EAHRC
EAST AFRICAN HEALTH RESEARCH COMMISSION
Research for Health and Prosperity

ORIGINAL ARTICLE

Prevalence of Sexually Transmitted Infections and Associated Factors Among Young Adult Female Students at Higher Learning Institutions in Mbeya, Tanzania: A Cross-Sectional Study

Anifrid Mahenge[a*], Wolfram Mwalongo[a], Jonathan Mnkai[a], Beatrice Komba[a], Regino Mgaya[a], Willyhelmina Olomi[a], Christof Geldmacher[b], Ruby Doryn Mcharo[a]

[a]National Institute for Medical Research-Mbeya Medical Research Center (NIMR-MMRC), Mbeya, Tanzania, [b]Division of Infectious Diseases and Tropical Medicine, University Hospital of Munich, LMU, Munich, Germany.

Correspondence to Anifrid Mahenge (amahenge@nimr-mmrc.org)

ABSTRACT

Background: Sexually Transmitted Infections (STIs) are prevalent among young people and bring about adverse reproductive, pregnancy and neonatal outcomes, as well as increasing the risk of acquiring HIV infection. STIs are often asymptomatic; however, in many low- and middle-income countries like Tanzania, they are routinely managed syndromically. There is uncertainty in the number of studies done among female students in higher learning institutions (HLIs) in Sub-Saharan Africa, and the majority of these assessed STIs based on the presence of symptoms. Due to the asymptomatic nature of STIs, syndromic management may underrate their magnitude. We report STI prevalence and associated factors among female students aged 18-24 from HLIs in Mbeya, Tanzania.

Methods: A cross-sectional study was conducted from February 2020 to June 2021. We tested self-collected cytobrush from female students aged 18-24 years. Deoxyribonucleic acid (DNA) extraction and molecular detection were done using 7-essential STIs Seegene assay with a real-time Polymerase Chain Reaction (RT-PCR) to test for ***Mycoplasma genitalium*** (MG), ***Chlamydia trachomatis*** (CT), ***Neisseria gonorrhoea*** (NG), ***Trichomonas vaginalis*** (TV), ***Ureaplasma parvum*** (UP), ***Mycoplasma hominis*** (MH) and ***Ureaplasma urealyticum*** (UU). Information on STI symptoms, sexual activity, and risk factors for STIs was collected using a self-administered questionnaire.

Results: We enrolled 150 participants from 5 HLIs. Accounting for (19.33%, 29/150) of the tested STIs were MG, CT, NG and TV, others were UP (56%), and a combination of MH and UU (38%). More than half (59.01%, 72/122) of positive cases had multiple infections. The majority of participants had poor levels of STI knowledge. Being a young female student (< 20 years) and having a history of practising oral sex were significantly associated with an increased likelihood of having an STI.

Conclusion: STI diagnosis using molecular assays is beneficial in detecting pathogens not routinely tested in health facilities; and for identifying asymptomatic infected individuals. There is a paramount necessity for health promotion, to scale up STI education and prevention intervention strategies among female students in HLIs.

BACKGROUND

Sexually transmitted infections (STIs) are caused by several bacteria, viruses, and parasites; and spread through vaginal, anal and/or oral sexual contact.[1,2] According to the World Health Organisation (WHO), more than one million STIs are acquired every day worldwide; and in 2020, 374 million new infections with *Chlamydia trachomatis*, *Treponema pallidum*, *Neisseria gonorrhoea* and *Trichomonas vaginalis* infections were reported.[2,3] Other commonly occurring STIs include human pappilomavirus (HPV), Hepatitis B virus, Herpes simplex virus and *Mycoplasma genitalium* infections.[2–7] STIs are often asymptomatic, bring about adverse health outcomes and are a serious threat to infected individuals.[2,3,8] If not detected and treated early, STIs are associated with severe long-lasting consequences such as pelvic inflammatory disease (PID) development in women, infertility in both men and women, adverse pregnancy and neonatal outcomes, and the development of cancers.[1–3] Worse still, they are also associated with an increased risk of acquiring and/or transmitting HIV.[2] Chlamydia, trichomoniasis and gonorrhoea infections may lead to ectopic pregnancy, spontaneous abortion, or infertility.[10] *Mycoplasma genitalium* and *Mycoplasma hominis* are not part of vaginal commensals, these can be found primarily during puberty after sexual contact and are commonly isolated from gravid women.[11]

Young people aged 15-24 years are more vulnerable and affected by STIs, accounting for almost half of all new STIs.[9,12] Most of these cases occur in low- and

middle-income countries (LMICs) particularly sub-Saharan Africa (SSA).[2,9,12] Previous studies have reported that young women are at a greater risk of STIs based on several socio-demographic, behavioural and biological characteristics.[1,3,7,9] Young adult female students in HLIs might be at a higher chance of contracting STIs since campus life is a time "free" of immediate supervision of a parent or guardian.[1,3,7,9] Young adults aged 18 years and above admitted to HLIs are independent, trying to establish their identity; and studies have shown that young adults in HLIs get experimental with sex, alcohol and other substances of abuse.[22,23] The latter may predispose young adult female students in HLIs to unsafe sex, a risk factor for contracting STIs as well as transactional and cross-generational relationships with older male sexual partners.[24,25] Students in their early years of study may become victims of "peer pressure" in an attempt to cope with the new environment and be recognised by older peers who may practice risky behaviours predisposing them to STIs.[26–30] Studies that assessed the risk of contracting an STI among University students in SSA noted that the majority of students believed to be at low or no risk of STIs; however, after assessing their sexual behaviour practices, they were found to be at high risk.[27,31]

In many LMICs, including Tanzania, diagnosis and management of STIs are based on the syndromic case management (SCM) approach; and few laboratory diagnostics rely on gram stain, wet preparation, microscopy and/or rapid tests depending on availability of such resources.[15,32,33] Conventional methods for STI diagnosis have low sensitivity and specificity and, therefore, are highly likely to miss a diagnosis from asymptomatic or symptomatic cases, which might hinder early treatment and management.[20,21] In Tanzania, there is limited information on the prevalence of STIs and associated factors among young adults, especially young female students enrolled in HLIs. We report study findings on STI prevalence and associated factors among young female adults at HLIs in Mbeya region-Tanzania to provide data for strengthening health promotion strategies in the region.

METHODS

Study Design, Site and Population

This was a cross-sectional study conducted between February 2020 and June 2021 from samples collected among 18–24-year-old female students at HLIs within Mbeya region-Tanzania. Mbeya is one of the regions located in the Southern Highlands Zone of Tanzania. The region forms the country's international borders with Zambia and Malawi. Mbeya is among the regions in Tanzania with a high prevalence of HIV and inadequate data on the burden of STIs considering these infections have similar modes of transmission.[32] Mbeya region has a youthful population and most program interventions targeting this age group focus on HIV/AIDS.[9,33] Young adults enrolled in HLIs at Mbeya are sexually active with poor levels of STI knowledge on STI prevention and health access.[32] At the time of data collection, six (6) HLIs were registered by the Tanzania Commission for Universities (TCU). These included the Mbeya University of Science and Technology, Tanzania Institute of Accountancy, Mzumbe University-Mbeya Campus, St. Augustine University, Theofilo Kisanji University, and the Open University of Tanzania. However, the Open University of Tanzania (OUT) did not take part in the study because when the study was conducted, none of the students at the OUT were eligible by age.

We analysed 150 archived vaginal cytobrush samples collected from female participants within the main STI prevalence study that enrolled a total of 504 male and female students.[32] The sample size calculation was reached by using the Pourhoseingholi MA, et al 2015.[34] formula as applied in the prevalence study which was done in Kenya with a prevalence of 13% for CT.[35] Invitation to participate in the main STI prevalence study was sent to all six (6) TCU-registered HLIs in the Mbeya region. Participant inclusion criteria included being enrolled as a student at any of the HLIs in any year of study or course, being Tanzanian, aged 18–24 years and able to provide written informed consent before all study-related procedures.

Sample Collection Methods and Study Procedures

In the main STI prevalence study[35] which collected the study samples, participants were instructed on how to self-collect a vaginal cytobrush sample with a well-trained clinic nurse following a Standard Operating Procedure (SOP) on self-cytobrush collection. Subjects were shown how to insert the cytobrush (Solann) into the vaginal canal through the endocervical wall and gently rotate the brush at 360˚ to ensure maximum collection of the targeted specimen. Each collected cytobrush sample was then put into a 15ml falcon tube containing 5ml PreservCyt cell collection media (Roche). All samples collected from data collection points at each University were immediately put into a cool box with a temperature monitor and transported to the College of American Pathologists (CAP) accredited National Institute for Medical Research-Mbeya Medical Research Centre (NIMR-MMRC) Molecular laboratory. On arrival, all cytobrush samples were checked for their integrity, and cells were thoroughly displaced from the cytobrush, aliquoted and temporarily stored at -20˚C or before STI testing. Data on associated factors to the presence of STIs were extracted from individual self-administered questionnaires of the main STI prevalence study (Supplement 1).[32] Information collected included socio-demographics, sexual experience, sexual behaviour, level of STI knowledge, and presence of STI symptoms.

Definition of Variables

The level of STI knowledge was assessed from the data of the main STI prevalence study, using a set of 17 questions with each correct response being given a single point. This variable was ranked based on the scores of all correct responses to either Excellent (above 75%), Moderate (45-75%) or Poor (below 45%). However, oral sex practices included any act of putting one's mouth on a penis, vagina, or genitals.

Sample Analysis and Statistical Management

DNA Isolation

Cytobrush samples were processed to extract DNA from cervical cells using QIAamp DNA 250 test, mini kit (*Qiagen, Germany*). A total of 5mls of cervical cells were centrifuged in an Eppendorf tube at 14000 revolutions

per minute for 15 minutes to concentrate the cells. The pellet was suspended with 200ul of Phosphate Buffered Saline (PBS) and lysing solution, proteinase-K was added and then incubated at 57^{0}C on a heat block. Extraction, filtration, and purification procedures proceeded in spin column tubes as per the manufacturer's instructions. Finally, DNA was eluted with 75µl of elution buffer and stored at -20˚C until detection. The purity and concentration of DNA were measured immediately after extraction using a spectrophotometer (*NanoDrop 2000 UV-IS, Thermo Fisher Scientific, Waltham, MA, USA*).

Detection of STIs with CFX96 PCR System

A multiplex Polymerase Chain Reaction (PCR) using CFX96™ RT-PCR System (Bio-Rad, USA) was carried out for the detection of the seven (7) STI pathogens, namely *Mycoplasma genitalium* (MG), *Chlamydia trachomatis* (CT), *Neisseria gonorrhoea* (NG), *Trichomonas vaginalis* (TV), *Ureaplasma parvum* (UP), *Mycoplasma hominis* (MH) and *Ureaplasma urealyticum* (UU), by using Anyplex™ 7-STIs essential test kit (Seegene). A volume of 20µl reaction volume was used for the amplification and detection of the target DNAs with the cycling conditions of 95°C for 15 minutes, 60°C for 1 minute and 72°C for 30 seconds. One external positive and negative control provided in the manufacturer's kit was incorporated with internal control (IC) in each run for STI testing. Anyplex™ test kits detect and use a human housekeeping gene as an IC that confirms the detection or integrity of cellular DNA from each specimen. All results were valid when both controls had passed with the expected results as recommended by the manufacturer's kit. All cytobrush samples without detectable DNA were re-tested using another stored aliquot of the original specimen. All PCR conditions including melting temperatures and detection complied with the manufacturer's instructions. Post-amplification and detection analysis was done using Seegene viewer software, and test results were transcribed onto Microsoft Excel, Microsoft Corporation, 2018.

Statistical Analyses

Data were imported into Stata Statistical Software version 14 (*Stata Statistical Software: Release 14. College Station, TX: StataCorp LP*) for data cleaning, management, and analysis. GraphPad Prism version 9 (*GraphPad Software, San Diego, CA*) was used for drawing figures. Data were summarized using frequency and percentages for categorical data, median and respective measures of dispersion for numerical variables. Binomial regression was used to estimate the crude and adjusted risk ratio for factors associated with the presence of an STI at 95% Confidence Intervals (CIs) and a p-value of <0.05 was considered statistically significant. The risk ratio was used as a measure of STI association as well as an estimate of the causal relationship to associated factors in the studied group because the STI prevalence in the study population was greater than 10%.[36–39]

Ethical Consideration

All study procedures commenced after a participant agreed to take part in the study and signed an informed consent form. Ethical approval for the study protocol was granted by the Mbeya Medical Research and Ethics Review Committee (Certificate Ref: SZEC-2439/R.A/V.1/64). The study team was trained on all required study SOPs. All study procedures and analyses were conducted in compliance with Good Clinical and Laboratory Practice, and all participants were informed of the outcome of their test results. Treatable STIs were managed following the WHO and Tanzanian STI treatment guidelines, and all participants received pre- and post-test counselling. Participants diagnosed with STIs were advised to inform their sexual partners; and if they agreed, the study clinician provided the required treatment and counselling to the participants' sexual partners too.

RESULTS

Participants' Characteristics and Level of STI Knowledge

From the main STI prevalence study, samples were analysed from a total of 150 female participants, with a median age of 21 years who reported median age at first sex of 19 years. Most of the participants were single (91.3%, 137/150) and first-year students (52.7%, 79/150) as shown in Table 1. The level of STI knowledge reported was poor among most participants (79.46%, 89/112) Table 2.

TABLE 1: The Socio-demographic Profile of the Respondents

Variables	Value (n (%))
Female	150(100)
Age Median (IQR)	21(20 – 22)
Age group	
18-19	38(25.3)
20 -24	112(74.7)
Age at first sex Median (IQR)	19(18 – 20)
Age group of first sex	
<18	38(25.0
≥18	112(75.0
Marital status	
Single	137(91.3)
Married	4(2.7)
Cohabiting/in a relationship	9(6.0)
University year	
First-year	79(52.7)
Second year	43(28.7)
Third year	26(17.3)
Fourth-year	02(1.3)

Prevalence of STI Among Participants, Presence of Single or Multiple Infections

Participants who were diagnosed with curable STIs accounted for (19.33%, 29/150), non-gonococcal urethritis pathogens were (61.66%, 72/150) and distribution of UP was (56.0%, 84/150). Next to this both MH and UU were present in (38%, 57/150) of the participants, and the proportion of CT was found to be (16.7%, 22/150). Figure 1 shows the prevalence of MG (6.67%, 10/150), TV (1.3%, 2/150), NG (0.4%, 1/150) and HIV (1.4%) among the study population.

In this study, 50 out of 122 participants (41.0%) had a single infection. The distribution of single infections, listed in ascending proportions, includes CT, MG, MH, UU, and

UP (Table 3). Among all participants, (59.0%, 72/122) had multiple infections. These include two pathogens (39.30%) MH+CT, UP+CT, UP+MG, UU+CT, UU+MG, UU+MH, UU+UP, three pathogens (13.1%) like UP+MH+MG, UP+MH+CT, UU+MH+CT, UU+UP+CT, UU+UP+MG and UU+UP+MH. Subsequently, our findings revealed infections of even four or five pathogens (6.60%), such as UU+UP+MG+MH, UU+UP+MH+CT, UU+UP+MG+MH+CT, UU+UP+MH+CT+TV, UU+UP+MH+NG+CT and UU+UP+MG+MH+CT+TV. Even so, CT was the most common infection occurring with UU, UP, MG and MH (Table 3).

Distribution of STI Pathogens with or without Symptoms

Results indicated that (54%, 66/122) of the participants diagnosed with at least one of the tested STIs did not express obvious symptoms of an STI. Also, it was noted that all gonorrhoea cases were symptomatic (Figure 2). Distribution of each pathogen for asymptomatic participants was UU (54.39%, 31/57) UP (54.76%, 46/84), MG (40.71%, 4/10), MH (56.14%, 32/57), CT (50%, 11/22) and TV (50%, 1/2). In addition, the symptomatic participants with STIs were seen on NG (100%, 1/1), TV 1(50%, 1/2), CT (50%, 11/22), UU (45.61%, 26/57), UP (45.24%, 38/84), MH (43.86%, 25/57) and MG (60%, 6/10). MH had the highest proportion of asymptomatic infections, while MG had the lowest (Figure 2).

Factors Associated with the Presence of AnySTI Among Young Female Students

Factors assessed for association with the presence of STIs (19.33%, 29/150) are shown in (Table 4)

Our findings show that practices of oral sex (adjusted RR 4.86; 95% CI, 1.91 to 10.67; P=.001) and not using a condom within the last four months during a sexual encounter (adjusted RR=1.64; 95% CI, 0.016 to 3.296; P=.164) were associated with an increased likelihood of having an STI. Having practised oral sex was statistically significant.

TABLE 2: Level of knowledge on STIs among young females (N=150)

Characteristics	Poor (n (%))	Moderate (n (%))	Excellent (n (%))	Total (%)
Age group				
18-19	28(73.68)	7(18.42)	3(7.89)	38(25.3)
20 -24	89(79.46)	16(14.29)	7(6.25)	112(74.7)
Age at first sex				
<18	1(33.33)	2(66.67)	(0)0%	03(2.6)
≥18	93(82.30)	13(11.50)	7(6.19)	113(75.33)
Marital status				
Single	106(77.37)	22(16.06)	(0)0%	9(6.57)
Married	4(100)	0(0%)	0(0%)	04(2.7)
In relationship/Cohabiting	7(77.78)	1(11.11)	1(11.11)	09(6.0)
University year				
First-year	57(72.15)	15(18.99)	0(0%)	79(52.7)
Second Year	33(76.74)	7(16.28)	3(6.98)	4328(28.7)
Third year	25(96.15)	1(3.85)	0(0%)	26(17.3)
Fourth year	2(100)	0(0%)	0(0%)	02(1.3)

TABLE 3: Distribution of STI Pathogens in Young Adult Females who engaged Sex (N=122)

Characteristics	Value n (%)
Single Pathogen	50(41.0)
CT	1(0.82)
MG	2(1.6)
MH	8(6.6)
UP	31(25.41)
UU	8(6.6)
Two pathogens	48(39.30)
MH+CT	1(0.82)
UP+CT	4(3.27)
UP+MG	2(1.6)
UU+CT	17(13.9)
UU+MG	3(2.5)
UU+MH	10(8.2)
UU+UP	11(9.02

Continue

TABLE 3: Continued

Characteristics	Value n (%)
Three Pathogens	16(13.1)
UP+MH+MG	1(0.82)
UP+MH+CT	1(0.82)
UU+MH+CT	4(3.27)
UU+UP+CT	1(0.82)
UU+UP+MG	1(0.82)
UU+UP+MH	8(6.6)
More than three Pathogens	8(6.60)
UU+UP+MG+MH	1(0.82)
UU+UP+MH+CT	3(2.5)
UU+UP+MG+MH+CT	1(0.82)
UU+UP+MH+CT+TV	1(0.82)
UU+UP+MH+NG+CT	1(0.82)
UU+UP+MG+MH+CT+TV	1(0.82)

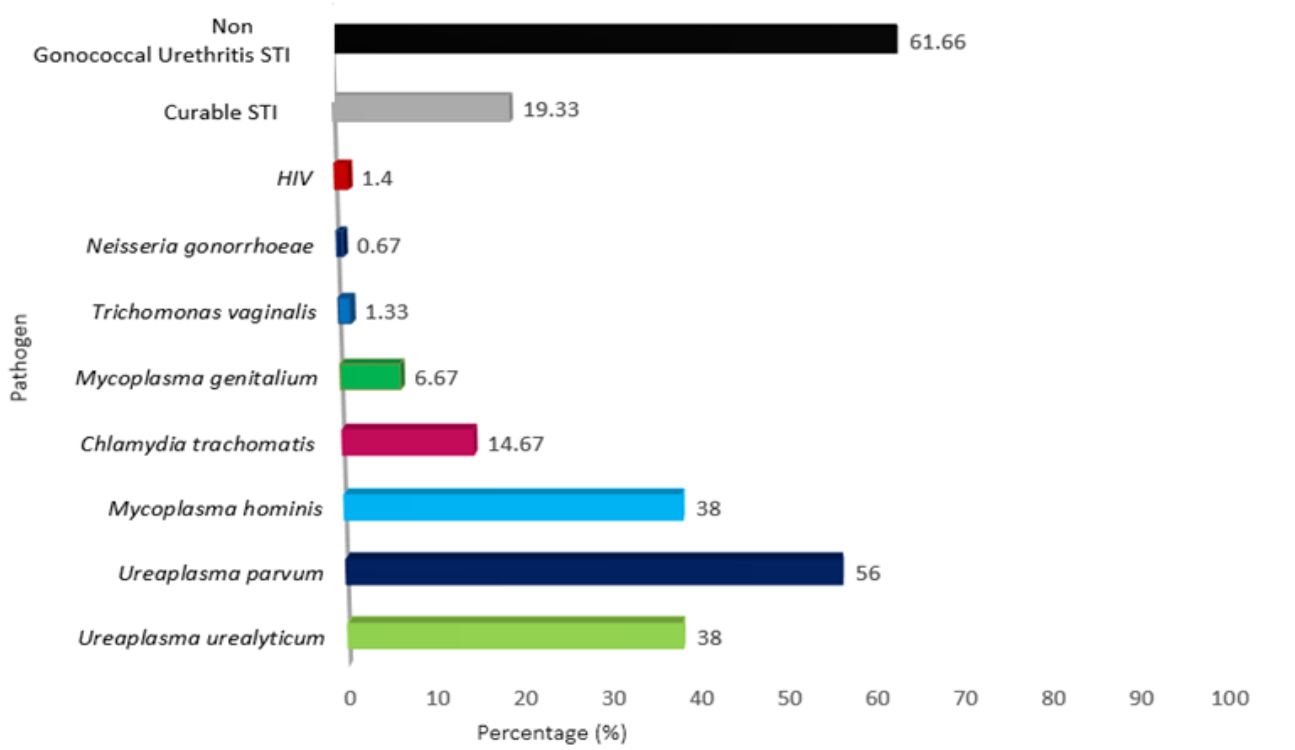
CT=Chlamydia trachomatis, NG=Neisseria gonorrhoeae, TV=Trichomonas vaginalis, MG=Mycoplasma genitalium, MH=Mycoplasma hominis,UU=Ureaplasma urealyticum, UP=Ureaplasma parvum

TABLE 4: Factors associated with sexually transmitted infections (CT, TV, NG and MG)

Variables	Total (n=150)	Total (n=150) Positive (n=29 (19.33%))	CRR (95% CI)	ARR (95%CI)	p-value
Age group					
18-19	38(25.33)	11(37.93)	Reference	Reference	0.076
20 -24	112(74.67)	18(62.07)	0.56(0.29 – 0.10)	0.52(0.26–1.07)	
Oral sex					
No	110(73.33)	26(89.66)	Reference	Reference	<0.0001
Yes	40(26.67)	3(10.34)	1.44(0.74 – 2.84)	4.86(1.91-10.67)	
Sex by the influence of alcohol					
No	143(95.33)	26(89.66)	Reference		
Yes	7(4.67)	3(10.34)	2.36(0.94– 5.93)		
Sex by force without willing					
No	110(73.33)	20(68.97)	Reference		
Yes	39(27.87)	9(31.03)	1.27(0.63 – 2.54)		
Use of condoms for the last 4 months					
Yes, I use	89(59.33)	20(68.97)	Reference	Reference	0.164
No, not used	61(40.63)	9(31.03)	1.52(0.74-3.12)	1.64(0.82-3.29)	

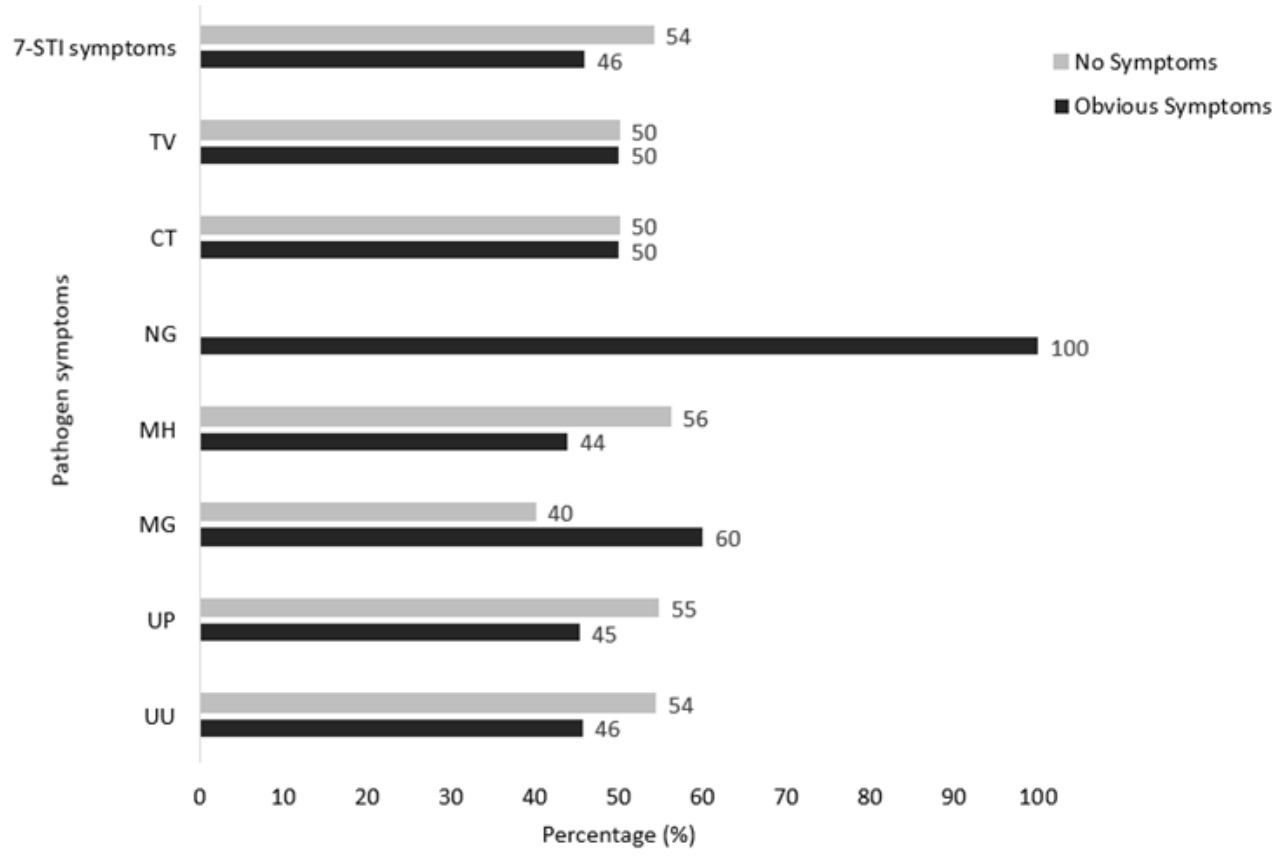
CI=Confidence Interval, CRR=Crude Risk Ratio, ARR=Adjusted Risk Ratio

FIGURE 1: Prevalence of STIs in Young Female Adults Students



The frequency of STIs was stratified by a single pathogen: Ureaplasma parvum 84(56%) followed by Ureaplasma urealyticum 57(38%), Mycoplasma hominis 57(38%), Chlamydia trachomatis 22 (14.67%), Mycoplasma genitalium 10(6.67%), Trichomonas vaginalis 2(1.33%) and Neisseria gonorrheae 1(0.67%).

FIGURE 2: Distribution of STIs From Symptomatic and Asymptomatic Young Female Adult Students



more than 54% of females who were diagnosed with STI pathogens had no obvious STI symptoms. Each pathogens for asymptomatic young adult females was UU 31(54.39%), UP 46(54.76%), MG 4(40.71%), MH 32(56.14%), CT 11(50%), TV 1(50%). In addition, the symptomatic participants with STIs were seen on NG 1(100%), TV 1(50%), CT 11(50%), UU 26(45.61%), UP 38(45.24%), MH 25(43.86%) and MG 6(60%).
Key: CT=Chlamydia trachomatis, NG=Neisseria gonorrhoeae, TV=Trichomonas vaginalis, MG=Mycoplasma genitalium, MH=Mycoplasma hominis,UU=Ureaplasma urealyticum, UP=Ureaplasma parvum

DISCUSSION

In this study, we evaluated the prevalence of STIs, using molecular tests, and associated factors among young adult female students aged 18-24 years enrolled in HLIs within Mbeya-Tanzania. In the studied population, we found the prevalence of STIs (CT, NG, MG, TV) to be as high as 19.33%, contrary to the previous study results [30,35], underscoring the fact that STIs in this population is a public health problem and the need for more awareness creation concerning these curable pathogens.

We observed an increased prevalence of CT 14.47%, MG 6.67% and lower cases of UP 56% in our study compared to other findings of CT 13.7%,12.7%+ MG 4.47% and UP 60.6% in Kenya, Tanzania and Brazil with similar populations respectively.[30,35] The increase in infection is not clear, although our study was made possible by utilizing a highly sensitive and specific Seegene real-time PCR test. In this context, the six sexually transmitted pathogens are predominantly detected using molecular assays, exceptionally conventional tests like Gram stain, culture, and wet preparation used for NG and TV detection which has low accuracy and efficiency.[2,3,9] This study gives evidence of the burden of STIs among young adult females attending HLI which are not routinely tested in resource-poor settings.[2,3,9] In addition, both MH and UU were present in 38% of the population associated with non-gonococcal urethritis compared to 46.2% in Chinese females,[5] however, a lower prevalence of these infections was reported before following an asymptomatic nature, particularly in LMIC.[1,40,41] More than half of the participants were diagnosed with any STIs despite showing no obvious symptoms, it became evident that the majority of these STIs were underreported when following a syndromic approach to diagnosis. Remarkably, multiple infections were commonly 59.0% in the young adult

females, of which CT regularly overlapped with UU, UP, MG, and MH which needs consideration during STI management. Despite the high prevalence of curable STIs as they have the same mode of transmission, a low proportion of HIV 1.4% was experiential in the study population. Our findings consolidate the argument of the extent of effectiveness of the syndromic approach for STI management in LMICs, especially in SSA.[1,40,41] At present, WHO recommends the use of point-of-care test for STIs which is either rapid or molecular, and that is cost-effective and affordable in LMICs like Tanzania.[2,42,43] Importantly, accurate detection and effective treatment are essential in reducing the transmission and impact of these infections for individuals affected by STIs.

So, the multivariable analysis of associated factors for STIs revealed that oral sex was statistically significantly associated with an increased risk of contracting STIs. Like the previous reports in Tanzania, Uganda, Kenya, and South Africa,[17,23-25,29] our report points out the impact of addressing age-related risk factors and sexual behaviours by promoting safe sexual practices and enhancing awareness of Sexual and Reproductive Health (SRH) prevention strategies regarding STI risk factors.

It is currently shown that participants exhibited poor knowledge of STIs, indicating a lack of awareness and understanding regarding these infections. The lack of SRH curriculum in HLIs and the 'vulnerable' college environment may play a causal role in this knowledge gap.[17,42] Thus, a SRH curriculum and continuous educational programs which include comprehensive information on STIs and sexual health to increase awareness and knowledge should be offered to students.[17,42,43] Addressing the vulnerable environment, by promoting safe sexual practices and access to healthcare, is crucial to reducing STI transmission,[42,43] as well as instilling a culture of and improving health-seeking behaviour is essential to encourage individuals to seek timely testing, diagnosis, and treatment for STIs.[17,42,43] Open discussions with parents about sexual health can play a vital role in educating adolescents, fostering a supportive environment, and breaking down taboos surrounding important and needed sexual health conversations.[17,42,43] Parent-child communication is key in refining awareness and education to address the noteworthy burden of STIs.

Similar to other reported research findings, [16,30,40,41,48] our study revealed that multiple infections were quite common, occurring in more than half (59%) of the participants. These multiple infections involved various pathogens, including CT, UU, UP, MH and MG; and specifically, CT infection that was often found to occur with UU, UP, MG, and MH infections. This suggests that young adult females are at an increased risk of experiencing multiple infections, with CT frequently occurring as a causative agent of STIs or potential urinary tract infections.[41,44] A high number of STI cases were reported previously from Tanzania (12.7%), Uganda (4.5%) and Kenya (13.42%), especially CT, which is not routinely screened in the East African regional setting.[16,30,40,41,48] Multiple infections can lead to more complex health challenges and may significantly impact overall sexual health and well-being.[41,44,46–48]

In the recent studies conducted in Indonesian and Mongolian women, reports have shown that genital Mycoplasma and Ureaplasmas are commonly found in the urogenital tracts of healthy females, sometimes not as genitourinary commensals in asymptomatic, and symptomatic both men and women.[41,46–48] It has also been suggested that Ureaplasma species bring about a more severe inflammatory response than other microbial infections.[12,29] Literature illustrates that after puberty, colonization of Ureaplasma species occurs through sexual contact; and can be detected in gravid women in similar proportions as in non-pregnant and immunocompromised individuals with the same degree of sexual activity, although more research is needed to report the existence of ancient evolution to these pathogens.[11,44,47] Young females must be aware of such risks and seek appropriate testing and medical care to address and manage multiple infections effectively. Early diagnosis with a reliable test and proper treatment can play a crucial role in reducing the burden of infection and promoting better sexual health.

In our study, more than half of the participants who were diagnosed with STIs did not exhibit obvious symptoms. Other studies have reported similar prevalence patterns of STIs among young girls aged 15-24 years who were sexually active, with no obvious symptoms.[16,30,40,41,46–48] and the proportion of those with STIs was higher among this vulnerable group.[1,11,40,46,47] and poor reproductive and sexual health. Such finding highlights the significance of asymptomatic or "silent" STIs, where the infected individuals may not experience noticeable signs or symptoms, may be misdiagnosed and not be properly treated based on the infecting pathogen.[18,19] As a result, these individuals may unknowingly transmit the infection to their sexual partners, contributing to the spread of STIs, and increasing the likelihood of getting HIV within the population[18,19]. Generally, the recurrence or persistence of most STIs can cause complications and sequelae including infertility, salpingitis, ectopic pregnancy, spontaneous abortion, premature birth, postpartum infection, neonatal and infant infection, as well as anogenital cancers among females.[19,42,44]

In the analysis for factors associated with STIs, an increase in age, specifically between 20-24 years old, was associated with a low likelihood of contracting STIs compared to the younger females. This finding suggests that age is a key factor in understanding the risk of STIs. Young females who reported practising oral sex were associated with an increased risk of getting STIs. This is similar to previous studies that assessed the risk of contracting an STI among University students in SSA.[25,29] Noted that the majority of students believed to be at low or no risk of STIs, however, after assessing their sexual behaviour practices, they were found to have considerable risk.[25,29] Our findings highlight the importance of focusing on age-related risk factors and sexual behaviours, having tailor-made programs for promoting safe sexual practices and raising awareness about STI risk factors to significantly reduce STI cases in the population.

The strength of this study was from analysis of STIs, using biological markers to ascertain sexual behaviour coupled with self-report. Sample analysis allowed participants diagnosed with any STI, regardless of reporting to have engaged in sex or not, to determine individuals with

at-risk sexual behaviours of being infected with STIs. During the study, the RT-PCR system was validated for its performance, of which the accuracy of the Seegene assay was 100% following the WHO proficiency panel report. As one of the study's limitations, only females were enrolled in the study and hence, the findings may not allow for an extrapolation among male counterparts.

Overall, the results of this study have shown the need for heightened concern regarding STIs among young adult females in limited resource settings. The use of molecular assays for STI diagnosis has proven beneficial, as it can detect pathogens not routinely tested in health facilities and identify asymptomatic infected individuals. The findings emphasize the paramount necessity for health promotion and the implementation of effective STI education and prevention intervention strategies, particularly among young females in HLIs. By increasing awareness and knowledge about STIs, these initiatives can contribute to improved STI diagnosis, management, and prevention.

REFERENCES

1. Francis SC, Mthiyane TN, Baisley K, Mchunu SL, Ferguson JB, Smit T, et al. Prevalence of sexually transmitted infections among young people in South Africa: A nested survey in a health and demographic surveillance site. PLoS Med. 2018;15(2). e1002512. doi: 10.1371/journal.pmed.1002512.
2. WHO STI fact sheet 2022. Sexually transmitted infections (STIs) [web-based]. [accessed on 2022 Jun 28]. Available from: https://www.who.int/news-room/fact-sheets/detail/sexually-transmitted-infections-(STIs)
3. UNAIDS. Epidemiological fact sheet 2004 [web-based]. [accessed on 2022 Jun 28]. Available from: https://data.unaids.org/publications/fact-sheets01/tanzania_en.pdf
4. Shipitsyna E, Khusnutdinova T, Budilovskaya O, Shedko E, Goloveshkina E, Khayrullina G, et al. Performance of the first commercial dual resistance assay, AmpliSens Mycoplasma genitalium -ML/FQ-Resist-FL, for detection of potential macrolide and quinolone resistance-associated mutations and prevalence of M. genitalium resistance mutations in St. Petersburg, Russia. Sex Transm Infect [web-based. 2022 Jun 16 [accessed on 2022 Jun 28];sextrans-2021-055249. Available from: https://sti.bmj.com/lookup/doi/10.1136/sextrans-2021-055249
5. Obasi AI, Balira R, Todd J, Ross DA, Changalucha J, Mosha F, et al. Prevalence of HIV and Chlamydia trachomatis infection in 15–19-year olds in rural Tanzania. Trop Med Int Health. 2001;6(7):517–25. doi: 10.1046/j.1365-3156.2001.00738.x.
6. Unemo M, Lahra MM, Escher M, Eremin S, Cole MJ, Galarza P, et al. WHO Global Antimicrobial resistance surveillance for Neisseria gonorrhoeae 2017–18: a retrospective observational study. The Lancet Microbe. 2021;2(11):e627–36. doi: 10.1016/S2666-5247(21)00171-3.
7. Yamazaki T, Matsumoto M, Matsuo J, Abe K, Minami K, Yamaguchi H. Frequency of Chlamydia trachomatis in Ureaplasma-positive healthy women attending their first prenatal visit in a community hospital in Sapporo, Japan. BMC Infect Dis [Internet]. 2012;12(1):82. Available from: http://www.biomedcentral.com/1471-2334/12/82
8. Online First | Sexually Transmitted Infections [Web-based]. [accessed on 2022 Jun 28]. Available from: https://sti.bmj.com/content/early/recent
9. The Response to STIs in Tanzania - The Borgen Project [Web-based]. [accessed on 2022 Jun 28]. Available from: https://borgenproject.org/stis-in-tanzania/
10. Detels R, Green AM, Klausner JD, Katzenstein D, Gaydos C, Handsfield HH, et al. The incidence and correlates of symptomatic and asymptomatic Chlamydia trachomatis and Neisseria gonorrhoeae infections in selected populations in five countries. Sex Transm Dis. 2011;38(6):503–9.
11. Leli C, Mencacci A, Latino MA, Clerici P, Rassu M, Perito S, et al. Prevalence of cervical colonization by Ureaplasma parvum, Ureaplasma urealyticum, Mycoplasma hominis and Mycoplasma genitalium in childbearing age women by a commercially available multiplex real-time PCR: An Italian observational multicentre study. J Microbiol Immunol Infect. 2018;51(2):220–5. doi: 10.1016/j.jmii.2017.05.004.
12. National Guidelines for Management of Sexually Transmitted and Reproductive Tract Infections – NACP-National AIDS Control Programme [Web-based]. [Accessed on 2023 May 15]. Available from: https://nacp.go.tz/download/national-guidelines-for-management-of-sexually-transmitted-and-reproductive-tract-infections/
13. Evers YJ, op den Camp KPL, Lenaers M, Dukers-Muijrers NHTM, Hoebe CJPA. Alcohol and drug use during sex and its association with sexually transmitted infections: a retrospective cohort study among young people aged under 25 years visiting Dutch STI clinics. Sex Transm Infect. 2023;99(2):97-103. doi: 10.1136/sextrans-2021-055355.
14. Clarke E, Horner PJ, Muir P, Turner KME, Harding-Esch EM. Assessment of online self-testing and self-sampling service providers for sexually transmitted infections against national standards in the UK in 2020. Sex Transm Infect. 2023;99(1):14-20. doi: 10.1136/sextrans-2021-055318.
15. Louis Kobina Dadzie, Ebenezer Agbaglo, Joshua Okyere, Richard Gyan Aboagye, Francis Arthur-Holmes, Abdul-Aziz Seidu, Bright Opoku Ahinkorah, Self-reported sexually transmitted infections among adolescent girls and young women in sub-Saharan Africa, International Health, Volume 14, Issue 6, November 2022, Pages 545–553, https://doi.org/10.1093/inthealth/ihab088
16. Abdul R, Gerritsen AAM, Mwangome M, Geubbels E. Prevalence of self-reported symptoms of sexually transmitted infections, knowledge and sexual behaviour among youth in semi-rural Tanzania in the period of adolescent-friendly health services strategy implementation. BMC Infect Dis [Internet]. 2018 May 19 [cited 2022 Jun 28];18(1):1–10. Available from: https://bmcinfectdis.biomedcentral.com/articles/10.1186/s12879-018-3138-1
17. The United Republic of Tanzania National Guidelines For Management of Sexually Transmitted and Reproductive Tract Infections. 2007[Web-based]. [accessed on 2023 May 15]. Available from: https://www.jica.go.jp/Resource/project/tanzania/001/materials/pdf/sti_01.pdf
18. Stephanie J Migchelsen, Qudsia Enayat, Ana Karina

Harb, Ubah Daahir, Lucinda Slater, Anja Anderson, Alireza Talebi, Jon Dunn, Erna Buitendam, Deborah Shaw, Norah O'Brien, Marta Checchi, Helen Fifer, John Saunders, Kate Soldan, Kate Folkard, Katy Sinka, Hamish Mohammed and contributors. Sexually transmitted infections and screening for chlamydia in England, June 2023, UK Health Security Agency, London; Available from https://www.gov.uk/government/statistics/sexually-transmitted-infections-stis-annual-data-tables/sexually-transmitted-infections-and-screening-for-chlamydia-in-england-2022-report. Accessed 11 October 2023

19. Wand H, Reddy T, Dassaye R, Moodley J, Naidoo S, Ramjee G. Estimating prevalence and incidence of sexually transmitted infections among South African women: Implications of combined impacts of risk factors. Int J STD AIDS. 2020;31(11):1093–101. doi: 10.1177/0956462420915388

20. Mwamba, B., Mayers, P. & Shea, J. Sexual and reproductive health knowledge of postgraduate students at the University of Cape Town, in South Africa. Reprod Health 19, 225 (2022). https://doi.org/10.1186/s12978-022-01507-6; Accessed 11 October 2023

21. Leigh, B. C., & Stall, R. (1993). Substance use and risky sexual behaviour for exposure to HIV. Issues in methodology, interpretation, and prevention. The American psychologist, 48(10), 1035–1045. https://doi.org/10.1037//0003-066x.48.10.1035

22. Kimiywe J, Callistus KP., Waudo JN, Mwanzo I, Orinda G. HIV & AIDS Baseline Sero-Behavioural Study in Six Universities in Kenya. 2014 Nov 25 [cited 2023 Apr 19]; Available from: https://ir-library.ku.ac.ke/handle/123456789/11741

23. Masanja, V., Wafula, S.T., Ssekamatte, T. et al. Trends and correlates of sexually transmitted infections among sexually active Ugandan female youths: evidence from three demographic and health surveys, 2006–2016. BMC Infect Dis 21, 59 (2021). https://doi.org/10.1186/s12879-020-05732-x; Accessed 11 October 2023

24. Masese LN, Wanje G, Kabare E, Budambula V, Mutuku F, Omoni G, et al. Screening for Sexually Transmitted Infections in Adolescent Girls and Young Women in Mombasa, Kenya: Feasibility, Prevalence, and Correlates. Sex Transm Dis [Internet]. 2017 Dec 1 [cited 2023 Apr 3];44(12):725–31; Available from: https://journals.lww.com/stdjournal/Fulltext/2017/12000/Screening_for_Sexually_Transmitted_Infections_in.3.aspx

25. Ranganathan, M., MacPhail, C., Pettifor, A. et al. Young women's perceptions of transactional sex and sexual agency: a qualitative study in the context of rural South Africa. BMC Public Health 17, 666 (2017). https://doi.org/10.1186/s12889-017-4636-6, Accessed 11 October 2023

26. Othieno CJ, Okoth R, Peltzer K, Pengpid S, Malla LO. Risky HIV sexual behaviour and depression among University of Nairobi students. Ann Gen Psychiatry [Internet]. 2015 Apr 11 [cited 2023 Apr 18];14(1):1–8. Available from: https://annals-general-psychiatry.biomedcentral.com/articles/10.1186/s12991-015-0054-2

27. Jenyo TO, Ojiezeh IT. Medicine and Nursing www.iiste.org ISSN. An Int Peer-reviewed J [Internet]. 2016 [cited 2023 Apr 18];29. Available from: www.iiste.org

28. Osberg TM, Insana M, Eggert M, Billingsley K. Incremental validity of college alcohol beliefs in the prediction of freshman drinking and its consequences: a prospective study. Addict Behav. 2011;36(4):333-340. doi:10.1016/j.addbeh.2010.12.00

29. Muche, A.A., Kassa, G.M., Berhe, A.K. et al. Prevalence and determinants of risky sexual practice in Ethiopia: Systematic review and Meta-analysis. Reprod Health 14, 113 (2017). https://doi.org/10.1186/s12978-017-0376-4

30. High prevalence of sexually transmitted infections in patients attending STI clinics in Tanzania [Internet]. [cited 2022 Jun 28]. Available from: https://www.walshmedicalmedia.com/proceedings/high-prevalence-of-sexually-transmitted-infections-in-patients-attending-sti-clinics-in-tanzania-39551.html

31. Ghebremichael M, Larsen U, Paintsil E. Association of age at first sex with HIV-1, HSV-2, and other sexually transmitted infections among women in northern Tanzania. Sex Transm Dis. 2009;36(9):570–6

32. Mcharo RD, Kisinda A, Njovu L, Mcharo M, Mbwilo F, Mihale G, et al. Prevalence of and risk factors associated with HIV, Herpes Simplex Virus-type 2, Chlamydia trachomatis and Neisseria gonorrhoeae infections among 18–24 year old students attending Higher Learning Institutions in Mbeya-Tanzania. PLoS One [Internet]. 2022 May 1 [cited 2023 Apr 27];17(5). Available from: /PMC/articles/PMC9135268/

33. The United Republic of Tanzania. National AIDS Control Programme National Guidelines For The Management of HIV and AIDS. 2015 [web-based]. [accessed on 2023 Apr Available from: https://differentiatedservicedelivery.org/wp-content/uploads/national_guidelines_for_the_management_of_hiv_and_aids_2019.pdf

34. Pourhoseingholi, M. A., Vahedi, M., & Rahimzadeh, M. (2013). Sample size calculation in medical studies. Gastroenterology and hepatology from bed to bench, 6(1), 14–1735.

35. Maina AN, Kimani J, Anzala O. Prevalence and risk factors of three curable sexually transmitted infections among women in Nairobi, Kenya. BMC Res Notes. 2016;9(1):1–5.

36. Lee J. Odds ratio or relative risk for cross-sectional data? [Internet]. Int J Epidemiol. 1994 Feb;23(1):201–3.

37. Axelson O, Fredriksson M, Ekberg K. Use of the prevalence ratio v the prevalence odds ratio as a measure of risk in cross-sectional studies [Internet]. Occup Env Med. 1994;51(8):574.

38. Barros AJD, Hirakata VN. Alternatives for logistic regression in cross-sectional studies: An empirical comparison of models that directly estimate the prevalence ratio. BMC Med Res Methodol. 2003 Oct;3(1):1–13.

39. Gnardellis C, Notara V, Papadakaki M, Gialamas V, Chliaoutakis J. Overestimation of Relative Risk and Prevalence Ratio: Misuse of Logistic Modeling. Diagnostics 2022, Vol 12, Page 2851 [Internet]. 2022 Nov 17 [cited 2023 May 15];12(11):2851. Available from: https://

www.mdpi.com/2075-4418/12/11/2851/htm

40. Vasudeva, M., Nakka, R., Stock, S., & Ghebremichael, M. Associations between Awareness of Sexually Transmitted Infections (STIs) and Prevalence of STIs among Sub-Saharan African Men and Women. Tropical Medicine and Infectious Disease, 7(8), 147. https://doi.org/10.3390/tropicalmed7080147

41. Yuh, T., Micheni, M., Selke, S., Oluoch, L., Kiptinness, C., Magaret, A., Chohan, B., Ngure, K., Wald, A., Mugo, N. R., & Roxby, A. C. (2020). Sexually Transmitted Infections Among Kenyan Adolescent Girls and Young Women With Limited Sexual Experience… Frontiers in public health, 8, 303. https://doi.org/10.3389/fpubh.2020.00303

42. World Health Organization., Guidelines For Treatment and Management of Sexually Transmitted Infections. Available from: http://www.who.int/HIV_AIDS/ Accessed: 2023-10-11

43. Global Health Sector Strategy on Sexually Transmitted Infections 2016-2021 Towards Ending STIS. 2016;Available from https://www.who.int/publications/i/item/WHO-RHR-16.09,Accessed: 2023-10-11

44. de Sanjose S, Quint WGV, Alemany L, Geraets DT, Klaustermeier JE, Lloveras B, et al. Human papillomavirus genotype attribution in invasive cervical cancer: a retrospective cross-sectional worldwide study. Lancet Oncol [Internet]. 2010 Nov [cited 2021 Apr 19];11(11):1048–56. Available from: https://pubmed.ncbi.nlm.nih.gov/20952254/

45. Otgonjargala B, Becker K, Batbaatar G, Sandag T, Enkhtsetseg J, Enkhjargal A, et al. Effect of Mycoplasma hominis and cytomegalovirus infection on pregnancy outcome: A prospective study of 200 Mongolian women and their newborns. PLoS One. 2017 Mar 1;12(3).

46. Feriyawati L, Anggraini DR, Nasution TA. Co-infection of human papillomavirus with mycoplasma hominis/ureaplasma urealyticum among female sex workers in Medan, Indonesia. Open Access Maced J Med Sci. 2019;7(20):3425–8.

47. Tjoa E, Joon S, Moehario LH. Diagnostic parameters of the AF Genital System for detection of Mycoplasma hominis and Ureaplasma urealyticum. J Int Med Res. 2021 Oct;49(10);doi: 10.1177/03000605211053278.

48. WHO Report 2021. Sexually transmitted infections (STI) https://www.who.int/news-room/fact-sheets/detail/sexually-transmitted-infections-(stis) Accessed: 2023-10-11

49. Nowak RG, Schumaker LM, Ambulos NP, Ndembi N, Dauda W, Nnaji CH, et al. Multiple HPV infections among men who have sex with men engaged in anal cancer screening in Abuja, Nigeria. Papillomavirus Res. doi: 10.1016/j.pvr.2020.100200

50. Zhu, C., Liu, J., Ling, Y., Dong, C., Wu, T., Yu, X., Hou, Y., Dong, L., & Cheng, X. (2012). Prevalence and antimicrobial susceptibility of Ureaplasma urealyticum and Mycoplasma hominis in Chinese women with genital infectious diseases. Indian journal of dermatology, venereology and leprology, 78(3), 406–407. https://doi.org/10.4103/0378-6323.95480

51. LOBÃO, T., CAMPOS, G., SELIS, N., AMORIM, A., SOUZA, S., MAFRA, S. TIMENETSKY, J. (2017). Ureaplasma urealyticum and U. parvum in sexually active women attending public health clinics in Brazil. Epidemiology & Infection, 145(11), 2341-2351. doi:10.1017/S0950268817001145

Peer Reviewed

Acknowledgments: Special thanks to Mr. Joseph Mkanyia for his support on finance matters during the whole study period. Along with a generous support from Ms. Matilda Paul, Mr. Jerry Kapungu, Ms. Clara Geofrey and Mr. Fadhili Mwakyusa for participant recruitment in Mbeya. Lastly, I appreciate all higher learning institutions for agreeing to participate and participants who consented for sample collection.

Competing Interests: None declared.

Funding: This study received funding from the NIMR-MMRC Seed Grant (2019) and support from the 2H3 funded by the DFG (grant award Project ID: 308-11).

Received: 21 Nov 2022**; Accepted:** 13 February 2024

Cite this article as Mahenge A, Mwalongo W, Mnkai J, Komba B, Mgaya R, Olomi W, Geldmacher C, Mcharo RD. Prevalence of Sexually Transmitted Infections and Associated Factors Among Young Adult Female Students at Higher Learning Institutions in Mbeya, Tanzania: A Cross-Sectional Study. East Afr Science J. 2024: 6(1): 38-47. https://doi.org/10.24248/easci.v6i1.91