 4. Distribution of TP Infection among Donors of Emezaka General Hospital, in Relation to Risk Factors.

Risk Factor	Number of Donors	Number of Positive TP infection	Prevalence (%)
Multiple sexual partner	35	6	4
Unprotected sex	35	4	2.7
Sharing of needles or syringes	30	3	2
Contact with blood or bodily fluids	25	2	1.3
Tattoos or piercings in non-sterile conditions	20	2	1.3
Gay men	5	1	0.7
Total		18	12

Distribution of TP infection based on risk factors

**Figure 4.** Pie chart showing the distribution of *Treponema pallidum* infection based on risk factors.

From Table 5, result Based on Education level attained, Donors who tested positive, showed that, out of 50 post-graduate, 6 tested positive for TP Infection, with the highest prevalence of 4%. This is followed by donors who held Bachelor's degree and high school certificate holders, with a prevalence of 2%,

which is followed by college degree holders, and Junior school certificate holders, with a prevalence of 1.3%, While primary certificate holders, and those who are Donors whose Education Level is not identified has the lowest prevalence rate of 0.7% respectively.

Table 5. Distribution of TP Infection Based on the Education Level Among Donors of Emezaka General Hospital.

Education Level	No of Donors	No of infection positive	Prevalence (%)
Post-graduate	50	6	4
Bachelor	35	3	2
College degree	25	2	1.3
High school	20	3	2
Junior school	10	2	1.3
Primary Education	5	1	0.7
Not identified	5	1	0.7
Total	150	18	12

4. Discussion

The seroprevalence of *Treponema pallidum* (TP) among blood donors in Emezaka General Hospital, is a major public health concern, as it can have significant implications for blood safety and transfusion practices. This study aimed to determine the seroprevalence of *Treponema pallidum* (TP)

among blood donors in Emezaka General Hospital, and identify associated factors.

The findings from the study provide valuable insights into the prevalence of TP infections, their distribution across gender, age groups, and associated risk factors.

From Table 1, it shows that out of the 150-sample tested for TP infection, 18 donors were found to be positive giving prevalence of 12% while the remaining 132 donors tested negative with 88% prevalence.

From Table 2, 150 individuals were used for this analysis which showed that 135 males were examined, and 16 appeared to be positive of TP infection with a percentage of 10.7 while 15 females were examined, only 2 appeared positive with a percentage of 1.3%

Based on age range, higher prevalence rate of TP infection among individuals was seen to be high between the age group of (31-34) which could be as a result of male-to-male intercourse, bisexuality, multiple sexual partners or sharing of needles or syringe, followed by (25-29) age group, which is followed by age 35 and above, while the least that is being affected is from the age grade of 20-24 according to Table 3.

From Table 4, individuals are highly affected with TP as a result of having multiple sex partner as shown in the Table 4. Out of 25 individuals tested, 6 appeared positive, followed by unprotected sex with 4%, followed by sharing of needles or syringe with 3%, followed by contact with blood or bodily fluids with a positive of 2%, and tattoos and piercing in non-sterile fluids with a positive of 2% while the least is among gay men with just 1 being positive.

From Table 5, result Based on Education level attained, Donors who tested positive, showed that, out of 50 post-graduate, 6 tested positive for TP Infection, with the highest prevalence of 4%. This is followed by donors who held Bachelor's degree and high school certificate holders, with a prevalence of 2%, which is followed by college degree holders, and Junior school certificate holders, with a prevalence of 1.3%, While primary certificate holders, and those who are Donors whose Education Level is not identified has the lowest prevalence rate of 0.7% respectively.

5. Conclusion

The study revealed a 12% prevalence of TP infection among donor participants in Emezaka General Hospital, with males exhibiting a higher infection rate than females. The age distribution indicates that TP infection is relatively consistent across age groups, with a higher prevalence among individuals aged 35 and above. The relationship between male-to-male intercourse, bisexuality, multiple sexual partners and increased TP infection highlights the need for targeted sexual health education and interventions.

In conclusion, the seroprevalence of *Treponema pallidum* (TP) among blood donors in Emezaka General Hospital is a significant public health concern. The study's findings highlight the need for enhanced screening and testing protocols, as well as education and awareness programs for blood donors. The implementation of more sensitive and specific testing could help minimize the risk of transmission and ensure the safety of blood supply.

Abbreviations

TP *Treponema pallidum*

ELISA	Enzyme-Linked Immunosorbent Assay
TTI	Transfusion Transmissible Infection
WHO	World Health Organization
(OMPs)	Outer Membrane Proteins
HIV	Human Immunodeficiency Virus
STDs	Sexually Transmitted Infection

Authors Contributions

Onu Euslar Nnenna: Conceptualization, Funding acquisition, Investigation, Methodology, Supervision, Visualization, Writing – original draft, Writing – review & editing

Ilang Donatus Chukwuma: Data curation, Supervision, Validation

Eze Blessing: Resources

Onu Henrrienta Chinaemerem: Formal Analysis, Project administration

Obaji Ezekiel Amuche: Methodology, Software

Conflicts of Interest

The authors declare no conflicts of interest.

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