SEROPREVALENCE AND ASSESSMENT OF RISK FACTORS ASSOCIATED WITH SYPHILIS AMONG INTRA - CITY TRANSPORTERS IN BENIN METROPOLIS

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UNIVERSITY OF BENIN

BENIN CITY.

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NOVEMBER,2025

CERTIFICATION

This is to certify that this research work was carried out by Ebosele Faith with matriculation number BMS2001155 under the supervision of Dr. (Mrs) Ifueko.M.Moses-Otutu in the Department of Medical Laboratory Science, School of Basic Medical Sciences, University of Benin, Benin City, Edo State.

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External Examiner

DEDICATION

This work is dedicated to God Almighty for his Grace and Divine intervention throughout the course of my study, Glory to the Holy one.

ACKNOWLEDGEMENT

My heart-felt gratitude goes to God Almighty who made it possible for me to complete this study. My profound gratitude goes to my supervisor Dr. (Mrs.) Ifueko.M Moses-Otutu for her genuine concern, support and guidance throughout the course of this study. To Dr. (Mrs.) Zainab Omoruyi, the Head of Department, Medical Laboratory Science, University of Benin, for always emphasizing on personal diligence. Also, to my dear lecturers Dr. Mrs. Olise, and Dr. Richard Omoregie whose advice contributed to the success of this work.I wish to thank Dr. Angela Eghioma for her guidance in laboratory Analysis.

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May the good Lord bless and keep you all Amen.

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ABSTRACT

Syphilis, a sexually transmitted infection caused by *Treponema pallidum,* remains a significant public health concern, particularly among mobile occupational groups.This study assessed the seroprevalence and risk factors associated with syphilis among intra-city transporters in Benin Metropolis. A cross-sectional descriptive design was adopted, enrolling 150 participants through convenience sampling technique. Data were collected using a structured questionnaire. About 4ml of venous blood samples were collected from each participant using sterile aseptic techniques into plain containers and centrifuged at 3,000 rpm for 5 minutes to obtain serum.The serum obtained were screened serologically for syphilis antibodies. Data were analyzed using SPSS version 27. An overall Prevalence of 32.0% syphilis was obtained.Age, education, marital status and location of transporters had no significant association with prevalence of syphilis (P=0.344),(P=0.884),(P=0.943)and(P=0.217).Behavioral factors such as non condom use, multiple sexual Partners and self reported symptoms (such as genital sore, painful urination) were strongest predictors of Syphilis infection in the study population (P=0.000 respectively). More than half (53.3%) of respondents had never heard of syphilis, and only a few had received health education.Knowledge was not significantly associated with Syphilis infection having Prevalence greater than 0.05.The high rate of asymptomatic cases further underscores the hidden burden of syphilis in this group. The study concludes that intra-city transporters in Benin metropolis are a high-risk population for syphilis transmission, driven primarily by behavioural and occupational factors. It recommends targeted health education campaigns, routine and affordable screening at motor parks, and collaborative interventions between government and transport unions to promote safer sexual practices.

CHAPTER ONE
INTRODUCTION

1.1. BACKGROUND

Syphilis is a systemic, bacterial infection caused by the spirochete *Treponema pallidum* (Tudor *et al.,* 2014). Syphilis is primarily acquired through sexual exposure involving infective lesions in forms of chancres, mucous patches, and rashes on the skin. The lesser common modes of infectivity include nonsexual personal contact such as vertical transmission (mother to fetus) in uterus, parental products such as blood or blood products transfusion, and organ transplantation (Rana, 2024). Though, it is curable, there is an increase in reported cases of syphilis. In January 2024, the Centers for Disease Control and Prevention (CDC) reported that cases of syphilis had reached their highest levels in more than a decade, with more than 203,500 cases of syphilis reported in the US in 2022, a figure that is nearly double in 2018. The cases surged by 32% between 2020 and 2021snd was 17% between 2021 and 2022 and to reach the highest number of reported incidences in 70 years (Krupa, 2025).

Intracity transporters are set of population who offer public transportation system that uses a varieties of motor vehicles with capacity of cars (1-4 people), and small buses (up to 7 passengers), mid buses (7-30 passengers) and large buses (more than 30passengers)(Christopher, 2022; Herrie and Roger, 2013; Korver *et al.,* 2012). They assist in social economy activities through it availability and are major source of income for low skilled workers (Gabriel, 2017). Intracity transporters (taxi drivers) often work in strenuous and hazardous conditions are expected to frequently interact with passengers (Bartel *et al.,* 2019).

Globally, there is a wide recognition of the association between migration and mobility and STIs/HIV Infections (Nahmias *et al.,* 2011).In Nigeria, it is common to see commercial bus drivers either intercity or intracity who have spent long hours on the road away from home.These

drivers and their assistants are away from home for long periods of time and in ports and high ways are usually unhealthy environment.During their journeys, long-distance drivers stop at rest houses, guest houses, and roadside hotels that usually provide food, rest, sex workers,alcohol and drugs for their relaxation. They pick up the women at their rest point, have sexual intercourse with them and leave them there. These women are mostly locals so other drivers also come and have sex with them as well as the local men.These environments which they engage in these sexual activities therefore crucial in spreading HIV, HBV and STIs throughout the country (Boahemaa-Atta, 2014).

Identifying groups mostly at risk of sexually transmissible infections (STIs) is important for prioritizing screening, targeting prevention strategies and alleviating the burden of STIs (Traeger *et al.,* 2022). And one of the most common High-risk groups include commercial bus drivers. These groups are often overlooked in surveillance programs despite them playing a crucial role in the spread of syphilis and other sexually transmitted infections (STIs) or sexually transmitted diseases (STDs).

1.2. STATEMENTOFTHE PROBLEM

Syphilis remains a significant public health interest in the world for over 100 years (Freyne *et al.,*2023). Over the years ,high transmission rates of Sexually Transmitted Diseases (STDs) have been documented among sexually active adolescents and adults. Adolescents and young adults are accountable for only 25% of the sexually active population and they represent almost 50% of all newly acquired STDs (Siracusano *et al.,* 2014). In a metropolis like Benin City, transporters(bus drivers, tricycles riders i.e. kekenapep riders motorcyclist) constitute a high-risk population for the acquisition and transmission of Sexually Transmitted Infections (STIs), a vulnerability largely attributed to their occupational mobility, frequent interstate travel, and engagement in high-risk sexual behaviors (Awoleye *et al.,* 2025). Studies has shown that transport workers often indulge in risky sexual behavior including multiple partners and low condom use, thereby increasing their vulnerability to syphilis and other common Sexually Transmitted Infections (STIs) or Sexually Transmitted Diseases (STDs) (Thakur *et al.,* 2015. Pachauri *et al.,* 2021).

Despite existing Sexually Transmitted Infections (STIs) or Sexually Transmitted Diseases (STDs) awareness programs, many bus drivers lack adequate knowledge about syphilis prevention, testing and treatment (Garcia *et al.*, 2017, Yardav *et al.*, 2018). Furthermore attached stigma and poor health care access further hinder early diagnosis and treatment. This study seeks to address this gap by determining the seroprevalence of syphilis among various commercial bus drivers in Benin City,thereby ,assessing their knowledge and risk factors and providing evidence for targeted interventions.

The burden of syphilis is managed and understood by this key population will help policymakers and health organizations design effective sexual health programs therefore promoting awareness,enhance regular screening and reduce transmission rates in Benin City and beyond.

1.3. JUSTIFICATION OFTHESTUDY

Intra-city transporters (Commercial bus drivers, tricyclist) are at high risk but still understudied group in Nigeria regarding Sexually Transmitted Infections like syphilis, Available data can be seen in more published works majorly on the seroprevalence of HIV/AIDS in long distance commercial drivers in Kano State (Usman *et al.,* 2023) and among others. Their consistent travels, extended periods away from home, indulgement in risky sexual behaviors e.g. multiple partners, low condom use (Awoleye *et al.,* 2025). Inspite of all these, no known published work on the seroprevalence of syphilis among bus drivers.

On awareness of seroprevalence of syphilis and risk factors associated with it, if not treated or managed the rate of syphilis infection will become high. In addition, if syphilis is left untreated for a long period of time can lead to the tertiary stage of syphilis infection which can cause damage to various organs of the human body (Tudor *et al.,* 2025)

This study is therefore justified as it will provide empirical data on the burden of syphilis among this under researched group. The findings can help guide public health policies, STIs prevention programs and routine screening practices for commercial bus drivers in Benin City and similar urban settings.

1.4. AIM OF STUDY

The aim of this study was to determine the seroprevalence of syphilis among intra-city transporters(commercial bus drivers, motorcyclist, tricyclist) in Benin City, Nigeria, and to evaluate the associated behavioral risk factors.

1.5. SPECIFIC OBJECTIVES

The Specific objectives include to;

1. determine the prevalence of syphilis among bus drivers in Benin City, Nigeria.
2. identify sociodemographic and behavioral risk factors associated with Postivity among

bus drivers in Benin city.

3. Evaluate the relationship between sociodemographic parameters and prevalence
4. Assess the knowledge,attitudes,and sexual practices of bus drivers concerning syphilis.
5. access the relationship between sexual practices, risk factors and the prevalence of syphilis infection among bus drivers in Benin city.

1.6. RESEARCHQUESTIONS

1. What is the prevalence of syphilis among bus drivers in Benin City, Nigeria?
2. What sociodemographic and behavioral risk factors are associated with syphilis positivity among bus drivers in Benin City?
3. Is there any relationship between sociodemographic parameters and the prevalence of syphilis among bus drivers in Benin City?
4. What are the levels of knowledge, attitudes, and sexual practices concerning syphilis among bus drivers in Benin City?
5. What is the relationship between sexual practices, risk factors, and the prevalence of syphilis infection among bus drivers in Benin City?

1.7 HYPOTHESES

Null Hypothesis

There is no significant association between sociodemographic or behavioral factors and syphilis infection among commercial bus drivers in Benin City (null).

Alternate Hypothesis

There is a significant association between sociodemographic or behavioral factors and syphilis infection among commercial bus drivers in Benin City (hypotheses).

CHAPTER TWO
LITERATURE REVIEW

2.1. HISTORICAL BACKGROUND OF SYPHILIS

Syphilis remains a harmful plague that continues to afflict millions of people worldwide. It is a systemic bacterial infection caused by the spirochete "*Treponema* pallimimicker". Due to it's Many clinical manifestations,syphilis has been named the great imitator and mimicker." The origin of syphilis has been tricky and under serious debate, and many theories have been presented regarding this (Anteric *et al.,*2014).The most pronounced hypotheses are the" Columbian "and" Pre-Columbian"theories.

The Columbian theory: This is the most accepted theory of Syphilis. This theory states that *Treponema pallidum* originated in the Americas and was brought back to Europe by Christopher Columbus's crew after their voyages in the late 15th century. The first recorded European outbreak happened in Naples in 1494-1495 among French troops. It is documented the name "Syphilis" comes from the work of Girolamo Fracastoro, by a noted poet and physician in Verona, Italy. In 1530, he wrote about a shepherd named Syphilis who angered Apollo, making the god to curse the entire population with the affliction that we now known as Syphilis (Lopez *et al.,* 2023; Tamper *et al.,* 2014).

The pre-Columbian theory: some hidden evidence suggests syphilis-like infections existed in Europe before Columbus, but genetic studies connect the modern *Treponema pallidum* strain to a New World origin (Majander *et al.,*2020). The 2019 Global pandemic of Disease Study indicated a worldwide prevalence of about 50 million syphilis cases, representing an alarming 60% overall increase from 1990 to 2019 (Chen *et al.,* 2019). The World Health Organization (WHO) estimated 7.1 million cases in 2020, with the highest incidence in sub-Saharan Africa, Southeast Asia, Latin

America, and the Caribbean (Rowley *et al.,* 2016; Byad, 2018).

In respect to the Centers for Disease Control and Prevention (CDC) statistics, the incidence of syphilis among adults in the US increased by 38% from 2008 to 2012 and by 80% between 2018 and 2022, with 88,042 new cases reported in 2016 and 207,255 in 2022. This is close to what was reported by the European Centre for Disease Prevention and Control, which reported almost 33,000 confirmed syphilis cases (roughly 8.5 cases per 100,000 population) in the European Union in 2022, showing a 34% increase from 2021.

The early used treatment Includes the use of mercury, guaiacum and syphilization, which are toxic and ineffective and cause large side effects until the year 1910, when Paul Ehrlich developed Salvarsan (asphenamine), an arsenic-based drug, which was the first truly effective treatment for syphilis. It reflected a significant improvement over mercury and the other treatments, but it is still toxic (Szreter, 2014). The identification of *Treponema*, the agent causing the disease, by Fritz Schaudinn and Enrich Hoffman in 1905 aided in the understanding of the disease.

The most significant change came with the discovery and worldwide use of penicillin. In 1943 John Mahoney and his colleagues illustrated its effectiveness against syphilis. Penicillin proved to be highly effective and relatively non-toxic and replaced the treatment and control of the disease, leading the decline in syphilis cases in the mid-20th century. With the idea of penicillin therapy, the Syphilis rate declined in many parts of the world. Although the disease remains a persistent public health issue, especially in low- and middle-income countries. The recurrence of syphilis in the recent time is due to the high-risk group of men indulging in sex with men, sex workers, transport workers and association with HIV (WHO, 2022).

2.2. ORGANISM AND ITS STRUCTURE(*Treponema pallidum*)

Syphilis is a systemic, bacterial infection caused by the spirochete *Treponema pallidum* (Tudor*et al.,* 2024). It is a microaerophilic, gram-negative bacterium (but stains poorly; best visualised via dark-field microscopy or silver staining), 6-20 micrometres long and 0.1-0.2 micrometres wide, and an obligate pathogen that cannot be cultured in vitro for a long time and depends on a host for cellular mechanism (Mindel *et al.,* 2016).

Treponemes are corkscrew-shaped, helically coiled organisms that measure 6 to 15 µm in length and 0.1 to 0.2 µm in width. The use of aniline dyes on the organisms do not stain well. Silver impregnation techniques are used to see treponemes in tissues. Dark-field microscopy are also used to visualize living treponemes, which are too micro to be seen by traditional light microscopy. The differential motility of *Treponema pallidum* sub-sp. *pallidum* are fast rotation around its longitudinal axis as well as bending, flexing, and snapping over its entire length.

According to the report in 1998, the first genome of strain Nichols, or *Treponema pallidum*, was sequenced. The single-stranded, circular DNA chromosome that makes up the thinnest spirochete genome, *Treponema pallidum*, is 1.14 Mb in size and has 1,041 open reading frames (Wang and Zhang, 2024). The following features set the *Treponema pallidum* genome aside from those of other bacteria and spirochetes: Because it lacks the functional genes for catalase, peroxidase, and superoxide dismutase, it may only survive in low-oxygen environments , where an oxygen content of 1.5% is ideal. It also has genes for glycolytic enzymes but not of tricarboxylic acid cycle or oxidative phosphorylation enzymes; therefore, ATP is produced only by glycolysis, which causes low metabolic abilities and untimely growth, and the G + C concentration of *Treponema pallidum* is 52.8%, which is amountably higher than that of Borrelia bacteria (28.6%), giving a distant relationship between the two bacterium. *T.Pallidum* appears to utilise host mechanisms to meet some of its metabolic demands because 55% of its1041open reading frames are identified as

having a biological activity(Radolf*al.,*2016).

Ultra-structure of the *Treponema pallidum*

Beneath the electron microscope, *T.pallidum* shows as a tight spiral with about seven to twelve helices. A single helix have a wavelength ranging from 0.6–1.2 μm and an amplitude of 0.15–0.3 μm. On the axial length at both ends varies from 7.0–13.0 μm, and the body axis spans from 8.3–22.0 μm. The body's length ratio varies from 1:1.2 and 1:1.9. The cross-sectional diameter is approximately 0.16 μm, with a cross-sectional area of approximately 0.025 μm2. Both ends of *Treponema pallidum* gradually tips to rounded conical shapes, and the cross-sectional diameter of each tip is approximately 0.08 μm. The structure of *Treponema pallidum* includes an outer membrane, a peptidoglycan layer, a periplasmic space, periplasmic flagellum, an inner membrane, and filaments (Fig. 1). Although *Treponema pallidum* is often regarded as special gram-negative bacillus owing to its structural similarities, there are small contrast in the membrane structure between it and other bacteria. (Wang *et al.,* 2024).

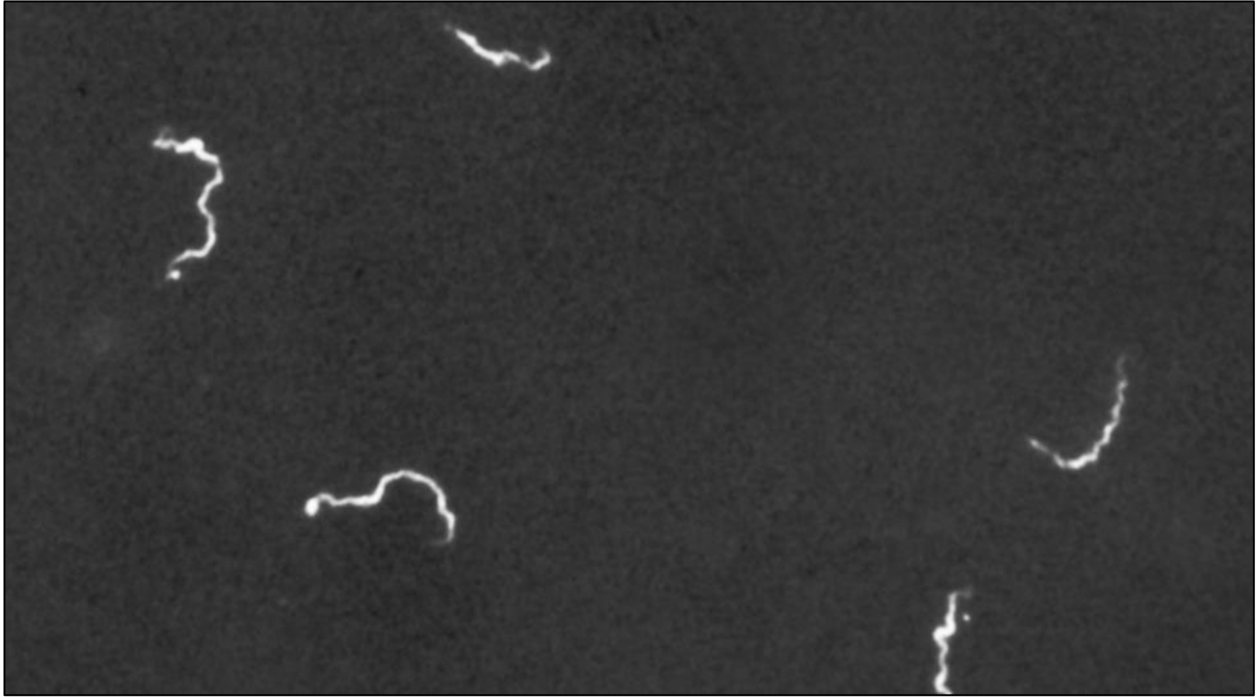

FIGURE 2.1:THE ULTRA-STRUCTURE OF *Treponema pallidum* (CDC, 2008).

2.3. SPECIES

Treponema pallidum is a species of bacteria with vary subspecies that cause different form, but related, human diseases known as treponematoses. While these subspecies are genetically very similar, they differ in their mode of transmission, clinical presentation, and geographical distribution.

There are four main subspecies of *Treponema pallidum:*

***Treponema pallidum* subspecies pallidum**

This causes venereal syphilis, a sexually transmitted infestation that can also be congenital (mother to child) or transmitted through blood transfusion. It's the most invasive of the subspecies, able to spread to almost every tissue in the body, including the central nervous system (neurosyphilis) and the cardiovascular system. It is the major manifestation of primary, secondary, latent and tertiary syphilis.

***Treponema pallidum* subspecies endemicum:**

This causes endemic syphilis, also known as bejel. It is a non-sexually transmitted disease, and contracted by skin-to-skin contact or kitchen utensils. It is often seen in dry, arid regions (Africa, Middle East). Bejel is a non-venereal disease that affects the mucous membranes (particularly in the mouth), skin, and bones.

***Treponema pallidum* pertenue:**

This causes yaws. It is a non-sexual, skin to skin contact, primarily found in rural, tropical areas of Africa, southeast Asia, and the pacific island. Yaws is not a venereal disease that mainly affects the skin and bones, specifically in children. It is less invasive than syphilis.

***Treponema pallidum* carateum:**

This causes pinta. It is a skin-to-skin contact disease majorly found in South/Central America. It is known to cause skin discolouration (hyper/hypopigmentation) but no systemic effect.(Norris *et al.,*2015)

2.4. TAXONOMICCLASSIFICATION

The taxonomic classification of *Treponema pallidum* is as follows:

Domain:Bacteria (Eubacteria)

Kingdom: Pseudomonadati

Phylum: Spirochaetota

Class: Spirochaetia

Order: Spirochaetals

Family: Spirochaetaceae (Treponemataceae)

Genus: Treponema

Species: pallidum

(Schoch *et al.,*2020).

2.5. MODE OF TRANSMISSION

Treponema pallidum subspecies *pallidum*, the causative agent of venereal syphilis, is primarily transmitted through direct contact with infected lesions during sexual intercourse. Transmission happens when a person's mucous membrane (mouth,vagina,or rectum)or abraded skin goes in contact with a syphilis lesion from an infected individual. It is highly contagious in the primary and secondary stages.

Apart from the sexual contact , Syphilis can also be transmitted through congenital transmission from mother to child. *Treponema pallidum* has ability to cross the placenta from an infected mother to her foetus. This occurrence may be at any stage of pregnancy but is most likely to occur during primary or secondary syphilis. Congenital syphilis can lead to severe health problems for the newborn. It can also occur during vaginal delivery if active lesions are present (McDonald, 2023). Another means of transmission though less common, is parenteral transmission, such as contaminated blood transmission and other blood products or shared needles. This mode of transmission is rare in developed countries due to routine screening of blood donors and not sharing one needle for two people.

2.6. PATHOGENESIS

Life cycle of Syphilis is classified as primary, secondary, latent,and tertiary/late.

Primary Syphilis

This stage is also known as the chancre phase a chancre is defined as a firm, round, painless ulcer at the site of entry of an infecting organism. Chancres appear 10 to 90 days (median of 21to 25 days) after being exposed to the infecting organism (Whitting *et al.,* 2023). A chancre starts as a papule, usually solitary, at the site of inoculation with the *Treponema pallidum* spirochete, which is typically on the genitalia. In women, the chance may manifest on the cervix, and since it is painless, the patient is likely to be completely unaware of it. The papule quickly progresses to a painless, indurated ulcer (chancre) with a raised, thickened border roughly about 1 to 2 cm in diameter and a base.

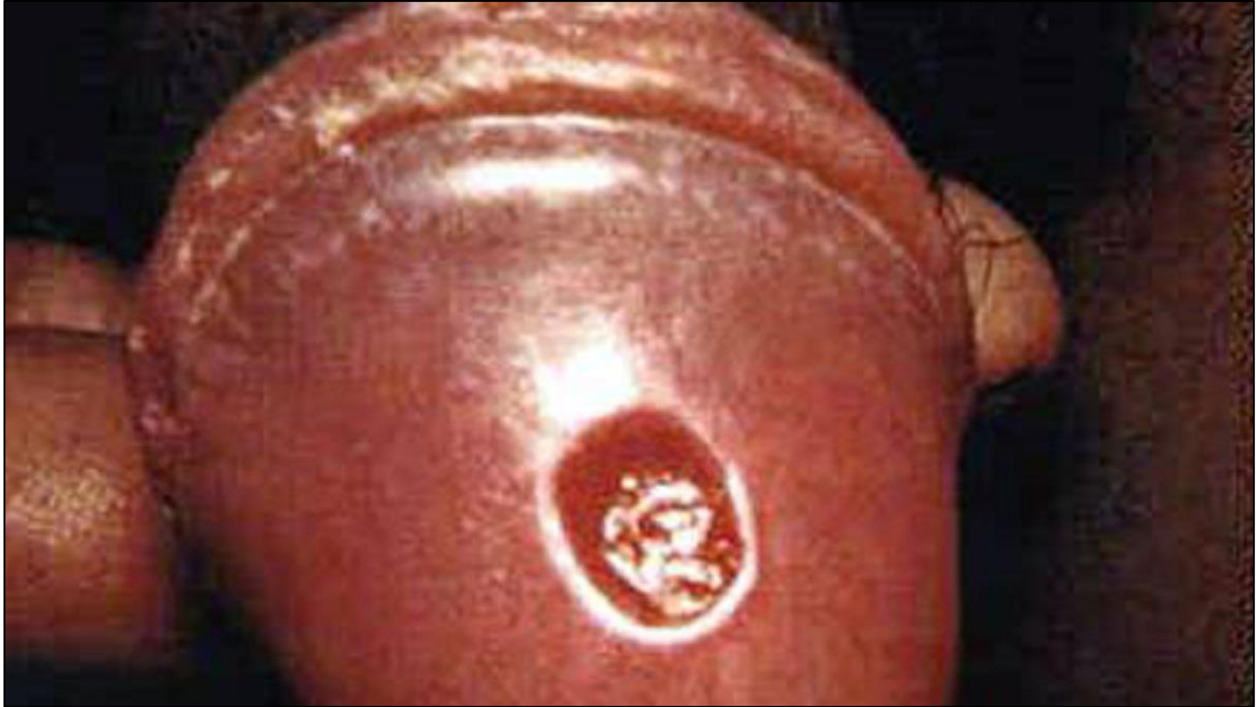

FIGURE 2.2: PRIMARY STAGE SYPHILIS SORE(CHANCRE) ON GLANS(HEAD)OF THE PENIS. (CDC, 2024)

Secondary Syphilis

This stage develops close to a quarter of all infected individuals with *Treponema pallidum* who go untreated. Symptoms typically appear 2 to 8 weeks after the disappearance of the primary chancre and have multiple systemic manifestations that can involve any system or body-part.The *Treponema pallidum* increases and spreads rapidly, causing fevers, myalgias, headaches, anorexia, sore throat, weight loss, joint pain, malaise, and particularly, the cutaneous manifestations characteristic of secondary syphilis. Swollen lymph nodes are common in this stage and are usually described as firm, rubbery, and minimal tenderness.

A wide spread rash that includes the palms of the hands and the soles of the feet, as well as oral lesions in the mouth, are the features of cutaneous expression of secondary syphilis. Inclusion of the palms and soles is an important and singular distinguishing feature, although skin lesions in secondary syphilis are highly differential and affect every skin surface (Ehlers *et al.,* 2020) Individual skin lesions are small (<6 mm) but may reach 2 cm in size (Whitting *et al.,* 2023) The lesions are usually diffuse, macular, scaly, reddish-brown (copper or ham colored), and not typically pruritic.

The lesions of secondary syphilis generally resolve within a few weeks, even without treatment, but will relapse in 25% of untreated patients, usually within 12 months. After that, without treatment, the disease enters the latent stage, and about 33% of patients will eventually develop tertiary syphilis (Peeling *et al.,* 2023).

"Lues maligna," or malignant syphilis, is a rare but particularly severe form of secondary syphilis, usually found in HIV-positive patients. Clinical symptoms as show on the skin are more significant, persistent, and severe than typical secondary syphilis and are defined as ulcerative, oval, and necrotic, with a central, thick crust usually found on the face, limbs, and trunk. It is also associated with systemic symptoms and higher *Treponema pallidum* bacterialcounts than other manifestations of secondary syphilis. When treated, patients affected by the infection are also more likely to develop a severe Jarisch-Herxheimer reaction. While usually associated with patients who are immunocompromised or have HIV, it has also now been described in some immunocompetent individuals (Margulies, 2022).Other risk factors for lues maligna include diabetes, a history of drug abuse, alcoholism, syphilitic hepatitis (characterized by high serum alkaline phosphatase levels), musculoskeletal disorders, transient nephropathy with proteinuria, and even acute renal failure (Pleas *et al.,* 2022). Secondary Syphilis lesions seen in palms are called **palmar lesions**, while Secondary Syphilis lesions seen in feet is called **plantar lesions**.

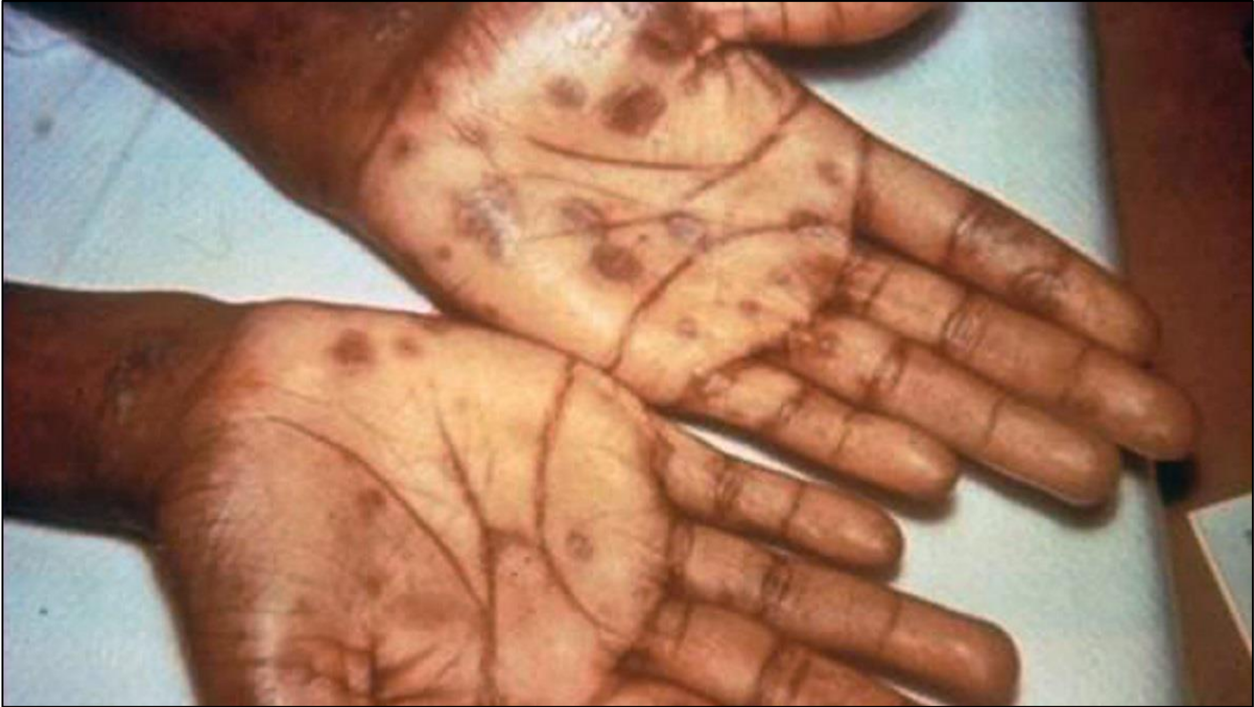

FIGURE 2.3: SECONDARY STAGE SYPHILIS SORE (LESIONS) ON THE PALMS OF THE HANDS. REFERRED TO AS “PALMAR LESIONS”. (CDC, 2024)

Latent Syphilis

This stage occurs after the secondary stage and it is characterized by the absence of clinical symptoms, regardless of on going infections. It is divided into early latent (less than a year of infection) and late latent (greater than one year or unknown duration) before it proceeds to tertiary stage (Ghanem, 2023).

Tertiary (or Late) Syphilis

Tertiary syphilis is a late stage symptomatic disease that can manifest months or many years after the initial infection as cardiovascular syphilis (aortic aneurysm, aortic valvulopathy), neurosyphilis (meningitis, stroke, aphasia, seizures, spinal neuro arthropathy, tabes dorsalis), or gummatous syphilis (infiltration of any organ and its subsequent destruction) (Whitting *etal.,* 2023).Between 25% and 40% of all patients with untreated Syphilis may eventually develop tertiary disease, although this may take 20 or 30 years to become clinically seen. Before clinical history, symptoms of primary or secondary syphilis may or may not be present.

Congenital Syphilis

Congenital syphilis results from transplacental transmission or contact with infectious lesions during birth and can be acquired at any stage. It is a main cause of stillbirth or neonatal congenital infections. In the US, congenital syphilis is higher among mothers with drug abuse and those without prenatal care during their period of pregnancy, and it is unevenly higher in the Black population (Smullin *et al.,* 2019)

The WHO approximates worldwide, 7 out of every 1000 pregnant women are infected with Syphilis infection and over 1.5 million infants are born with congenital syphilis. Without treatment, up to 40% of women having Syphilis will have stillborn births,and others will have premature labor or low-birth-weight babies (Leslie, 2024). Sadly from 2012 to 2022, the incidence of congenital syphilis in the US increased more than 10-fold, representing a major public health

failure (Gregory, 2024).

Routine screening is recommended at the first prenatal visit, early during the third trimester (around 28 weeks), and at the time of delivery, mostly in high-risk mothers (O' connor *et al.,* 2020). The fetus often becomes infected as the bacteria easily cross the placental barrier. Most neonates (70%) born with congenital syphilis are asymptomatic at birth, and a growing number are not diagnosed until 1 month or longer after delivery (Kimbal *et al.,* 2021).

During period of pregnancy, the weight of the placenta will increase along with gestational age. If infected with syphilis, the placentas tend to enlarge beyond the expected range because of Inflammation caused by the bacteria . More than three-quarters (76%) of infants born with a placenta larger than the 90th percentile for their birth weight were found to have congenital syphilis, and it is therefore suggested that such neonates and their mothers receive serological syphilis testing (Pillay *et al.,* 2023). Ultrasound of the prenates may demonstrate various abnormalities,such as hepatomegaly, placental enlargement, and hydrops fetalis, starting at 18 weeks gestation (Stafford *et al.,* 2024).Some neonates with congenital syphilis are asymptomatic at birth but show symptoms within the first 3 months. The most common findings in neonates with congenital syphilis are a generalized bullous rash, anemia, jaundice, and hepatosplenomegaly. Other clinical manifestations are as follows nasal cartilage destruction (saddle nose), frontal bossing (Olympian brow), bowing of the tibia (saber shins), measles-like or bullous rash (sniffles), sterile joint effusion (Cluttonjoints),Hutchinsonteeth, fetalhydrops, hepatosplenomegaly,jaundice, anemia, pseudoparalysis of an extremity, and a desquamating skin rash that develops a few months after birth (Leslie, 2024)

Every neonates born of mothers having a positive serology should be screened with a VDRL or RPR test (David *et al.,* 2022). However, since maternal IgG antibodies cross the placenta, interpreting positive treponemal serology testing in neonates can be problematic. In such cases,

the diagnosis is based on maternal testing, other clinical evidence of congenital syphilis in the neonate, as well as a comparison of maternal and neonatal nontreponemal serological titers (Leslie, 2024).

As adults, about 30% of affected patients who are left untreated can develop tabes dorsalis, syphilitic paresis, nerve-related deafness, and ocular syphilis, resulting in possible visual disturbances or even blindness (Koundanya *et al.,* 2023).Severe outcomes from mother- to-child syphilis can be well prevented with a single IM injection of 2.4 million units of benzathine penicillin G administered before week 28 of gestation. It is described 98% effective in eliminating congenital syphilis in the neonate but must be given 30 days or more prior to delivery (Leslie, 2024). Some experts recommend a second dose of benzathine penicillin 1 week later (Dalby, 2022).

Congenital syphilis is said to be a diagnostic challenge as maternal antibodies are transferable to the fetus. Such antibodies can persist for 15 months (Leslie, 2024). Darkfield microscopy or PCR testing of any suspicious lesions on the neonate are advised be performed. Further laboratory diagnostics for suspected cases of congenital syphilis includes x-rays of the long bones, a complete blood count (CBC), and an analysis of CSF fluid for white blood cell (WBC) count, protein, and a VDRL titer. (Leslie, 2024).

2.7. IMMUNE RESPONSE TO SYPHILIS.

Immune Response to Syphilis

Syphilis is transmitted from one stage to another through active primary or secondary lesions with treponemal organisms, especially during sexual activity, or any mucosal surface that shelters treponemes even in the absence of a macroscopic lesion (Liu *et al.,* 2025). Its immune response can be divided into three:

Host Innate Immune Response:

The body's first line of defense against *Treponema pallidum* begins when immune cells recognize unique structures on the bacterium, known as pathogen-associated molecular patterns (PAMPs). It is described that they are detected by pattern recognition receptors (PRRs) found on close macrophages and dendritic cells. On immediate activation , macrophages release signaling proteins called pro-inflammatory cytokines such as tumor necrosis factor-α (TNF-α), interleukin-1β (IL-1β), interleukin-6 (IL-6), and interleukin-12 (IL-12) which attract other immune cells to the site of infection. Among the first responders are neutrophils, which attempt to kill the spirochetes using processes like releasing toxic granules, making reactive oxygen species, and engulfing the bacteria (Mayadas *et al.,* 2014). At the same time, dendritic cells capture and digest the spirochetes, then travel to nearby lymph nodes to present treponemal antigens to naïve B and T lymphocytes. This step is described crucial for teaching the adaptive immune system to identify the pathogen.In order to support this process, dendritic cells increase the expression of adhesion molecules such as CD54, which aids them in maturing and effectively bridge the innate and adaptive immune responses (Avila-Nieto *et al.,* 2023).

Host Adaptive Immune responses:

As *Treponema pallidum* infection advances, both the cellular and humoral branches of the adaptive immune system become engaged. Antibodies released by plasma cells perform vital effector roles such as neutralization, opsonization for phagocytosis, and cytolysis of infected cells. However, the effective clearance of *Treponema pallidum* depends primarily on cellular immune mechanisms mediated by T lymphocytes (Hawley *et al.,* 2017). Acting as the link between innate and adaptive immunity, dendritic cells present treponemal antigens to naïve T cells, driving the activation and differentiation of CD4+T-helper cells. In particular, the Th1 subset secretes interferon-γ (IFN-γ), which stimulates macrophages and enhances their bactericidal activity through opsonophagocytosis .

In line, dendritic cells also activate cytotoxic CD8+ T cells, which contribute to host defense by producing IFN-γ and interleukin-17 (IL-17) (Refs. 15, 16). This cytotoxic response appears in individuals with impaired CD4+ T-cell activity, such as those co-infected with HIV (Radolf *et al.,* 2016). The identification of perforin and granzymes in human syphilitic lesions further tells that CD8+ T cells, together with natural killer (NK) cells, play a vital role in cytotoxic immune responses. However , Natural Killer cells increase macrophage function by releasing IFN-γ and additional pro-inflammatory cytokines, thereby amplifying the cellular immune response against *Treponema pallidum* (Cruz *et al.,* 2012).

Humoral Immunity:

Additionally cellular mechanisms, humoral immunity helps significantly to host defense during syphilis infection by generating antibodies that opsonize *Treponema pallidum*, thereby enhancing phagocytosis and improving bacterial clearance. In primary infection, IgM antitreponemal antibodies appear first, typically within two weeks of exposure, and are followed by a gradual rise in specific IgG antitreponemal antibodies. The size and pattern of these antibody responses can vary depending on the patient's history of previous syphilis infection, the antigenic proteins targeted, and the particular *Treponema pallidum* strain involved (Konda *et al.,* 2022).Given example, both IgM and IgG antibodies may be detectable within days after the visibility of a primary chancre, with early responses directed against structural components such as flagellated proteins, as well as membrane- associated lipoproteins included Tp0171 (the 15-kDa lipoprotein), Tp0435, and Tp0574 (Sena *et al.,* 2010).

RISK FACTORS ASSOCIATED WITH SYPHILIS

The risk factor associated with Syphilis can be grouped into two:

Behavioral Risk factors:

These are referred actions, habits, or lifestyle choices that increase a person's chance of acquiring syphilis infection. these factors remain under the control of the individual(s). These includes; Having multiple sexual partners, inconsistent or non-use of condoms, engaging in commercial sex(either as client or worker),alcohol and drug use before sex(causing to impaired judgment), low health-seeking behavior (not going for screening or treatment) (Forrestel *et al.,* 2020).

Epidemiological Risk Factors:

These are population-level or demographic factors that affect the spread, burden, or vulnerability to syphilis. They are not just about the individual's choices, but where they live, and the social/structural environment. The said factors include: Age (young adults 20–39 years are more affected), sex (males,

particularly men who have sex with men (MSM), may have higher prevalence), occupation (e.g., long-distance drivers, sex workers), marital status (single/divorced individuals may have higher risk), socioeconomic status (poverty, low education), geographic setting (urban centers with high commercial sex activity), co-existing HIV epidemic (syphilis risk increases with HIV) (Arando *et al.,* 2019).

2.8. PATIENTS

In the course of this study, patients or desired study population are intra-city drivers (bus drivers, cyclists, motorcyclists, tricycle riders) Benin metropolis, Edo State, Nigeria. Intra-city drivers constitute an important occupational group in Nigerians transport sector. In Benin City, Edo State,they play a central role in daily urban and intra-city transportation. However, several studies across sub-Saharan Africa have detected transport workers as a high-risk group for sexually transmitted infections (STIs), including syphilis (Shiferaw *et al.,* 2024).

Intra-city transportation refers to systems and services that facilitate movement within a single urban area or city, encompassing methods like public transit (buses, trains, tricycles e.t.c), personal vehicles, taxis, ride-sharing services biking, and walking.Further information says intra-city transport is vital for urban development, economic activity, and a good quality of life, as it enables people to access jobs, services, and leisure activities, while also contributing to reduced congestion (Ibrahim, 2012).

Bus drivers are specifically vulnerable due to a combination of behavioral and epidemiological risk factors. The mobile nature of their occupation often requires them to travel long distances and spend nights away from their families. This creates ways for engaging in unprotected sexual behavior such as visiting commercial sex workers, having multiple casual partners, and inconsistent condom use (Atilola *et al.,* 2010). Demographically, most bus drivers in Nigeria are adult males within the sexually

active age group (20–50 years). Many have low levels of formal education and limited access to health information, making them less likely to adopt safe sexual practices. Increasing stigma, long work hours, and lack of structured health insurance limit their access to timely screening and treatment services for STIs, including syphilis. Intracity transporters (taxi drivers) often work in strenuous and hazardous conditions are expected to consistently interact with different individuals including passengers (Bartel *et al*., 2019).

2.9. CLINICAL MANIFESTATIONS OF SYPHILIS

The systemic bacteria infection Syphilis involve , multi-stage sexually transmitted infection caused by the spirochete *Treponema pallidum.* Its clinical manifestations vary widely depending on the stage of infection, ranging from localized ulcers to severe systemic complications. The disease progresses in stages if untreated: primary, secondary, latent, and tertiary syphilis. Congenital syphilis may also occur through vertical transmission from mother to child.

CLINICAL MANIFESTATIONS IN PRIMARY SYPHILIS

Symptoms of primary Syphilis usually emerge at about ten days to three months after infection. This may be seen in the form of a small, painless sore called chancre. The chancre is seen in organs like the penis, tongue, vagina, lips, anus and rectum. The sore will then disappear within 2 to 6 weeks. If left untreated, syphilis will move into its second stage (Bjekić *et al.,* 2012).

CLINICAL MANIFESTATIONS IN SECONDARY SYPHILIS

Symptoms of secondary syphilis begin a few weeks after the first sore disappears. Similar symptoms of secondary syphilis include: a non-itchy skin rash appearing anywhere on the body, but mostly on the palms of the hands or soles of the feet, . patchy hair loss and joint pains. These symptoms are said to disappear within a few weeks or come and go for a few months (Chaudhry *et al.,* 2023).

CLINICAL MANIFESTATIONS IN TERTIARY OR LATENT SYPHILIS

If left untreated during the second stage, it would then move to its latent stage. During the latent stage, no symptoms are shown or expressed . And it could be in this stage for years and still be transmitted via sex.The symptoms of tertiary syphilis can begin years after the initial infection. 1 in 3 people who are not treated for syphilis develop severe symptoms .The effect of these symptoms of tertiary syphilis will depend on what part of the body the infection spreads to. A given example include brain, nerves, eyes, heart, bones, skin or blood vessels, eventually causing stroke, dementia, loss of co-ordination, numbness, paralysis, blindness,deafness, heart disease, skin rashes. At this stage, syphilis can be dangerous enough to cause death (Ferriera, 2018.

2.10. LABORATORY DIAGNOSIS OF SYPHILIS

Syphilis possess vary clinical manifestations, making laboratory testing a very significant tool of diagnosis. The causative agent of syphilis is *Treponema pallidum*. . Syphilis follows a peculiar progression through primary, secondary, latent, and tertiary stages. The ulcers seen in primary and secondary disease are very infectious due to their high treponemal content, and venereal transmission transmitted primarily through direct contact with these lesions (Hanumanthayya and Rajiwate, 2025). Relevantly , the stage of disease at the time of presentation affect both diagnostic strategies and treatment approaches. Diagnostic challenges occurs in different ways including very early syphilis, neurosyphilis, asymptomatic congenital syphilis, and infections in intravenous drug users or individuals coinfected with HIV or other agents that produce serological cross-reactivity (Satyaputara *et al.,* 2021)

Although, *T. pallidum* cannot be grown in culture, there are many tests for the direct and indirect diagnosis of syphilis.

SEROLOGICAL TESTING FOR SYPHILIS

The two form of syphilis screening are Treponemal and non Treponemal tests.They remain the main method for screening, diagnosis, and monitoring of disease activity.

Treponemal testing:

Treponemal tests are defined as qualitative serologic assays designed to detect antibodies, primarily IgG but occasionally IgM, directed against a range of *Treponema pallidum* antigens. These antibodies become detectable 2 to 4 weeks after first exposure (Forrestel *et al.,* 2020). Test results are reported as either reactive or nonreactive,without quantitative titers. Treponemal screening shows higher sensitivity in primary infection, and once reactive, they usually remain positive for life, regardless of

treatment status (Procop *et al.,* 2020). As a result of this outcome they are unsuitable for monitoring therapeutic response or identification of infection as their reactivity does not reliably relate with disease activity (Forrestel *et al.,* 2020). In addition, treponemal tests lack specificity for venereal syphilis, as cross-reactivity with antibodies to other pathogenic treponemes such as *Treponema pallidum* subsp. *pertenue* (yaws) and *T. carateum* (pinta) may occur , thereby reducing their diagnostic reports.

Non-treponemal testing:

Non-treponemal tests are defined as quantitative assays performed on individual's diluted serum to detect both IgM and IgG antibodies directed against lipoidal antigens, such as cardiolipin and lecithin, which are Produced from damaged host cells as well as from *Treponema pallidum* itself (Aguero-Séna *etal.,*2019).The reffered antibodies are non specific and particularly become Seen only a few weeks after infection (Soreng *et al.,* 2014).oftenly, used non-treponemal tests involve the following the Venereal Disease Research Laboratory (VDRL) test, the rapid plasma reagin (RPR) test, the unheated serum reagin (USR) test, and the toluidine red unheated serum test (TRUST). In contrast to treponemal tests, non-treponemal assays are quantitative and results are represented in tiers, making them valuable for monitoring disease activity and treatment therapies.

A microflocculation assay that identifies ―reagin antibodies formed against a complex of cardiolipin, lecithin, and cholesterol is referred to as the VDRL screening. Its Assay requires microscopy under ×100 magnification (Morshed *et al.,* 2015). Relevantly, defined statement says the VDRL remains the only nontreponemal Assay currently verified for cerebrospinal fluid (CSF) in the diagnosis of neurosyphilis. Though it has limitations in interpretation which may be subjective, the antigen suspension must be prepared fresh daily, and serum requires high temperature of 56 °C for 30 minutes to inactivate the complement. Preheating, is not required when CSF is tested.

2.11. PREVENTION AND CONTROL

Productive prevention and control of syphilis depends on early counseling, quick diagnosis, and accurate treatment of both affected individuals and their sexual partners involved. Counseling in periods of diagnosis is vital to limit the risk of current transmission and to prevent re-infection.

Individuals with suspected or confirmed syphilis should be enlightened on the potential for transmission to sexual partners and the risk of reoccurrance , since syphilis does not possess protective immunity following initial infection. Individuals with having lesions, including chancres, condylomata lata, or secondary syphilis rash, should be strongly recommended to abstain from sexual intercourse until lesions have completely resolved and for at least 7 days after treatment to minimize the risk of spread (Workowski, 2021)

Prevention strategies are included for congenital syphilis, specifically among people of childbearing age, since untreated maternal infection can result in stillbirth, neonatal death, or severe congenital disease (Lazarini *et al.*2017). immunological inter. In contribution, routine syphilis screening and partner awareness should form an significant component of syphilis control programs.

CHAPTER THREE
MATERIALS AND METHODS

3.1. STUDY DESIGN

This was a cross-sectional descriptive study conducted among 150 intra-city transporters in Benin City, recruited using a convenience sampling technique. The design is appropriate as it enables the assessment of the seroprevalence of Syphilis infection and associated risk factors within the study population(Intra-city Transporters) at a specific point in time. This method enable the collection of data on current infection status;due to production of antibodies by the body.Data was collected from Intra -City Transporters using Structured questionnaire to obtain Demographic and Behavioural factors associated with Syphilis infection.

3.2. STUDY AREA.

The study was conducted in Benin Metropolis, the capital City of Edo State, Nigeria. The metropolis serves as a commercial hub, administrative seat, and transit point for travelers and goods, making it an important socio-economic center in Nigeria (Butu *et al.,* 2019). Geographically, Benin Metropolis lies approximately between latitude 6°19′N and longitude 5°36′E (Okoye, 2025). Urban expansion is evident in the increase in built-up areas from 9.49%in 2017 to 15.29% in 2023, representing a 5.8% rise. This result is consistent with pasted research indicating that Benin City has experienced rapid urbanization over the past few years.(Olayiwola and Igbavboa *et al.,* 2014). The metropolis is featured by a youthful and economically active population, with many individuals engaged in both formal and informal occupations (Butu *et al.,* 2019).

3.3. STUDY POPULATION

The Study population consisted of intra-city transporters (commercial bus/minibus drivers, tricycle (Keke Napep) riders, motorcycle (okada) riders, taxi.)operating within Benin Metropolis, Edo State, Nigeria.

3.4. INCLUSION CRITERIA

Participants included in this study were intra-city transporters ;

- aged 18 years and above
- (bus/minibus,taxi,tricycle,motorcycle)Transporters.
- who consented to participate in the research.

3.5 EXCLUSION CRITERIA

Participants excluded from the study were;

- aged younger than18years old.
- Non intra-city transporters (i.e., individuals not engaged in bus/minibus, taxi, tricycle, or motorcycle transport services).
- Those that Declined consent to participate in the research.

3.6.SAMPLE SIZE DETERMINATION

The sample size was determined using a statistical formula that considered the Seroprevalence and assessment of risk factors of syphilis among Intra-city transporters(commercial busdrivers). The minimum sample size for this study was determined using the statistical analysis below

$$n = \frac{Z^2 \times P(1-p)}{n^2}$$

Where,

N= Minimum sample size,

P= Prevalence rate (13.4% or 0.134) (Adewunmi *et al.,* 2018)

D= Margin of error (5% or 0.05)

Z= Confidence level (1.96)

Minimum sample size

Minimum sample size; $n = \frac{1.96^2 \times 0.134(1-0.134)}{0.005^2}$

$$n = \frac{3.8416 \times 0.91924}{0.0025}$$

$$n = \frac{0.3531}{0.0025}$$

n =141 participants

To reduce attrition, a sample size of 150 was used in this study

3. 7.MATERIALS

Ethical Approval

Ethical Approval on Seroprevalence and Risk assessment of syphilis among Intra-city transporters (commercial bus workers, okada riders) was obtained from Health Research Ethics Committee

(HREC) of Edo State Ministry of Health with approval number HA/737/25/D/07230740. Approval was sought to guarantee that the rights,dignity,and confidentiality of participants were respected throughout the study.Informed consent was obtained from each participant before sample collection.

Data Collection Forms

A structured questionnaire was administered to collect sociodemographic information and knowledge of syphilis from the Participants.

3.8.METHODS

SampleCollection

A sterile 4 ml disposable syringe was used to collect venous blood from each participant through venepuncture under aseptic conditions,immediately after withdrawal of the syringe, the blood sample was then transferred into a plain sterile container, properly labeled with the participant's identification number.These samples were transported to the Department of Medical Microbiology at the University of Benin Teaching Hospitals in Benin City, Edo State Nigeria for proper serological screening.

3.9.LABORATORY ANALYSIS

Laboratory analysis was done using Syphilis Test strip for invivo determination of IgM antibodies manufactured by the brand Narrow- care,all instructions of the manufacturer was followed.

- **Principle of Test**

The test is based on the principle of immunochromatography,where antibodies move along the membrane by capillary action and react with cardiolipin–lecithin–cholesterol antigen to form

visible lines on the test strip, while a control line confirms test screening.

- **Sample Processing**

Upon arrival at the laboratory, the collected blood samples were arranged on the work bench and carefully inspected to ensure proper labeling and integrity. The clotted blood samples in plain containers were centrifuge at 3,000 revolutions per minute (rpm) for 3–4 minutes to separate the serum from the cell and clear serum was then carefully aspirated into a clean plain container using sterile pipette.

- **Procedures**

Arrangement of the rapid diagnostic Syphilis test Strips under the brand Narrow- Care with corresponding labels were arranged on the work bench andtest control samples were used for quality control before properly screening of the samples for syphilis infection,the separated serum was aspirated using a clean micropipette and 2-3 drops was placed on the Syphilis test strip for 10-15 minutes and then read before discarded.All procedures were carried out under standard bio-safety and quality control measures in the medical laboratory

3. 10.RESULT INTERPRETATION

The syphilis test strip was interpreted according to the manufacturer's instructions. After applying the serum sample , the results were read within the recommended time frame (usually 10–15minutes). The interpretation was based on the appearance of colored bands in the test (T) and control (C) regions of the strip as follows:

Negative Result: The interpretation is appearance of Only one colored band in the control region (C), with no visible band in the test region (T).

Positive Result: The interpretation was based on appearance of Two distinct colored bands

, one involving the control region (C) and the other is the test region (T).

Invalid Result: There is no appearance of band both in the control region (C), and the test region (T). In situations like this , the test was considered invalid, and the sample was retested with a new strip.

Only results with a screened valid control line were considered for analysis. Positive and negative results were documented, and reported in the prevalence assessment

Data Analysis

Data analysis was conducted using SPSS version 27. Descriptive statistics including mean, standard deviation, frequencies, and percentages were used to summarize the demographic characteristics,knowledge, and sexual practices of theparticipants. The results werepresented in tables and figures for clarity. The Chi-square test was employed to assess associations between syphilis infection and selected demographic, knowledge, and behavioral variables. Furthermore, multivariate logistic regression analysis was carried out to identify independent predictors of syphilis infection among the study participants. Statistical significance was defined as a p-value below 0.05.

CHAPTERFOUR

RESULT

Table 4.1: Demographic Characteristics of Intra-City transporters in Benin Metropolis

Table 4.1 shows the sociodemographic characteristics of intra-city transporters in Benin metropolis. The largest age group was 26–35 years (34.7%), followed by 36–45 years (28.7%) and 46–55 years (21.3%), while the smallest proportion was participants aged above 55 years (15.3%). The mean age of the participants was 41.47 ± 10.85 years. With respect to marital status, the majority were married (60.0%), while 40.0% were single. Regarding educational attainment, almost half of the participants had secondary education (49.3%), followed by those with primary education (30.7%) and tertiary education (20.0%). In terms of occupation location, New Benin commercial drivers accounted for the highest proportion (27.3%), closely followed by Ring Road bus drivers (26.0%), while Ekosodin tricycle drivers (20.0%) and both East Circular taxi drivers and Lucky Way keke drivers (13.3% each) constituted the remainder.

Table 4.1: Demographic Characteristics of Intra-City transporters in Benin Metropolis

Variables	Frequency	Percentage(%)
Age Range		
26–35Years	52	34.7
36–45Years	43	28.7
46–55Years	32	21.3
>55Years	23	15.3
Total	150	100.0
MaritalStatus		
Single	60	40.0
Married	90	60.0
Total	150	100.0
EducationalLevel		
Primary	46	30.7
Secondary	74	49.3
Tertiary	30	20.0
Total	150	100.0
Location of Transport service		
EastCircularTaxiDriver	20	13.3
EkosodinTricycleDriver	30	20.0
LuckyWayKekeDriver	20	13.3
NewBeninCommercial Driver	41	27.3
RingRoadBusDriver	39	26.0
Total	150	100.0
MeanAge±SD	**41.47 ± 10.85**	

Table 4.2: Prevalence of Syphilis Infection among Intra-City transporters in Benin Metropolis

Table 4.2 illustrates the prevalence of syphilis infection among intra-city transporters in Benin metropolis. The findings show that nearly one-third of the participants (32.0%) tested positivefor syphilis, while the majority (68.0%) tested negative.

Table 4.3: Seroprevalence of Syphilis Infection among Intra-City transporters in Benin Metropolis in Relation to Age

Table 4.3 presents the seroprevalence of syphilis infection among intracity transporters in Benin metropolis in relation to age. The results show no statistically significant associations between age, and the prevalence of syphilis infection ($p > 0.05$). However, prevalence of syphilisinfection was higher in the age group 25-35 years (41,7%), followed by 46-55 years (25.0%), with 55 years recording the least prevalence (16.7%).

Table 4.2: Prevalence of Syphilis Infection among Intra-city transporters in Benin Metropolis

Result	Frequency	Percentage(%)
Positive	48	32.0
Negative	102	68.0

Table 4.3: Seroprevalence of Syphilis Infection among Intra-city transporters in Benin Metropolis in Relation to Age

AGE	Sample size(%)	No.of Sero positive	%Sero positive	p-value	Oddsratio	95%CI
Age(Years)						
25–35	52(33.1)	20	41.7	0.344	0.907	0.652 – 1.261
36–45	43(27.4)	10	20.8			
46–55	32(20.4)	12	25.0			
>55	23(14.8)	6	12.5			
Total	**150 (100)**	**48**	**100**			

Table 4.4: Seroprevalence of Syphilis Infection among Intra-City transporters in Benin Metropolis in Relation to Educational Level.

Table 4.4 presents seroprevalence of syphilis infection among intra-city transporters in Benin metropolis in relation to education level.The results show no statistically significant associations between educational level and the prevalence of syphilis infection ($p > 0.05$).Nevertheless,prevalencewashighestamongdriverswithsecondaryeducation(47.9%), followed by those with primary education (33.3%), while the lowest prevalence was observed among drivers with tertiary education (18.8%).

Table 4.5: Seroprevalence of Syphilis Infection among lntra-city Transporters in Benin Metropolis in Relation Marital Status

Table 4.5 presents the seroprevalence of syphilis infection among intra-city transporters in Benin metropolis in relation to marital status. The results show no statistically significant associations between marital status and the prevalence of syphilis infection ($p > 0.05$). However, prevalence of syphilis infection washigher among married drivers (60.4%) compared to single drivers (39.6%)

Table 4.4: Seroprevalence of Syphilis Infection among Intra-city Transporters in Benin Metropolis in Relation to Educational Level

Variable	Sample size	No. of sero positive	%sero positive	p-value	Odds ratio	95%CI
Educational Level						
Primary	46(30.7)	16	33.3	0.884	0.858	0.523 – 1.408
Secondary	74(49.3)	23	47.9			
Tertiary	30(20.0)	9	18.8			
Total	150 (100.0)	48				

Table 4.5: Seroprevalence of Syphilis Infection among Intra-city Transporters in Benin Metropolis in Relation to Marital Status

Variable	Sample size(%)	No.sero positive	%sero positive	p-value	Odds ratio	95%CI
Marital Status						
Single	60(39.9)	19	39.6	0.943	1.045	0.513 – 2.131
Married	90(60.1)	29	60.4			
Total	**150 (100)**	**48**				

Table 4.6: Seroprevalence of Syphilis Infection among Intra-city Transporters in Benin Metropolis in Relation to Location of Transport service

Table 4.6 presents seroprevalence of syphilis infection among intra-city transporters in Benin metropolis in relation to location. The results show no statistically significant associations between location and the prevalence of syphilis infection ($p > 0.05$). However, prevalence of syphilis infection was highest amongNew Benin commercial drivers (25.0%), followed byEast circular drivers(22.9%) and Ring Road bus drivers (22.9%).Ekosodin keke riders had prevalence of (18.8%).The lowest prevalence was observed among Lucky Way keke drivers (10.4%).

Table 4.6: Seroprevalence of Syphilis Infection among Intra-city Transporters in Benin Metropolis in Relation to Location of Transport service

Variable	Sample size	No. of sero Positive	%sero positive	p-value	Odds ratio	95%CI
Location of Transport service						
East Circular Taxi Drivers	20(19.6)	11	22.9	0.217	0.820	0.639 – 1.052
Ekosodin Tricycle Drivers	30(29.4)	9	18.8			
Lucky Way Keke Drivers	20(19.6)	5	10.4			
New Benin Commercial Drivers	41(40.2)	12	25.0			
Ring Road Bus Drivers	39(38.2)	11	22.9			
Total	**150 (100)**	**48**	**32.0**			

Table 4.7: Sexual behaviour and practices as a risk factor associated with Syphilis among Intra-city Transporters in Benin Metropolis

Table 4.7 presents the sexual behaviour and practices associated with Syphilis infection among intra-city transporters in Benin metropolis. The results show that one-third of the participants (33.3%) admitted to sharing sharp objects, while 66.7% reported they did not. In terms of condom use, 45.3% reported consistent use, 11.3% used condoms sometimes, while 43.3% did not use them at all. Regarding sexual partners, the majority of respondents (72.7%) reported not having multiple sexual partners, while 27.3% admitted to having more than one partner. About a quarter of the participants (25.3%) reported experiencing symptoms such as sore genitals, painful urination, or skin rash, while 74.7% had not experienced such symptoms. Concerning blood transfusion, most participants (86.7%) had never been transfused, while 13.3% had a history of transfusion. With respect to testing, 74.7% of respondents had never been tested for sexually transmitted infections (STIs), whereas 25.3% had undergone testing. Similarly, two-thirds of the participants (66.7%) had never been screened for syphilis, while 33.3% had been screened at some point.

Table 4.7: Sexual behaviour and practices as a risk factor associated among Intra-city Transporters in Benin Metropolis

Variables	Frequency	Percent
Shared Sharp Objects		
No	100	66.7
Yes	50	33.3
Total	150	100.0
Uses Condom		
No	65	43.3
Sometimes	17	11.3
Yes	68	45.3
Total	150	100.0
Multiple Sexua lPartners		
No	109	72.7
Yes	41	27.3
Total	150	100.0
Experience Sore/Painful Urination/Skin Rash		
No	112	74.7
Yes	38	25.3
Total	150	100.0

Blood Transfused		
No	130	86.7
Yes	20	13.3
Total	150	100.0
Ever Tested for STIs		
No	112	74.7
Yes	38	25.3
Total	150	100.0
Screened for Syphilis Before		
No	100	66.7
Yes	50	33.3

Table 4.8: Relationship between Sexual Behaviour, Practices and the Prevalence of Syphilis Infection among Intra-city Transporters in Benin Metropolis

Table 4.8 presents the relationship between sexual behaviour, practices and the prevalence of syphilis infection among intra-city transporters in Benin metropolis. For condom use, the prevalence of syphilis was highest among those who did not use condoms (72.9%), compared to 10.4% among those who used condoms sometimes and 16.7% among consistent users (X2 = 27.10, df = 2, p = 0.000). In terms of multiple sexual partners, 64.6% of positive cases were drivers with multiple partners,while 9.8% were those without multiple partners (X2=49.31,df = 1, p = 0.000). For experience of sore/painful urination or skin rash, 56.3% of those who tested positive were those with symptoms, compared to 10.8% for those without symptoms (X2 = 35.67, df = 1, p = 0.000). Other factors, including sharing sharp objects, history of blood transfusion, previous STI testing, and prior syphilis screening, did not show significant associations with syphilis infection (p > 0.05).

Table 4.8: Relationship between Sexual Behaviour, Practices and the Prevalence of Syphilis Infection among intra-city transporters in Benin Metropolis

Variables	Positive	Negative	X^2	df	p-value
Shared Sharp Objects					
No	32(66.7)	68(66.7)	0.00	1	1.000
Yes	16(33.3)	34(33.3)			
Uses Condom					
No	35 (72.9%)	30 (29.4%)	27.10	2	0.000*
Sometimes	5 (10.4%)	12 (11.8%)			
Yes	8 (16.7%)	60 (58.8%)			
Multiple Sexual Partners					
No	17(35.4)	92(90.2)	49.31	1	0.000*
Yes	31(64.6)	10 (9.8)			
Experience Sore/Painful Urination/Skin Rash					
No	21(43.8)	91(89.2)	35.67	1	0.000*
Yes	27(56.3)	11(10.8)			
Blood Transfused					
No	43 (89.6)	87(85.3)	0.52	1	0.471
Yes	5 (10.4)	15(14.7)			
Ever Tested for STIs					
No	37 (77.1%)	75 (73.5%)	0.22	1	0.641
Yes	11 (22.9%)	27 (26.5%)			
Screened for Syphilis Before					
No	34(70.8)	66(64.7)	0.55	1	0.458
Yes	14(29.2)	36(35.3)			

Table 4.9: Knowledge and awareness of Syphilis among Intra-city Transporters in Benin Metropolis

Table 4.9 presents the knowledge of syphilis among intra-city transporters in Benin metropolis. The results show that a greater number of the participants (53.3%) had never heard about syphilis, while 46.7% reported awareness of the disease. With respect to health education, the majority (74.7%) had never received any form of health education, whereas only 25.3% had. Regarding modes of transmission, majority of the respondents (56.0%) knew that syphilis can be transmitted through sharing needles, while 58.7% correctly identified blood transfusion as a possible route. Knowledge about mother-to-child transmission was evenly distributed, with 49.3% affirming and 50.7% denying this possibility. 44.7% of participants believed that syphilis could be transmitted through casual contact, while 55.3% correctly indicated otherwise.

Table 4.9: Knowledge and awareness of Syphilis among Intra-city Transporters in Benin Metropolis

Variables	Frequency	Percentage(%)
Heard About Syphilis		
No	80	53.3
Yes	70	46.7
Total	150	100.0
Ever Received Health Education		
No	112	74.7
Yes	38	25.3
Total	150	100.0
Can be transmitted via sharing Needles		
No	66	44.0
Yes	84	56.0
Total	150	100.0
Can be transmitted via blood transfusion		
No	62	41.3
Yes	88	58.7
Total	150	100.0
Can be transmitted via mother-to-child		
No	76	50.7
Yes	74	49.3
Total	150	100.0
Can be transmitted via casual contact		
No	83	55.3
Yes	67	44.7
Total	150	100.0

Table 4.10: Relationship between Knowledge of Syphilis and Prevalence of Syphilis Infection among Intra-city Transporters in Benin Metropolis

Table 4.10 shows the relationship between knowledge of syphilis and the prevalence of syphilis infection among intra-city transporters in Benin metropolis. The analysis indicates no statistically significant associations between participants' knowledge variables and syphilis prevalence ($p > 0.05$).

Table 4.10: Relationship between Knowledge of Syphilis and Prevalence of Syphilis Infection among Intra-city Transportersin Benin Metropolis

Variables	Positive	Negative	X^2	df	p-value
Heard About Syphilis					
No	28 (58.3%)	52 (51.0%)	0.71	1	0.400
Yes	20 (41.7%)	50 (49.0%)			
Ever Received Health Education					
No	34 (70.8%)	78 (76.5%)	0.55	1	0.459
Yes	14 (29.2%)	24 (23.5%)			
Can be transmitted via sharing Needles					
No	17(35.4)	49(48.0)	2.11	1	0.146
Yes	31(64.6)	53(52.0)			
Can be transmitted via blood transfusion					
No	17(35.4)	45(44.1)	1.02	1	0.313
Yes	31(64.6)	57(55.9)			
Can be transmitted via mother-to-child					
No	21(43.8)	55(53.9)	1.35	1	0.245
Yes	27(56.3)	47(46.1)			
Can be transmitted via casual contact					
No	23(47.9)	60(58.8)	1.57	1	0.210
Yes	25(52.1)	42(41.2)			

Table 4.11: Risk Factors Associated with Syphilis Infection among Intra-City Transporters in Benin Metropolis

Table 4.11 presents the risk factors associated with syphilis infection among intra-city transporters in Benin metropolis using multivariate logistic regression analysis. The results indicate that condom use ($p=0.001$, OR=0.30, 95%CI:0.14–0.61), multiple sexual partners ($p = 0.000$, OR = 21.80, 95% CI: 5.61–84.76), and experience of sore/painful urination or skin rash ($p = 0.000$, OR = 18.97, 95% CI: 4.63–77.66) were statistically significant predictors of syphilis infection. This implies that drivers who did not use condoms were more likely to test positive, while those with multiple sexual partners and those reporting sore/painful urination or skin rash had substantially higher odds of syphilis infection.

Other factors assessed including age, marital status, educational level, occupation, history of blood transfusion, previous STI testing, prior syphilis screening, health education, and knowledge-related variables were not significant predictors ($p > 0.05$).

Table 4.11: Risk Factors Associated with Syphilis Infection among Intra-city Transporters in Benin Metropolis

Variables	p-value	OR (Exp(B))	95% C.I. for OR
Age Range	0.922	0.97	0.57 – 1.66
Marital Status	0.467	1.54	0.48 – 4.98
Educational Level	0.421	1.42	0.60 – 3.34
Occupation location	0.062	0.67	0.43 – 1.02
Heard About Syphilis	0.653	0.77	0.24 – 2.44
Use Condom	0.001*	0.30	0.14 – 0.61
Ever Received Health Education	0.524	0.61	0.14 – 2.75
Multiple Sexual Partners	0.000*	21.80	5.61 – 84.76
Ever Tested for STIs	0.603	0.70	0.18 – 2.71
Ever Been Transfused Before	0.665	1.44	0.28 – 7.52
Screened for Syphilis Before	0.176	0.43	0.13 – 1.46
Experience Sore/Painful Urination/Skin Rash	0.000*	18.97	4.63 – 77.66
Share Sharp Objects	0.782	1.18	0.37 – 3.81
Sharing Needles	0.863	1.11	0.35 – 3.49
Blood Transfusion	0.078	2.97	0.89 – 9.95
Mother-to-child	0.855	0.90	0.27 – 2.95
Casual Contact	0.368	1.71	0.53 – 5.45
Constant	0.082	0.00	–

CHAPTER FIVE

5.1 Discussion

The sociodemographic profile of intracity bus drivers in Benin metropolis, displays a predominantly middle-aged workforce (34.7%),This age distribution is lower compared with findings from studies on commercial drivers in other Nigerian regions, such as Southwestern cities, where approximately 60% of drivers were under 45 years old as reported by Adewum*i et al*. 2018, thereby showing the the demanding nature of the occupation that attracts younger individuals. Marital status showed a majority (60.0%) being married, which may imply greater financial responsibilities influencing work hours and stress levels, consistent with patterns observed in Uyo where 63.9% of commercial vehicle drivers were married (Johnson, 2020). In terms of educational, nearly half (49.3%) had secondary schooling, with only 20.0% who obtained tertiary degrees suggesting limited formal training opportunities that impacted on road safety awareness. The location breakdown, dominated by New Benin commercial drivers (27.3%), underscores the localized nature of transport operations in urban Benin, warranting targeted interventions for high-risk subgroup

Demographic factors such as age, marital status, education, and Location did not show significant associations with syphilis prevalence P=(0. 922,0.467,0.421,0.062,0.653). This contrasts with studies that have documented higher prevalence among less educated, unmarried and older groups (Cardoso *et al.,* 2024; Biswas *et al*., 2021). The lack of significant demographic effects here may display similar lifestyle of the driver population, whose shared occupational and behavioural risks out shown demographic differences.

The syphilis infection prevalence (32%) in this study is substantial and higher than what has been documented in the general population in Nigeria (Cookey, *et al.,* 2024; Ibijola, *et al.,* 2023; Oseni and Omatola,2021).Also,higher compared to the 21.9%reported by Hameed *etal.,*2023. Commonly, occupationally targeted studies in other locations have also shown unevenly high prevalence among drivers. For instance, a study in India found a syphilis prevalence of 1% among long-distance truck drivers (Krupp *et al.,* 2019), while in Bangladesh, a prevalence of 3.8% was reported among truck drivers (Alam *et al.,* 2017). The much higher prevalence observed in the present study suggests that bus drivers in Benin City may represent a particularly vulnerable population due to occupational exposure, mobility, and lifestyle practices.

Sexual Behaviour and practices proved to be stronger determinants of syphilis infection.Notably, condom use emerged as a significant predictor in this study. Drivers who did not use condoms had the highest prevalence(P=0.00)and regression analysis confirmed that non-use increased the odds of infection almost three fold. This matches with exiting evidence that inconsistent condom use is a major facilitator of syphilis transmission (Gilbert, *et al.,* 2021). However, the relatively high infection prevalence even among consistent condom users draws questions about possible inconsistencies in self-reported condom use,condom breakage, or other overlooked risk pathways.Furthermore, It may also be possible that some infections were acquired long before consistent use of condom practices. Multiple sexual partnerships also showed a very strong association with syphilis seropositivity (P=0.000). Drivers with multiple partners were nearly 22 times more likely to be infected compared to those with a single partner. This contributes to the findings from East Africa, where high partner turnover among drivers has been linked to STIs spread along transporters. (Mutie *etal.*,2021). Self-reported symptoms such as genital sores,

painful urination, or skin rash were also significantly associated with syphilis infection(P=0.000), with symptomatic drivers being almost 19 times more likely to test positive. This relationship is expected since such symptoms presented are clinical manifestations of syphilis. Moreover, the fact that about half of infected individuals reported no symptoms underlines the asymptomatic nature of syphilis, which is referred to as latent stages (Gullette and Hopkins,2021). Kaur *et al.*(2023) reported that 94.16% of syphilis cases presented in the latent stage without symptoms or clinical signs, with only 1.45% showing primary chancres and 4.37% secondary lesions. This makes routine screening vital, especially in high-risk groups, since depending on symptoms alone would not show the true burden of infection.

Other potential risk factors associated with Syphilis infection , such as sharing sharp objects, blood transfusion history, and prior STI testing, showed no significant associations(P=0.863,0.078,0.603.).Common this, Sexually transmitted infections testing and screening were not significant as did not reduce infection risk, which could suggest issues of poor follow-up, inadequate counselling, or reinfection due to persistent risky behaviours

More than half of the participants had never heard of syphilis, and only a minority had received any health education. This limited awareness is concerning, especially considering the high prevalence of syphilis infection (32.0%) found in this study. Previous research in Nigeria and other sub-Saharan African countries has consistently reported gaps in awareness of sexually transmitted infections (STIs) among transport workers and other high-risk occupational groups (Vasudeva *et al*., 2022; Badawi *et al*., 2019). Presentation of the rate of complete unawareness observed here appears even higher than that reported in a study among drivers in Kaduna, where 13.4% misconception about STDs like syphilis (Adewunmi *et al*., 2018). This difference may reflect disparities in exposure to health campaigns or varying levels of access to healthcare

services.Analysis of transmission in relation to knowledge presented some misconceptions. While just over half of participants recognized blood transfusion and sharing of needles as possible routes,close to half incorrectly believed syphilis could spread through casual contact. Such misconceptions are consistent with findings by Obohwemu (2018), who reported that poor understanding of STIs transmission pathways remains a barrier to prevention in many Nigerian communities. Misconceptions not only show gaps in knowledge but also contribute to stigma, which may discourage drivers from testing or seeking care. Furthermore, knowledge variables did not show any significant statistical association with syphilis infection (P=0.524,0.653,0.176).

5.2 Conclusion

The findings from this study presents a high prevalence of syphilis (32.0%). More than half of the participants had never heard of syphilis, and only a few had received health education, showing a serious knowledge gap. Although, knowledge levels were not directly linked with infection. Risky sexual behaviours such as not using condoms, having multiple sexual partners, and the presence of symptoms like genital sores or painful urination were the strongest predictors of infection and contributed deeply to the spread of Syphilis Infection . Furthermore, results suggest that behavioural and occupational factors play a more vital role than demographic or knowledge linked factors in driving syphilis transmission among bus drivers. Overall, the study highlights the urgent need for targeted interventions in this population to reduce infection and it's spread to the wider community.

5.3 Limitations

i. The study depended on self reported sexual Practices and risk Behaviours, which may have been under- or over-reported due to stigma or social status effect.

ii. The study was limited to bus drivers in Benin City, so the results may not represent drivers in other parts of Nigeria.

iii. Laboratory diagnosis was limited to non Treponemal screening

iv. The sample size,though adequate for basic analysis,may not fully capture less common risk factors.

5.4 Recommendations

Health educational programs should be developed for bus drivers, in order to correct misconceptions about syphilis transmission and emphasizing importance of condom use.

provision of syphilis screening should be introduced at motor parks and transport hubs to detect infections early, mostly since many cases are asymptomatic.

Campaigns enhancing safer sexual practices, reduction of multiple partnerships, and consistent condom use should be prioritized.

Policy action which should include non Governmental Organization and Government organisation and transport unions should collaborate to integrate STI prevention and testing into workplace health programs for drivers.

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APPENDIX I

EDO STATE MINISTRY OF HEALTH
HEALTH RESEARCH ETHICS COMMITTEE

PROTOCOL NUMBER	HA/737/25/D/06130740 (PLEASE QUOTE IN ALL ENQUIRIES)
APPROVAL NUMBER	HA/737/25/D/07230740
TITLE OF RESEARCH PROPOSAL	SEROPREVALENCE AND ASSESSMENT OF RISK FACTORS OF SYPHILIS AMONG COMMERCIAL BUS DRIVERS IN BENIN METROPOLIS
PRINCIPAL INVESTIGATOR (S)	EBOSELE FAITH
DATE CONSIDERED	23RD JULY, 2025.
DECISION OF THE COMMITTEE	APPROVED

THIS APPROVAL DATES 23/07/2025 TO 23/07/2026. IF THERE IS A DELAY IN STARTING THE RESEARCH, PLEASE INFORM THE HREC EDO SMOH SO THAT THE DATES OF APPROVAL CAN BE ADJUSTED ACCORDINGLY

REMARK: Please kindly note that the HREC Edo SMoH seal authenticates this approval

DR (MRS.) OMONYEMEN B. BELLO
(MBBS, MPH, FPHCM) *(CHAIRMAN)*

SIGNATURE & DATE 01/08/2025

SUPERVISOR(S) DR (MRS) I. M. MOSES-OTUTU

ATTESTATION BY INVESTIGATOR(S)

No participant accrual or activity related to this research may be conducted outside of the approval dates. All informed consent forms used in this study must carry the Edo SMoH HREC-assigned number and duration of your research. No changes are permitted in the research without prior approval of the Edo SMoH HREC except in circumstances outlined in the Code. The Edo SMoH HREC reserves the right to conduct compliance visits to your research site without previous notification.

Signature & Date 2/08/2

edohrec@edostate.gov.ng

Room 16, Block D, 2nd floor, State secetariat building.

APPENDIX II

Informed Consent Form

Title of Study: Seroprevalence and assessment of risk factors Among Intra-city transporters (Bus Drivers, keke riders, taxi drivers) in Benin City, Nigeria.

Name of Researcher: Ebosele Faith.

Institution: University of Benin

Phone Number: 08152208521

Department: Medical LaboratoryScience

1. **Purpose of the Study**

You are invited to participate in a research study aimed at determining the seroprevalence of syphilis among Intra-city transporters (commercial bus drivers) in Benin Metropolis . The results of this study will help to better understand the risk factors and develop appropriate intervention programs.

2. **Procedures**

If you agree to participate, you will be asked to complete a short questionnaire about your background and sexual health practices. A small amount (about 4 mL) of your blood will be collected using sterile procedures for syphilis testing.

3. **Voluntary Participation**

Your participation in this study is entirely voluntary. You may choose not to participate or withdraw at any point without any penalty or loss of benefits.

4. **Risks and Benefits**

There is minimal risk involved in participating in this study. You may experience slight pain or discomfort from the blood draw. The benefit of participation includes free syphilis testing and referral for treatment if the result is positive.

5. **Confidentiality**

All information collected in this studywill be kept strictlyconfidential. Your identity will not be revealed in any reports or publications resulting from this study.

6. **Contact Information**

If you have any questions about this study, you may contact the researcher using the details provided above.

7. **Consent Statement**

I have read (or have read to me)the information above. I understand the purpose of the study,the procedures involved, and my rights as a participant. I voluntarily agree to participate in this study.

Participant's Name: ___________________________

Signature ___________________________ Date: ________________

Researchers Name: ____________________________

Signature: ___________________________________

Date: ________________

APPENDIX III

QUESTIONNAIRE FOR RESEARCH PARTICIPANTS

Title: Seroprevalence and Assessment of Risk Factors of Syphilis among Intra-cityTransporters in Benin Metropolis

Instructions: Please answer all questions honestly. All information provided will be treated with strict confidentiality and used solely for academic purposes.

Tick(✓)where appropriate.

SECTIONA:Socio-Demographic Information

1. Age: ___________

2. Gender: ☐Male☐Female

3. Maritalstatus: ☐Single☐Married☐Divorced ☐Widowed

4. Educational level: ☐Noformal education ☐Primary☐Secondary☐Tertiary

5. Occupation: ____________________________

SECTIONB:Knowledge of Syphilis

6. Have you heard of Syphilis? ☐Yes☐No

7. Do you know how these infections are transmitted? ☐Yes ☐No

8. If yes, what are the ways? (Tick all that apply):

☐ Sharing needles or sharp objects

☐ Blood transfusion

☐ Mother-to-child transmission

☐ Casual contact like hugging or shaking hands

9. Have you ever received health education on Syphilis ? ☐Yes☐No

SECTION C: Sexual Behaviour and Practices of Syphilis

10. Do you have multiple sexual partners ?☐Yes☐No

11. Have you ever been tested for sexually transmitted infections (STIs) ?☐Yes ☐No

12. Have you ever shared sharp objects (razor,clippers,needles)? ☐Yes☐No

13. Have you ever had a blood transfusion? ☐Yes☐No

14. Do you always use condoms during sexual intercourse?

☐ Always☐Sometimes ☐Never

15. Have you ever been screened for Syphilis? ☐Yes☐No

16. Do you experience any of the following ?(Yes/No):

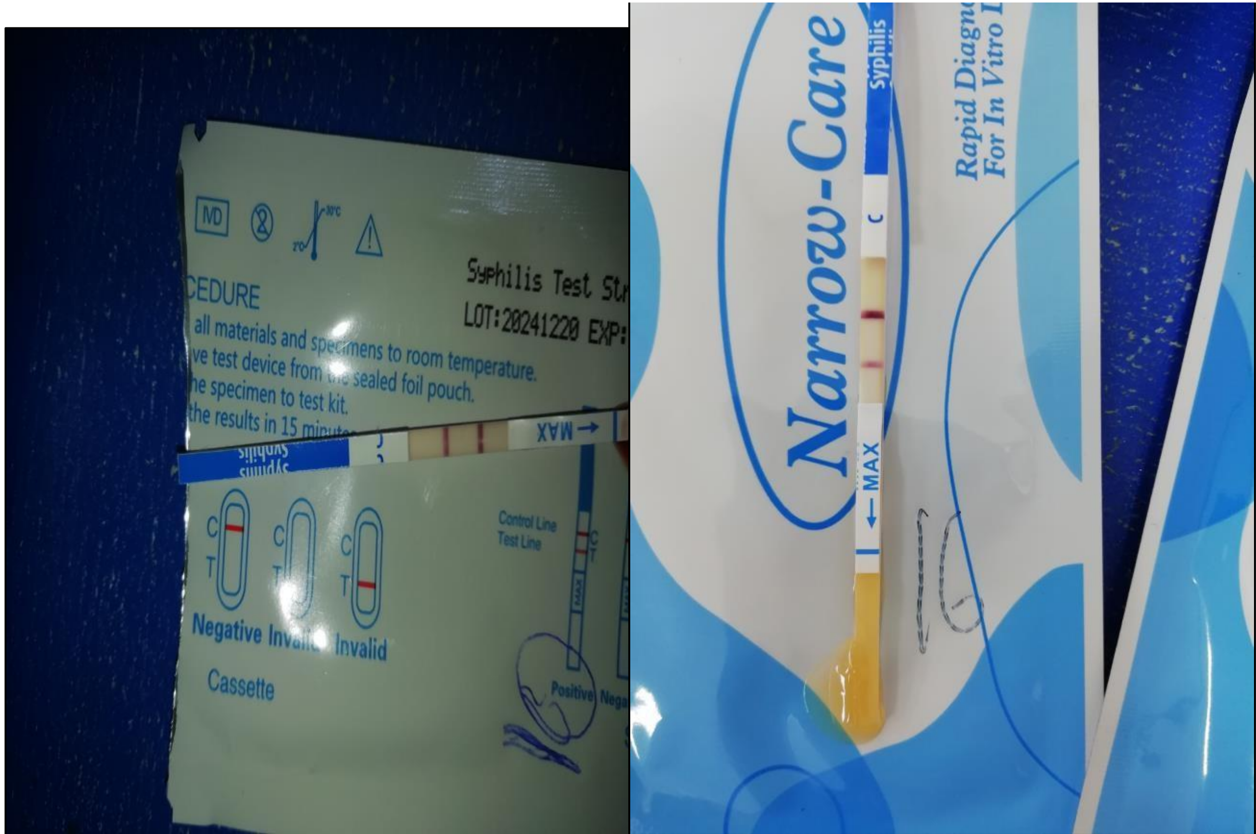
☐ Genital sores

☐ Skin rash

☐ Pain during urination

APPENDIX IV

APPENDIX V



A POSTIVE SYPHILIS TEST STRIP