

Incidence of Chlamydia and Gonorrhoeae Infection among Patients at the Namibia Institute of Pathology

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Abstract— Sexually Transmitted Infections (STIs) are associated with increased HIV transmission, infertility and other sexual health complications. This study aimed to determine the prevalence of chlamydia and gonorrhoeae in people within the reproductive age referred to Namibia Institute of Pathology. A descriptive, retrospective cross sectional study was conducted to determine the prevalence of chlamydia and gonorrhoeae among 465 patients within the age group of 15 – 49 years and covering 12 regions of Namibia. The urine sample was analyzed using Cepheid GeneXpert CT/NG. The overall prevalence of 12.7% and co-infection of 1.94%, with adolescent within the age group of 15 – 19 yrs were predominantly infected (18.2%). Oshikoto region was mostly affected with the prevalence of 6.5% and only in women. Meanwhile, males were more affected than females in 7 regions with the marked prevalence of 3% in both Ohangwena and Khomas and 3.5% in Kavango East. In this study however, men were more positive to STIs (14.5%) than women (11.6%) in general; while the prevalence of 8.40% and 4.30% were recorded for *C. trachomatis* and *N. gonorrhoeae* respectively. Regular STIs screening and surveillance, using extra genital clinical samples is required for disease control purposes and prevention.

Keywords—Chlamydia; gonorrhoeae; prevalence; sexually transmitted infections

I. INTRODUCTION

Sexually Transmitted Infections (STIs) are spread predominantly by sexual contact namely vaginal, anal, and oral sex, with; more than thirty different bacteria, viruses and parasites known to be transmitted. Among the eight commonly accounted sexually transmitted pathogens, four are curable, such as; Syphilis, Gonorrhoeae, Chlamydia, and Trichomoniasis, meanwhile; the cures for the other four viral pathogens Hepatitis B, Herpes simplex virus (HSV), Human Immunodeficiency Virus (HIV), and Human papillomavirus (HPV) have not yet been found [1, 2]. It has been reported that gonorrhoeae have a growing threat of antibiotic resistance, and Namibia, like any other nations is facing a threatening major public health crisis that would result in significant reproductive

morbidities, including infertility [3, 4]. In 2010 Centers for Disease Control and Prevention (CDC) reported that the number one cause of mortality in Namibia is HIV, which could be associated with STIs as it facilitates HIV infection [5]. Chlamydia and gonorrhoeae are caused by an obligate, aerobic, gram-negative, dimorphic intracellular *Chlamydia trachomatis* (*C. trachomatis*) and a non-motile, non-spore-forming, gram-negative intracellular diplococci *Neisseria gonorrhoeae* (*N. gonorrhoeae*) respectively. These pathogens are spread through unprotected sexual intercourse with an infected person. Nevertheless, they can also be transmitted from mother to child during vaginal childbirth. In women, chlamydial and gonococcal infections may cause pelvic inflammation, tubal infertility, chronic pelvic pain, and ectopic pregnancy. Chlamydial infection may also be linked to cervical cancer. Chlamydial and gonococcal infections may also increase the susceptibility of human immunodeficiency virus (HIV) in both men and women transmission [6].

C. trachomatis cause infection by their ability to attach and invade susceptible host cells, which are generally the columnar epithelial cells by the aid of two primary candidates; the major outer membrane protein (MOMP) and the chlamydial 60-kD cysteine-rich protein OmcB. They invade the host cell by phagocytosis, pinocytosis, or receptor-mediated endocytosis and internalized in membrane bound vacuoles transformed into reticulate bodies (RBs) which are the metabolically active form [7, 8]. About 60% – 70% of infants exposed to *C. trachomatis* during vaginal childbirth acquire the infection, with conjunctivitis as the most frequent clinical manifestation in 15% - 37% of exposed infants. *C. trachomatis* has an incubation period of 7 - 21 days with more than 50%-infected males reported to be asymptomatic. The most common manifestation is urethritis and complications such as epididymitis and reactive arthritis may occur because of persistent infection. In females, chlamydia is reported to be the most common infection, and it commonly presents with cervicitis and urethritis. It is known to cause complications in females such as pelvic inflammatory disease (PID), which can lead to infertility, perihepatitis (Fitz-Hugh-Curtis syndrome), and reactive arthritis. Chlamydia causes trachoma in all ages, urogenital infection in both males and females, lymphogranuloma venereum (LGV), and pneumonia in neonates [2, 9-11]. *N. gonorrhoeae* is the second most common bacterial sexually transmitted infection after *C. trachomatis* [4, 8, 11]. *N. gonorrhoeae* primarily infects columnar or cuboidal epithelium cells as it invades the mucous membrane of the contacted tissue and attaches to the microvillus

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of the epithelial cells. It is engulfed by the host cell's membrane endocytosis, which is mediated by lipo-oligosaccharide (LOS), and replicates through the endocytotic vacuoles that are formed [8]. Similar to Chlamydia, acute urethritis is the predominant manifestation of gonorrhoeae in men with initial symptoms of scant and mucoid urethral discharge and dysuria, usually without urinary frequency or urgency, while; within 1 – 2 days it becomes overtly purulent. Acute epididymitis is the most common complication of urethral gonorrhoeae and rarely; penile lymphangitis, periurethral abscess, acute prostatitis, seminal vesiculitis, and infections of Tyson's and Cowper's glands [2, 8]. *N. gonorrhoeae* affects the mucous membrane of the urethra, and the columnar epithelial cells that line the endocervix in women. About 80% of females with gonorrhoeae are asymptomatic, and it takes 10 days of infection to manifest in symptomatic patients. The dominant symptoms are increased vaginal discharge, dysuria often without urgency or frequency, and intermenstrual bleeding, sometimes triggered by coitus. Purulent discharge from the urethra or the ducts of Bartholin's glands may be observed. Ascending genital infection may occur with abdominal or pelvic pain, and it leads to PID the predominant complication and one of the most common causes of female infertility. Other complications are ophthalmitis, disseminated infection with arthritis, dermatitis, and sometimes endocarditis [4, 8].

It has been projected that by the year 2040, the number of young people in Africa would have been increased by 60% [12]. Health interventions targeted at this age group are important for current and future adult health and for the health of the next generation. This is particularly true for sexually transmitted infections (STIs), which when acquired in adolescence, can jeopardize sexual and reproductive health later in life and, for women, the health of their babies [12, 13]. Namibia, with 66% of the population under the age of 30 and 39% below the age of 15, requires comprehensive efforts to address youth health issues [3]. STIs, including the human immunodeficiency virus (HIV), are the most common cause of illness in Namibia, posing social and economic consequences. Reproductive age is different in men and women, since in women it is described as the years of life between menarche and menopause, roughly from ages 12 to 49 years. The term is imprecise, since some women can become pregnant and bear children at younger or older ages. In men, this is the year between the onset of puberty and loss of fertility [14]. Meanwhile, according to the World Health Organization, the reproductive age is 15 – 49 years as it is derived from most of reported fertility studies for both women and men [2, 4]. To the best of our knowledge, there is no recent data on the prevalence of chlamydia and gonorrhoeae among people within the reproductive age in Namibia; hence, this study sought to determine the prevalence of *C. trachomatis* and *N. gonorrhoeae* in patients referred and tested at Namibia Institute of Pathology (NIP) in 2017.

II. MATERIALS AND METHODS

A. Study Design and Subjects

This study was a descriptive, retrospective cross sectional investigation, which involved analysis of patients' laboratory

records for the period of one year; January – December, 2017. We evaluated 465 patients within the age group of 15 – 49, referred for chlamydia and gonorrhoeae examination, using nucleic acid amplification tests (NAATs) method at NIP-WRCL. Patients with no gender or age indicated were not included and the permission to carry out the study was granted by the Department of Medical Laboratory Health Sciences, Namibia University of Science, and Technology (NUST); Ministry of Health and Social Services (MoHSS) and by Namibia Institute of Pathology (NIP) [Protocol number 55-2018].

B. Sampling and Data Collection Techniques

Probability and convenience sampling methods were used; whereby, the records were stratified into two groups; age and sex for the selection of chlamydia and gonorrhoeae test results. The validity and reliability of the study was ensured by studying the maintenance, calibration, and quality control records of the equipment (Cepheid GeneXpert CT/NG) used for laboratory tests of urine samples in 2017. The sample size was estimated by means of Fisher's formula using the following equation:

$$n = \frac{z^2 pq}{d^2} \quad (1)$$

Where:

n = minimum sample size

z = constant, standard normal deviation (1.96 for 95% confidence interval)

p = expected prevalence (the prevalence of chlamydia, gonorrhoeae, and co-infection in the reproductive age patients tested at NIP-WRCL is unknown, therefore 50% prevalence was assumed)

d = degree of accuracy desired usually set at 0.05

q = 1-p

z = 1.96

p = 0.5

q = 0.5

The minimum sample size for the study was calculated with the confidence level of 95% and a confidence interval of 5% used according to the method described by Kasiulevicius et al. [15].

III. RESULTS

A. Analysis of the Study Population

A total of 465 patients were enrolled and their mean age was 31.32 years (range 15 – 49 years). Considering the age group, 30.97% (144/465) and 69.03% (321/465) were older and less than 35 years respectively. There were 172 (36.99%) males and 293 (63.01%) females (male/female ratio 1:1.7). Data collected was representing 12 geopolitical region of Namibia; namely, Erongo, Hardap, Karas, Kavango East, Kavango West, Khomas, Kunene, Ohangwena, Omusati, Oshana, Oshikoto and Zambezi.

B. Demographic distribution of *C. trachomatis* and *N. gonorrhoeae*

Marked prevalence of *C. trachomatis* and *N. gonorrhoeae* was observed between the age group of 15 – 19, 20 – 24 and 25 – 29 yrs, with high percentage of 18.2%, 16.7% and 8.7% recorded in *C. trachomatis* than 9.1%, 8.3%, and 6.4% in *N. gonorrhoeae* respectively. There was 6.7% of co-infection within the age group of 20 – 24 yrs. There was a decrease in prevalence of *C. trachomatis* to 4.4% at the age group of 30 – 34 yrs, which subsequently increased to 6.5% (35 – 39) and 6.8% (40 – 44). The lowest percentage for both *C. trachomatis* and *N. gonorrhoeae* was 4.4% at the age group of 30 – 34 and 45 – 49 (Table I). Regarding gender, 21 (7.2%) of the 293 enrolled females and 18 (10.5%) of the 172 males were positive to *C. trachomatis*; while for *N. gonorrhoeae*, 13 (4.4%) females and 7 (4.1%) males were positive with co-infection of 1% and 3.5% respectively (Table I). STI was observed to be high in male than females between the age groups; 20 – 24, 30 – 34, 35 – 39, 40 – 44 and 45 – 49 yrs with 4.7% (8/172), 3% (5/172), 1.2% (2/172), 1.2% (2/172), and 0.6% (1/172) respectively. Meanwhile, it was high in female than in male only within age group of 15 – 19 and 25 – 29 yrs having percentage prevalence of 1.4% (4/293) and 4.8% (14/293). Noticeable prevalence was measured at the age groups of 20 – 24 (male) and 25 – 29 (female) yrs (Fig. 1). Of the 465 subjects, 39 had *C. trachomatis*-positive and 20 *N. gonorrhoeae*-positive patients, giving the overall prevalence of 8.40% and 4.30% respectively. Meanwhile an overall STI prevalence of 12.7% (59/465) and co-infection of 1.94% (9/465) were observed, with more in men (14.5%) than in women (11.6%) [Table I and II].

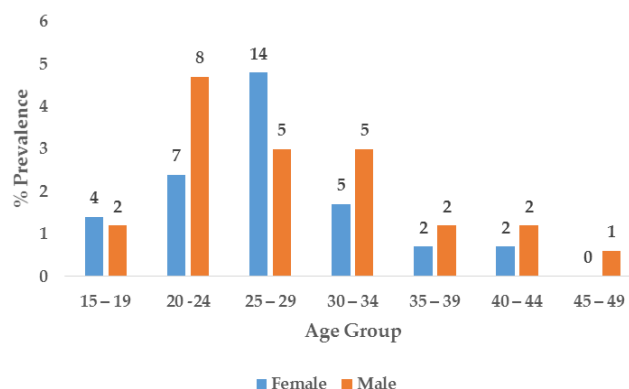


Fig. 1. Gender distribution of STIs within age group

Of the 12 regional location covered in this study, the prevalence of *C. trachomatis* and *N. gonorrhoeae* were high in 4 regions when compared to others. Marked prevalence of 1.94% (9/465) and 2.20% (10/465) were observed in Oshikoto region for *C. trachomatis* and *N. gonorrhoeae* with co-infection of 1.10% (5/465). The prevalence of *C. trachomatis* in Kavango East and Khomas was 1.94% (9/465), which is the same as that of the Oshikoto region. Five patients (1.10%) were positive to *C. trachomatis* and 2 (0.43%) to *N. gonorrhoeae* with only 1 (0.22%) co-infected in Ohangwena region (Table II). The prevalence in Erongo, Kavango West, Oshana, Kunene, Omusati, Zambezi, Karas and Hardap regions was ranging between 0.22% (1/465) and 0.43% (2/465) for *C. trachomatis* and *N. gonorrhoeae*, which is very low when compared to others. Co-infection of 0.22% (1/465) was also noted in Erongo, Zambezi and Hardap regions despite the low prevalence recorded (Table II). Males were more affected than females in 7 regions; including Erongo, Kavango East, Khomas, Ohangwena, Zambezi, Karas and Hardap with marked prevalence of 3.5% (6/172) in Kavango East, followed by 3% (5/172) in both Khomas and Ohangwena. Similar trend of 2.3% (4/172) and 1.7% (3/172) was observed in Zambezi and Hardap. Moreover, a significant number of 19 (6.5%) females were positive to STIs in Oshikoto with no infection observed in males (Fig. 2).

Table I: PREVALENCE OF *C. TRACHOMATIS* AND *N. GONORRHOEAE* IN RELATION TO AGE GROUP AND GENDER

Variables	Study subjects	<i>C. trachomatis</i> +ve (%)	<i>C. trachomatis</i> -ve (%)	<i>N. gonorrhoeae</i> +ve (%)	<i>N. gonorrhoeae</i> -ve (%)	Co-infection (%)
Age (yrs)						
15 – 19	22	4 (18.2)	18 (81.8)	2 (9.1)	20 (90.9)	1 (4.6)
20 – 24	60	10 (16.7)	50 (83.3)	5 (8.3)	55 (91.7)	4 (6.7)
25 – 29	126	11 (8.7)	115 (91.3)	8 (6.4)	118 (93.7)	3 (2.4)
30 – 34	113	5 (4.4)	108 (95.6)	5 (4.4)	108 (95.6)	1 (0.9)
35 – 39	62	4 (6.5)	58 (93.6)	0 (00)	0 (00)	0 (00)
40 – 44	59	4 (6.8)	55 (93.2)	0 (00)	0 (00)	0 (00)
45 – 49	23	1 (4.4)	22 (95.7)	0 (00)	0 (00)	0 (00)
Gender						
Male	172	18 (10.5)	154 (89.5)	7 (4.1)	165 (95.9)	6 (3.5)
Female	293	21 (7.2)	272 (92.8)	13 (4.4)	280 (95.6)	3 (1)

Table II: REGIONAL LOCATION AND THE PREVALENCE OF *C. TRACHOMATIS* AND *N. GONORRHOEAE*

Geographical region	<i>C. trachomatis</i> +ve (%)	<i>N. gonorrhoeae</i> +ve (%)	Co-infection (%)
Erongo	1 (0.22)	1 (0.22)	1 (0.22)
Hardap	2 (0.43)	1 (0.22)	1 (0.22)
Karas	1 (0.22)	0 (00)	0 (00)
Kavango East	9 (1.94)	0 (00)	0 (00)
Kavango West	0 (00)	1 (0.22)	0 (00)
Khomas	9 (1.94)	1 (0.22)	0 (00)
Kunene	0 (00)	1 (0.22)	0 (00)
Ohangwena	5 (1.10)	2 (0.43)	1 (0.22)
Omusati	0 (00)	1 (0.22)	0 (00)
Oshana	1 (0.22)	0 (00)	0 (00)
Oshikoto	9 (1.94)	10 (2.20)	5 (1.10)
Zambezi	2 (0.43)	2 (0.43)	1 (0.22)
	39 (8.40)	20 (4.30)	9 (1.94)

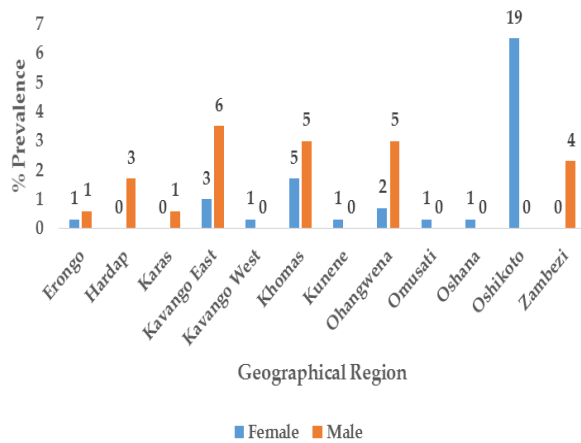


Fig. 2. Gender distribution of STIs across the region

The overall prevalence of STIs was therefore recorded as high with 4.1% in Oshikoto, followed by 2.2%, 1.9%, and 1.5% in Khomas, Kavango East and Ohangwena respectively. The other 8 regions had prevalence of 0.2% for Kunene, Omusati, Karas, Oshana, Kavango West and 1.0%, 0.7%, 0.4%, for Zambezi, Hardap and Erongo respectively (Fig. 3).

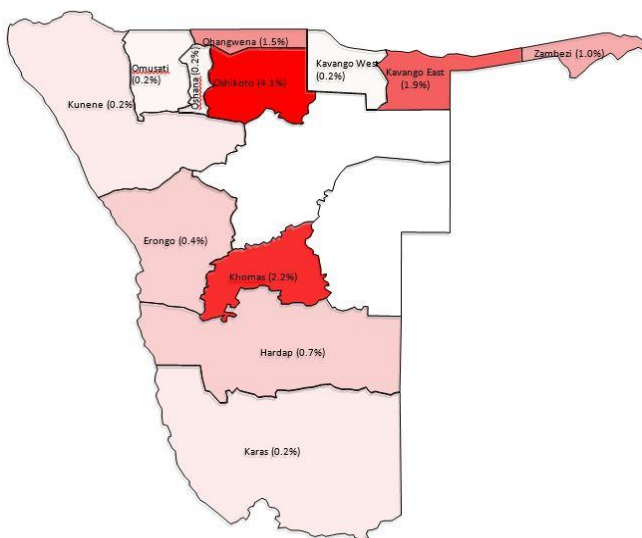


Fig. 3. Map of regional distribution of STIs

IV. DISCUSSION

Sexually transmitted infections (STIs) caused by *N. gonorrhoeae* is on the increase, with practically 400,000 cases reported in the US in 2015 and epidemics were among young, black heterosexuals and men who have sex with men [16]. A recent projection revealed that *Chlamydia trachomatis* newly infected 50 million women worldwide, of which 34 million were in Africa and Asia. Chlamydial infection in women is commonly asymptomatic and when untreated can spread to genitalia, which may cause infertility, chronic pelvic pain, pelvic inflammatory disease (PID) and ectopic pregnancy [17]. This study determined the prevalence of chlamydia and gonorrhoeae in people within the reproductive age group (15 – 49 yrs), tested at NIP in 2017. We recorded among females *C. trachomatis*

prevalence of 7.2% and in males 10.5% (Table 1). This is a lower prevalence when compared to a study conducted in Northern Nigeria where a prevalence of 26% was reported for *C. trachomatis* among women. High prevalence of *C. trachomatis* in this region has been linked with lack of use of condoms, low level of education, several sexual partners, early age marriage, and sexual intercourse [18]. In USA 60% of non-Hispanic black women were reported to be infected with *C. trachomatis* which is 5 times more than in non-Hispanic whites with chlamydia-associated tubal factor infertility [13]. Meanwhile, in China 4.12% of women with associated demographic (e.g., ethnic minority) and behavioral risk factors were reported to be infected with *C. trachomatis* [19]. Overall 8.40% and 4.30% (Table 1 and 2) of participants were positive for *C. trachomatis* and *N. gonorrhoeae* respectively. Studies have shown that the prevalence of *C. trachomatis* is usually higher than that of *N. gonorrhoeae* and *C. trachomatis*’ prevalence similar in men having sex with men when compared with prevalence in women, whereas *N. gonorrhoeae* prevalence is higher in men having sex with men than in women [19-21]. In this study 4.1% of male and 4.4%, females were positive to *N. gonorrhoeae* in Namibia (Table 1). South Africa using Spectrum-STI tool has estimated in female and male between 1990 and 2017, the prevalence of 6.6% and 3.5% for *N. gonorrhoeae* and for chlamydia 14.7% and 6.0% respectively. High rates of STIs and antimicrobial resistant in gonorrhoeae have prompted South Africa to conduct a national STI estimation of trends in the population burden of antimicrobial resistant gonorrhoeae [22].

A high prevalence of STIs was mostly found in rural setting or an area of ethnic minority group, among the adolescent and in an area with high HIV prevalence. It has been projected that by 2040, the number of youth in Africa would have increased by 60% to more than 466 million [19, 23]. High prevalence of *C. trachomatis* and *N. gonorrhoeae* observed within the reproductive age group of 15 – 19 (18.2%, 9.1%), 20 – 24 (16.7%, 8.3%), and 25 – 29 (8.7%, 6.4%) [Table 1] corroborates the findings reported in South Africa with the estimated range of 8.0% – 20.6% for chlamydia, 1.4% – 8.9% for gonorrhoeae among the youth within the age group of 15–19 and 20–24 yrs [23]. This may be because, at this age group, the individuals become sexually active and engage in risky contributing factors for contracting the disease. Adolescents tend to be at a higher risk of contracting STIs due to unawareness of preventive methods and it can also be biologically related to the columnar epithelial cells on the ectocervix, known as the ectopy, which is more common in female adolescents, and it is known to increase susceptibility to infection [11, 24]. *C. trachomatis* interchanges between two morphological forms, the elementary body (EB) and the reticulate body (RB). Elementary bodies (EBs) are extra-cellular, the infectious particles found in secretions and they are metabolically inert. Within eight hours, they transform into reticulate bodies (RBs) which are the metabolically active form. RBs undergo repeated cycles of binary fission leading to secondary differentiation back to EBs within 24 hours. In 48 – 72 hours, the inclusion matures and the cell lysed to release infectious EBs. Released elementary bodies attach and invade

other neighboring cells or are transmitted to another individual and cause an infection [9]. This process induces a strong immune response that can result in damage and scarring to the infected site [7, 8, 11]. Endocytotic vacuoles formed by host cell's membrane in which *N. gonorrhoeae* can replicate; transport the bacterium to the bottom membrane of the host cell and with time, the infected membrane dies; hence the release of accumulated bacterium into sub-epithelial space which disarm the complement system for survival in the host [8, 10, 11]. Health mediations directed towards this age group are essential for current and future adult health and that of the next generation. STIs, when developed in youth, can endanger sexual and reproductive health later in life and that of their children. High STI prevalence among adolescent has been observed worldwide which places an interest on the serious need for inclusive efforts to advance sexual and reproductive health among this age group [23].

Namibia is a huge country with 824 116 square kilometres of geographical area, but one of the smallest countries in Africa when it comes to its population size of about 2.1 million. Like many other African countries, Namibia emerged from suppression under apartheid, which resulted in extremely entrenched levels of inequality and poverty [3]. The prevalence of STIs was high in Oshikoto and Khomas region of Namibia than others with 4.1% and 2.2% respectively (Table 2 and Figure 3). Oshikoto region also had the highest co-infection rate of 1.10% and a marked STIs prevalence of 6.5% observed only in females (Table 2 and Figure 2). *C. trachomatis* and *N. gonorrhoeae* were both common in Oshikoto region while only *C. trachomatis* was predominant infection in Khomas and Kavango East region and more in males than in females (Table 2 and Figure 2). High prevalence among women in Oshikoto region could be associated with the anatomy of females' reproductive tract, which makes it more possible to acquire an STI. The vagina has a thin lining and it is delicate compared to the skin on a penis; hence easier for bacteria to penetrate. In addition, the vagina is a good environment for bacteria, because of its moist and favorable pH for bacterial growth [24]. Moreover, it could be associated with oral contraceptives, that may increase the cervical ectopy and this makes one susceptible to STIs [8]. Guy et al. [25] reported in Australia similar rate in women (2.0%) and men (4.1%) of *C. trachomatis* and *N. gonorrhoeae* co-infection among 16 – 19 yrs reproductive age group. A higher prevalence could be associated with a higher sample size used for the study, or it could be that there is a high rate of infection with contributing factors such as culture, level of education and socio-economic status. STI is more prevalent in men than in women in Namibia as we recorded 14.5% for male and 11.6% in females as well as high co-infection of 6.7% in males' within the reproductive age group of 20 – 24 yrs than female (Table 1). This could be because males may present with symptoms after an infection unlike females who could be asymptomatic. Omusati, Oshana, Kunene, and Kavango west regions had 1 (0.22%) case of STI per region and only in females (Table 2 and Figure 2). This could be associated with high rates of pregnancy in these regions or cultural reasons such as early marriage. Hardap, Zambezi, and Karas regions had cases of STIs infection in males with no female infection

observed which could be related to females being asymptomatic or a possibility of men who have sex with other men [20].

Oshikoto is one of the fourteen regions of Namibia and the northern part of the region is largely into agriculture, especially the growing of pearl millet crop, while the main economic activities in the southern part are cattle rearing and mining. Meanwhile, Oshikoto is one of the three regions without either a shoreline or a foreign border. Although the mining may have a limited life span, it can support and boost industrial activities and services. This is comparable to Khomas region, which is at the center of capital city Windhoek, the second region with high prevalence of STIs in this study. Oshikoto region is similar to Mwanza region in Tanzania, which was described by Changalucha et al. [26] as a rural population that lives mostly on subsistence farming; mainly of cotton, maize, and fishing farming with some gold mining activities in the western part of the region. The engagement of foreign companies in the gold mining and the associated developments are likely to bring about major changes in terms of demography, economics, and STIs. These may be some of the contributing factors to the high prevalence of STIs observed in Oshikoto region among women. Even though the minimum sample size was reached, this study may not fully represent the reproductive population of Namibia as there were months when data was not available as well as the fact that only urine sample was collected for analysis and not all regions were represented in this study. Regular surveillance may be necessary for a period of 3 – 7 years of study, covering all regions and the use of 2 – 3 specimens or samples for analysis.

V. CONCLUSION

The prevalence of STIs is on the rise in Namibia as this study showed an overall prevalence of 12.7%, with co-infection of 1.94% in the year 2017. Adolescent with the age group of 15 – 19 yrs were predominantly infected (18.2%). Young people in general, and especially women in Oshikoto region may need special attention from the public health agency, as the infection was high in women of that region (6.5%). More men (14.5%) were affected than in women (11.6%); meanwhile, *C. trachomatis* (8.40%) was more in circulation than *N. gonorrhoeae* (4.30%). Sexual health education and the screening of all sexually active people, using in addition extra genital specimens especially when symptomatic, as well as the screening and testing of the rectal and pharyngeal specimens in men who have sex with other men even when asymptomatic is important in order to prevent and control STIs. Routine rescreening and treatment of positive patients' sex partners, appropriate diagnostic testing in people with compatible clinical syndromes, adherence to recommended treatment regimens, periodic testing of isolates to monitor trends in antimicrobial resistance, routine testing for other common infection in all people with a newly acquired sexually transmitted disease, administration of systemic antibiotics immediately before or soon after sexual exposure and public education and awareness campaigns on STIs are essential and recommended. This study might help to explain the differences in STI prevalence at regional level where increased efforts are needed to control the burden of *C. trachomatis* and *N. gonorrhoeae* infections. Insight into the mechanisms that drive the burden of these

infections is essential for disease control. Hence, the study outcomes can have important implications on developing rationale measures to effectively detect and manage STIs. Results may be used for awareness campaign, policy, and program development.

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