# Original Article

# Prevalence, Antimicrobial Susceptibility Patterns and Associated Factors of *Neisseria gonorrhoeae* among Women Attending Health Institutions in Debre Markos Town, Northwest Ethiopia

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**Abstract**

**Background:** *Neisseria gonorrhoeae* is the causative agent of gonorrhea and accounts for the majority of sexually transmitted infections globally. There are few studies on the prevalence and antimicrobial susceptibility patterns of *N. gonorrhoeae* in Ethiopia.

**Objective:** This study aimed to assess the prevalence, antimicrobial susceptibility patterns, and associated factors of *N. gonorrhoeae*.

**Method:** A cross-sectional study was conducted among women attending Debre Markos town health institutions; in Northwest Ethiopia from June 1, 2022 to October 30, 2022. An endocervical swab was collected and cultured on Modified Thayer Martin medium. Antimicrobial susceptibility testing was performed using the modified Kirby-Bauer disk diffusion technique for isolates, following Clinical and laboratory standards institute guidelines. Logistic regression was applied to show the relationship between dependent and independent variables. *P*-value $\leq$ 0.05 with 95%CI was considered statistically significant.

**Results:** A total of 384 women were recruited and tested for *N. gonorrhoeae* in this study. The prevalence of *N. gonorrhoeae* was found to be 29 out of 384 (7.60%). Rural residency (AOR: 2.95; 95%CI: 1.11-7.75), multiple sexual partners (AOR: 2.68; 95%CI: 1.17- 6.11), and HIV sero-positivity (AOR: 3.40; 95%CI: 1.4-8.26) were significantly associated with *N. gonorrhoeae infection*. The antimicrobial susceptibility of *N. gonorrhoeae* was 93.10% to ceftriaxone, 55.2% to ciprofloxacin, and 0% to tetracycline and penicillin. Multidrug resistance (MDR) was detected in 19 out of 29 (65.40%) of *N. gonorrhoeae* isolates.

**Conclusion:** The prevalence of *N. gonorrhoeae* and multi-drug resistance is higher in the study area. *N. gonorrhoeae* is significantly associated with patients living in rural areas, having multiple sexual partners, and being HIV positive. The high prevalence of *N. gonorrhoeae* infection highlights the need for regular screening and treatment of women of reproductive age and their partners. [*Ethiop. J. Health Dev.* 2025; 39(1)]

**Keywords:** Antimicrobial susceptibility pattern, *Neisseria gonorrhoeae*, prevalence

## Introduction

*Neisseria gonorrhoeae* (also known as gonococcus) causes gonorrhea. It is a Gram-negative bacterium that is the second most common cause of sexually transmitted diseases (STD) and accounts for the majority of sexually related illnesses, making it a major public health concern worldwide (1, 2). Gonorrhea is transmitted through sexual contact with an infected partner's penis, vagina, mouth, or anus, and kissing or saliva exchange during sexual activity. The mucous membranes of the reproductive system, including the cervix, uterus, and fallopian tubes in women, and the urethra in both women and men, are infected by *N. gonorrhoeae.* It can also infect the mouth, throat, eyes, and rectum mucous membranes (3, 4). Gonorrhea increases a person's chances of acquiring or transmitting the human immunodeficiency virus (HIV), the virus, causing acquired immunodeficiency syndrome (AIDS). In a pregnant woman, with gonorrhea, the infection could spread to her baby when it goes through the birth canal during delivery. This can result in blindness, joint infection, or a life-threatening blood infection (3, 5).

In 2008, the World Health Organization (WHO) estimated that approximately 106.1 million new cases of gonococcal infections occurred globally, and about 21.1 million in Africa, making it the second most common sexually transmitted bacterial infection worldwide Moreover, the global prevalence of *N. gonorrhoeae* in adults between the age d 15 and 49 years was estimated to be 36.4 million (6). The pooled prevalence of *N. gonorrhoeae* infection among reproductive-aged women in sub-Saharan Africa was 3.28% (7).

In 2005, the Ministry of Health's Integrated Disease Surveillance Team of Ethiopia revealed that STI cases particularly gonorrhea were underreported in the country. Some healthcare organizations claim to employ a syndromic approach, while others report using an etiologic approach (8, 9). The emergence of antibiotic resistance in the management of infectious diseases is a serious public health issue. The resistance of *N. gonorrhoeae* to antimicrobials was discovered in the mid-1930s when sulfonamides were introduced (10). Subsequently, the introduction of penicillin, tetracycline, fluoroquinolones, macrolides, and early-generation cephalosporins as empirical antimicrobials

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mono-therapy proved very effective until recent strains resistance emerged and gradually reduced susceptibility of *N. gonorrhoeae* to these antimicrobials (11, 12). Sexual behaviors and sex practices are proximate causes of STI acquisition and transmission. Several other individual-level behaviors are risks for the acquisition and transmission of *N. gonorrhoeae* (13, 14).

Currently, there is no surveillance report or data available in Ethiopia estimating the prevalence and antimicrobial susceptibility patterns of *N. gonorrhoeae, as* most health organizations use a syndromic approach for reporting. Therefore, this study aimed to determine the prevalence, current antimicrobial resistance patterns, and risk factors associated with *N. gonorrhoeae* at health institutions in Debre Markos town , Northwest Ethiopia.

## Materials and methods

### Study area, design, and period

An institutional-based cross-sectional study was conducted among symptomatic women with sexually transmitted infections attending Debre Markos town health institutions, in Northwest Ethiopia. Debre Markos town is the capital town of the East Gojjam zone, located 300 km Northwest of Addis Ababa and 255 Km from Bahir Dar, the capital city of Amhara regional state. It is located at an altitude of 2411m above sea level. There are Five governmental health institutions, seven private health institutions, and two non-governmental health institutionsfound in Debre Markos town. All these health institutions give reproductive health services and the two non-governmental health institutions additionally give youth-friendly and family health services. This study was conducted from June 1, 2022 to October 30, 2022.

### Study population

The study population consisted of all women aged 15 to49 years attending selected health institutions in Debre Markos Town during the study period.

### Eligibility criteria

All women aged 15–49 who attended selected health Debre Markos town-selected health institutions with sexually transmitted infection were eligible for the study. women who took antibiotics in the last two weeks and were unable to respond due to severely complicated diseases were excluded.

### Sample size determination

The sample size was calculated based on single population proportion estimation. The assumption to estimate the proportion (P) of women who were infected by *N. gonorrhoeae* is 50% because there is no prior study on similar study populations. Considering a 95% confidence interval, and a 5% margin of error, the sample size was calculated using the formula

$$N = \frac{\left(\frac{Z\alpha}{2}\right)^2 * p(1-P)}{d^2} = \frac{(1.96)^2 * 0.5(1-0.5)}{(0.05)^2} = 384$$

Where, n= sample size, α= level of significance, z= at 95% confidence interval Z value (α= 0.05), Zα/2 = 1.96, p= proportion 50% (0.5), d= margin of error at 5% (0.05). Therefore, a total of 384 study participants were enrolled in this study.

### Sampling technique

One governmental hospital was purposively included; while one governmental health center, one private health institution, and one non-governmental health institution were selected by a simple random sampling technique. The proportional allocation method was applied to determine the total number of women to be included in this study. The calculated sample size was proportionally allocated to the selected institutions (**Figure 1**). A convenience sampling technique was employed to enroll study participants who met the inclusion criteria.

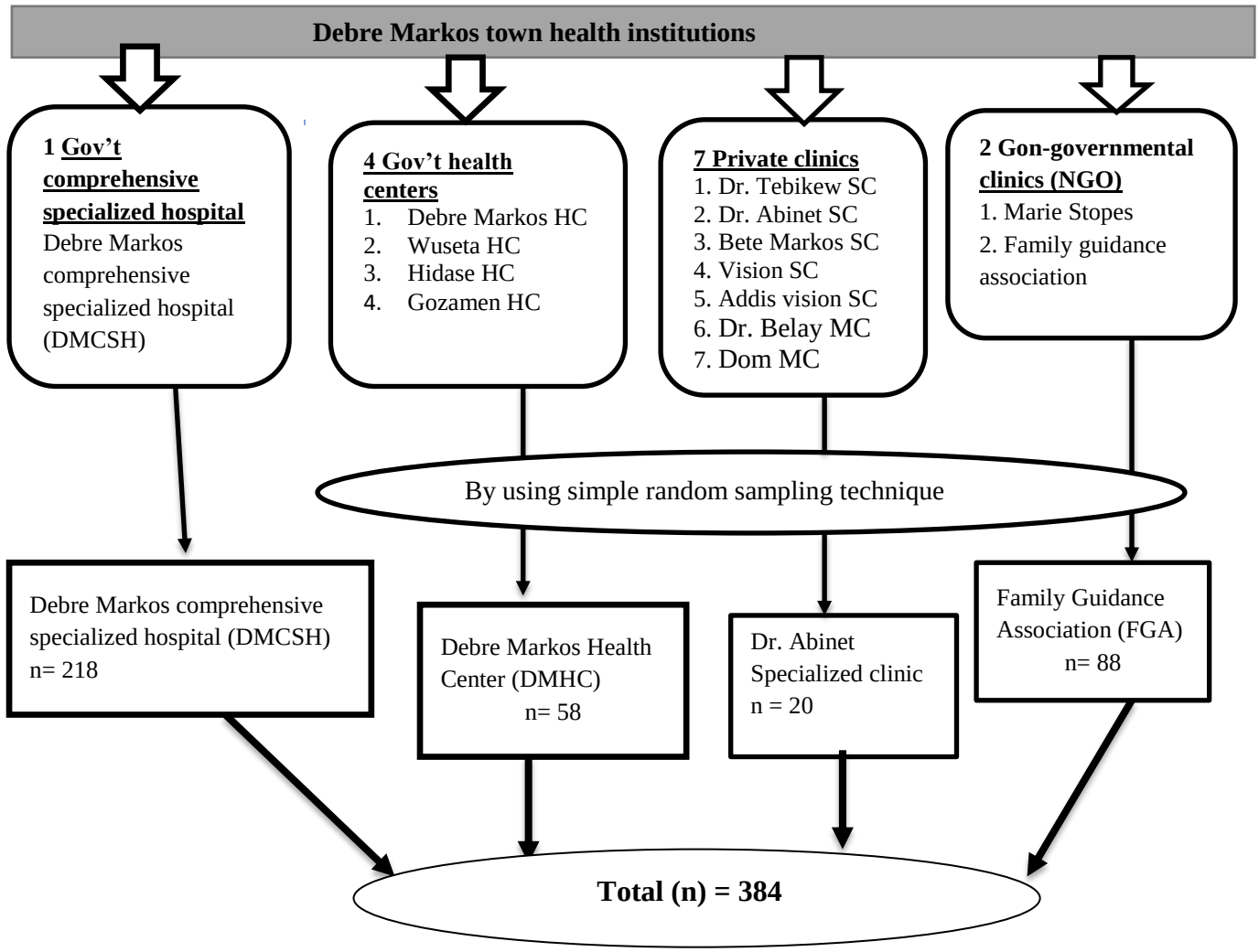


**Figure 1:** Sampling technique to select study participants from Debre Markos Health Institutions, 2022

**Socio-demographic and clinical data collection**

A predesigned and semi-structured questionnaire was used to collection of data on the socio-demographic (age, sex, residence, income, and education level) and behavioral and clinical characteristics (condom usage, having multiple sexual partners, substance use, HIV serostatus, history of forced sexual activities and sharing bath towels) of the participants. Trained professional nurses and midwives participated in collecting data from participants via face-to-face interviews.

**Laboratory data collection and processing**

Endocervical swabs were collected before antibiotic therapy after washing the vaginal area with saline. A sterilized vaginal speculum was used to obtain swabs from the endocervical canal. Two endocervical swabs were taken by a nurse or midwife using standard procedures and transported to the laboratory using Amies transport media. One swab was immediately streaked onto modified Thayer Martin media (MTM) (Thermo scientific ™, UK), while the second swab was used for a Gram stain smear.

**Isolation and identification of *Neisseria gonorrhoeae***

The isolation and identification of *N. gonorrhoeae* isolates were accomplished using the standard microbiological techniques which involved assessing colony growth characteristics, Gram staining, and biochemical tests like oxidase and glucose fermentation tests. The MTM media was incubated at 37°C in a candle jar overnight, and with ad 72 hour observation period to check for growth. *Gonococci* on MTM media form smooth, round grey/brown colonies. Growth colonies were further identified by morphology on gram stain and biochemical tests. The organism which is Gram-negative diplococci on Gram stain, oxidase-positive, and ferment glucose however, does not ferment the carbohydrate lactose, sucrose, and maltose (15).

**Antimicrobial susceptibility testing**

Antimicrobial susceptibility testing was carried out by the disk diffusion method on modified Muller Hinton agar (MHA) (Oxoid; Hampshire UK) for the following drugs (Oxoid Ltd; Cambridge, UK):- penicillin (P, 10IU), azithromycin (AZI, 15µg), cefotaxime (CTX, 30µg), tetracycline (TE, 30µg), ciprofloxacin (CIP,

5µg), ceftriaxone (CRO, 30µg), cefixime (CFM, 5µg, cefoxitin (FOX, 30µg), cefpodoxime (CPD, 10µg) and spectinomycin (SPT, 100µg) according to CLSI guideline (16). All antimicrobial agents were also selected based on their availability and Ethiopian Federal Minster of Health treatment guidelines. Gonococcal isolates were sub-cultured on chocolate agar to obtain a pure culture of the isolates. A pure culture of 3-5 selected colonies of bacteria was transferred to a tube with a straight wire and prepared a suspension in 2.5ml normal saline and incubated at 37$^{o}$C until the turbidity of the suspension became adjusted to a McFarland 0.5. A sterile swab was used to inoculate the bacteria evenly over the entire surface of MHA with a selective supplement and incubated for 24 hours. Then the zone of inhibition was measured and interpreted based on CLSI guidelines (16). A quality control test was done for Modified TMA and Modified MHA before each step-in laboratory test using *N. gonorrhoeae* ATCC® 49226 strains. Multidrug resistance is defined as simultaneous resistance to three or more antimicrobial agents from different groups of antibiotics (17).

**Data analysis and interpretation**

Data were cleaned, coded, and entered to Epi Data version 4.6 , then exported to SPSS software version 25 for analysis. Logistic regression models were used to examine any associations between independent variables and the dependent variable. A variable with a *p*-value $\leq$ 0.25 in the bivariable logistic regression was included in the multivariable logistic regression analysis to identify variables that were independently associated with the outcome variable. The presence and strength of association between independent variables and the outcome variables were computed using adjusted odds ratios with 95% confidence intervals (CI) and the Hosmer–Lemeshow test to assess model's fit. When the Hosmer and Lemeshow values are greater than 0.05, the null hypothesis cannot be rejected, implying that the model's estimates fit the data at an acceptable level. A *p*-value of $\leq$ 0.05 was considered indicative of a statistically significant association between the predictors and the outcome variable.

**Ethical considerations**

Ethical clearance was obtained from the Institutional Research Ethics Review Committee (IRERC) of the College of Health Sciences, Debre Markos University (HSC/R/C/SeR/PG/Co/193/11/14). A support letter was provided to the selected health institutions and written permission was obtained from these health institutions. The purpose of the study was explained to the participants and the information collected through the research process was told to participants to be kept confidential. Current and future medical services would not be affected if they refused to participate or withdraw from the study. Participants/guardians are assured by signing the consent to participate in this study. Then, written informed consent was obtained from each study participant. Similarly, written informed assent was also taken from parents or legal guardians for participants below 18 years old. All results were stored securely to maintain confidentiality. The results of each participant were communicated to clinicians for appropriate treatment and management.

**Results**

**Socio-demographic characteristics of the study participant**

A total of 384 women participated in this study and were tested for *N. gonorrhoeae*. The mean age was 30, ranging from 15 to 49 years. Regarding age nearly half of the participants, 191 of384 (49.10%), were in the 25–34 age group. The majority of women 245 out of 384 (63.80%), were married and a similar , majority resided in an urban setting, 299 out of 384 (77.70%) (**Table 1**).

**Table 1**: The socio-demographic characteristics of women attending Debre Markos town health institutions, Northwest Ethiopia, 2022

| Variable | Category | Frequency | Percent (%) |
|---|---|---|---|
| **Age** | 15 – 24 | 85 | 22.1 |
| | 25 – 34 | 191 | 49.1 |
| | ≥35 | 108 | 28.1 |
| **Residence** | Urban | 299 | 77.7 |
| | Rural | 85 | 22.3 |
| **Marital status** | Married | 246 | 63.8 |
| | Single | 70 | 18.22 |
| | Divorced/widowed | 68 | 17.7 |
| **Occupation** | Gov't or NGOs employed | 180 | 46.9 |
| | Self-employed | 62 | 16.1 |
| | Non-employed | 66 | 17.2 |
| | Farmers | 76 | 19.8 |
| **Education status** | Unable to read and write | 27 | 7 |
| | Able to read and write | 48 | 12.5 |
| | Primary school | 117 | 30.5 |
| | Secondary school | 110 | 28.9 |
| | College/University | 82 | 21.4 |
| **Monthly income** | ≤ 1000 | 68 | 17.7 |
| | >1000 | 316 | 82.3 |

**Prevalence of *Neisseria gonorrhoeae***

Of 384 women, the prevalence of *N. gonorrhoeae* infection was 29/384 (7.60%) (95%CI: 5.10- 10.70). The prevalence of *N. gonorrhoeae* infection among urban and rural residents was 20/299 (6.68%) and 9/85(10.58%), respectively. The prevalence of *N. gonorrhoeae* infection was highest, 8/85 (9.40%) among the age group 15-24 followed by 25-34 years which was 16/19 (8.30%). The highest 14/131 (10.70%) and lowest 6/115 (5.20%) proportion of *N. gonorrhoeae* infection was observed among participants from the ART clinic and ANC clinic, respectively (**Figure 2**). Overall, the highest prevalence of *N. gonorrhoeae* infection was observed among participants from government health institutions 26/276 (9.42%), non-governmental health institutions 3/88 (3.41%) and none of the study participants were positive for *N. gonorrhoeae* in the private clinics, 0/20.

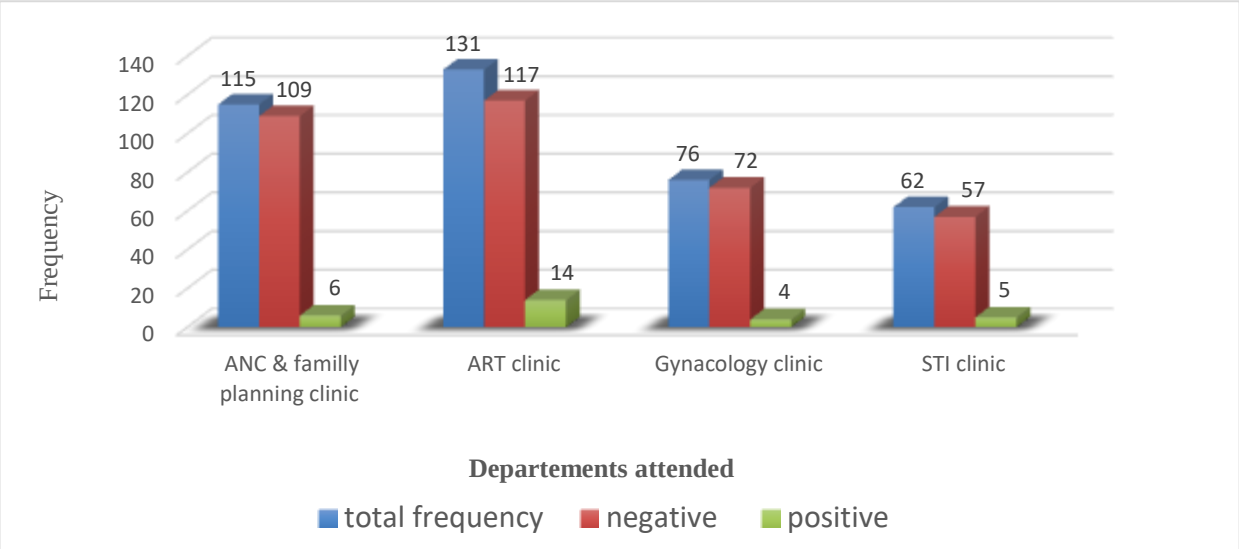


**Figure 2**: Distributions of the study participants tested for *N. gonorrhoeae* to departments attended during the study period at Debre Markos town health institutions, Northwest Ethiopia, 2022

**Antimicrobial susceptibility pattern**

An in vitro antimicrobial susceptibility test was determined on all 29 *N. gonorrhoeae* isolates against 10 antimicrobial agents. The overall resistance rate was 29/29 (100%). Among the tested antimicrobial agents, the high rate of susceptibility to *N. gonorrhoeae* isolates was observed to be ceftriaxone 27/29 (93.10%), cefixime 26/29 (89.70%) and cefotaxime 26/29 (89.70%). Whereas, a lower rate of susceptibility was found for two antimicrobial agents: ciprofloxacin, 16/29 (55.20%) and, azithromycin, 16/29 (55.2%). However, all the isolates showed 100% resistance to penicillin and tetracycline (**Table 2**).

**Table 2**: Antimicrobial susceptibility pattern of *N. gonorrhoeae* isolates among women attending at Debre Markos town health institutions, Northwest Ethiopia, 2022

| **Antimicrobial agents** | ***N. gonorrhoeae* isolates (N=29)** | | | | |
|---|---|---|---|---|---|
| | **Sensitive n (%)** | **95%CI** | **Intermediate n (%)** | **Resistant n(%)** | **95%CI** |
| Penicillin | 0/29 (0.0) | 0.0 - 14.6 | 0/29 (0.0) | 29/29 (100) | 85.4 -100 |
| Ceftriaxone | 27/29 (93.1) | 75.8 - 98.8 | 0/29 (0.0) | 2/29 (6.9) | 1.2 - 24.2 |
| Cefoxitin | 22/29 (75.9) | 56.1 - 89.0 | 5/29 (17.2) | 2/29 (6.9) | 1.2 - 24.2 |
| Cefotaxime | 26/29 (89.7) | 71.5 - 97.3 | 0/29 (0.0) | 3/29 (10.3) | 2.7 - 28.5 |
| Cefixime | 24/29 (82.8) | 63.5 - 93.5 | 0/29 (0.0) | 5/29 (17.2) | 6.5 - 36.5 |
| Cefpodoxime | 24/29 (82.8) | 63.5 - 93.5 | 0/29 (0.0) | 5/29 (17.2) | 6.5 - 36.5 |
| Azithromycin | 16/29 (55.2) | 36.0 - 73.0 | 0/29 (0.0) | 13/29 (44.8) | 27.0 - 64.0 |
| Tetracycline | 0/29 (0.0) | 0.0 - 14.6 | 0/29 (0.0) | 29/29 (100) | 85.4 -100 |
| Ciprofloxacin | 16/29(55.2) | 36.0 - 73.0 | 0/29 (0.0) | 13/29 (44.8) | 27.0 - 64.0 |
| Spectinomycin | 20/29 (69.0) | 49.0 - 84.0 | 8/29 (27.6) | 1/29 (3.4) | 0.2 - 19.6 |

CI: Confidences Interval

Of *N. gonorrhoeae* isolates, 29/29 (100%) were resistant to two classes of drugs while 13/29 (44.80%) were resistant to three classes of drugs. Among all isolates of *N. gonorrhoeae*, 19/29 (65.40%) were multidrug-resistant (MDR) isolates. None of the isolates was susceptible to all drugs tested (**Table 3**).

**Table 3**: Multidrug resistance pattern of *N. gonorrhoeae* isolates from patients in selected health institution at Debre Markos town, Northwest Ethiopia (n=29)

| No. of antibiotic | Resistance pattern | *N. gonorrhoeae* (n) | Total number of MDR, n (%) |
|---|---|---|---|
| **R3** | P, TE, CTX | 9 | |
| | CIP, P, TE | 1 | |
| | CRO, P, TE | 1 | 13/19 (68.4%) |
| | CPD,P, TE | 1 | |
| | CRO, P, TE, CTX | 1 | |
| **R4** | CIP, P, TE, CTX | 1 | |
| | CPD, CIP P, TE | 2 | 4/19 (21.0%) |
| | FOX, P, TE, CTX | 1 | |
| **R5** | CPD, CIP,P, TE, SPT | 1 | 2/19 (10.6%) |
| | FOX, CPD, P, TE, CTX | 1 | |
| **Total** | | | 19/19 (100%) |

**Key:** R2= Resistance to two drug classes, R3=Resistance for three drug, R4= Resistance to four drug class, and R5= Resistance for five drug classes

**Factors associated with *N. gonorrhoeae***

In the bivariable logistic regression analysis rural residence (COR=1.65; 95%CI: 0.72- 3.77, *P*=0.234), unprotected sex (COR=3.43; 95%CI: 1.05- 8.32, *P*=0.022), HIV sero-status (COR=2.5; 95%CI: 1.16- 5.37, *P*=0.019), sexual activity with more than one partner (COR=2.41; 95%CI: 1.12- 5.18, *P*=0.024), history of forced sexual activities (COR=2.25; 95%CI: 0.80- 6.34, *P*=0.123) were entered into multivariable logistic regression (*P*< 0.025) (**Table 4**).

In the multivariable logistic regression analysis rural residence, having multiple sexual partners, being HIV sero-positive, not using condoms regularly, and alcohol use before sexual activity were significantly associated with *N. gonorrhoeae* infection with a *P*<0.05. Similarly, in the multivariable logistic regression analysis, rural residents were 2.9 odds to have *N. gonorrhoeae* compared to urban dwellers (AOR=2.9; 95%CI: 1.11-7.75, *P*=0.029). Those who had sexual activities with multiple partners were 2.6 times more likely to have *N. gonorrhoeae* compared to those with no multiple partner sexual activities (AOR=2.6; 95%CI: 1.17- 6.09, *P*=0.019). HIV positives were 3.4 times more likely to have *N. gonorrhoeae* compared to those with HIV negatives (AOR=3.4; 95%CI: 1.39- 8.26, *P*=0.007), patients with no condom use were 4.5 times more likely to have *N. gonorrhoeae* compared to frequent condom users (AOR=4.50; 95%CI: 1.42- 11.46, *P*=0.046). Those who had used alcohol before sexual intercourse were 2.7 times more likely to have the acquisition of *N. gonorrhoeae* infection compared to those who did not use alcohol before sexual intercourse (AOR=2.7; 95%CI: 1.13- 6.45, *P*=0.025) (**Table 4**).

**Table 4**: Associated factors of *N. gonorrhoeae* infection among women attending Debre Markos town health institutions, Northwest Ethiopia, 2022

| Variables | | *N. gonorrhoeae* status | | COR (95%CI) | P-value | AOR (95%CI) | P-value |
|---|---|---|---|---|---|---|---|
| | | Positive, n(%) | Negative, n (%) | | | | |
| Age | 15 – 24 | 8 (9.41) | 77 (90.58) | 2.14 (0.67-6.79) | | | |
| | 25- 34 | 16 (8.37) | 175 (91.62) | 1.88 (0.67-5.29) | | | |
| | ≥35 | 5 (4.62) | 103 (95.37) | 1 | 0.393 | | |
| Residence | Urban | 20(6.68) | 279 (93.31) | 1 | | 1 | |
| | Rural | 9(10.58) | 76(89.41) | 1.65 (0.72 – 3.77) | 0.234* | 2.947(1.11 - 7.75) | 0.029** |
| Occupation | Gov't or NGOs) employed | 11 (6.11) | 169 (93.88) | 1 | | | |
| | Self-employed | 5 (8.06) | 57 (91.93) | 1.34 (0.44-4.04) | 0.595 | | |
| | Non employed | 6 (9.09) | 60 (90.90) | 1.53 (0.544-4.33) | 0.417 | | |
| | Farmer | 7 (9.21) | 69 (90.76) | 1.55 (0.58-4.18) | 0.379 | | |
| Monthly income (ETBR) | ≤1000 | 63(92.64) | 5(7.35) | 0.96 (0.35-2.62) | 0.945 | | |
| | ≥1000 | 292(92.4) | 24(7.59) | 1 | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Marital status | Married | 14 (5.69) | 232 (94.30) | 1 | | | |
| | Single | 9 (12.85) | 61 (87.14) | 2.44 (1.01 – 5.91) | 0.353 | | |
| | Windowed/ Divorced | 6 (8.82) | 62 (91.17) | 1.6 (0.59 – 4.34) | 0.449 | | |
| Sexual activity with greater than 1 partner | Absent | 15(5.53) | 256(94.46) | 1 | | 1 | |
| | Present | 14(12.38) | 99(87.61) | 2.41 (1.12 – 5.18) | 0.024* | 2.68(1.17 – 6.09) | 0.019** |
| Forced sexual activity | Yes | 5(14.28) | 30(85.71) | 2.25 (0.80 – 6.34) | 0.123* | 2.09(0.57 - 7.59) | 0.262 |
| | No | 24(6.87) | 325(93.12) | 1 | | 1 | |
| Having information about STIs | Yes | 13(8.9) | 133(91.1) | 1 | | 1 | |
| | No | 16(6.7) | 222(93.2) | 0.35 (0.16 – 0.77) | 0.009* | 0.7 (0.30 - 1.62) | 0.406 |
| HIV Sero-status | Positive | 16(12.03) | 117(87.96) | 2.50 (1.16 – 5.37) | 0.019* | 3.4 (1.39 - 8.26) | 0.007** |
| | Negative | 13(5.17) | 238(94.82) | 1 | | 1 | |
| Condom use | Frequently | 1(1.82) | 54(98.18) | 1 | | 1 | |
| | Occasionally | 1(2.80) | 35(97.20) | 0.54 (0.44 – 2.10) | 0.501 | 0.75(0.71 – 3.12) | 0.727 |
| | No use | 27(9.21) | 266(90.78) | 3.43(1.05-8.32) | 0.022* | 4.50(1.42– 11.46) | 0.046** |
| Alcohol use before sex | Yes | 11(12.8) | 75(87.2) | 1.96 (0.87 – 4.4) | 0.101* | 2.70 (1.13 – 6.45) | 0.025** |
| | No | 18(6.04) | 280(93.95) | 1 | | 1 | |

COR: crude odds ratio; AOR: adjusted odds ratio; CI confidence interval, *candidate for multivariable, ** Significant at $P< 0.05$, 1 = reference, ETBR=Ethiopian Birr

**Discussion**

The findings of this study help to document the epidemiology and antimicrobial resistance of the *N. gonorrhoeae* because the current antimicrobial resistance of the bacteria is unpredictably increased. Thestudy t provides pertinent information for healthcare professionals to assist in empirical treatment in the absence of a standardized laboratory setup. The prevalence of gonorrhea varies widely between countries in both the developing and developed world. The distribution of gonorrhea is influenced by social factors, individual behaviors, and personal attributes, which cause various epidemics, typically with varying drug resistance patterns. This study revealed the prevalence of *N. gonorrhoeae* to be 7.60% (95%CI: 5.1- 10.70). The finding is in line with a study conducted in Hawassa, 5.1% (8), Uganda, 5.4% (7), Congo, 7.8% (18), South Africa, 6.20% (19), and Guinea 9% (20).On the other hand, the finding of this study was lower than studies conducted in Addis Ababa 50% (21), Gambella,11.3% (22), Gondar 20.8% (23), Jimma 17.70% (24), Uganda 13% (25), Malawi 42% (26), Papua New Guinea11.2% (27) and Bangladesh 80% (28). This discrepancy in prevalence may be due to differences in the study area, characteristics of the women studied, sampling techniques, sample size, and methodological variations. The variation in prevalence rates across these studies may be attributable to the different target populations used among studies, which included patients only with urethral discharge in Malawi, commercial sex workers in Bangladesh and Uganda, and patients with suspected STI cases in Addis Ababa, Gambella, Gondar and ART patients in Jimma, Ethiopia.

In our study, patients who came from rural areas appeared to have a 3-fold increased risk of developing infections (AOR: 3.01; 95%CI: 1.14- 7.93) compared to those from urban areas. This is because the impact of gonococcal infection on ill health tends to be more severe among rural women in resource-poor settings. Patients without a healthcare resources are less likely to be tested, diagnosed, and treated effectively for STDs, and poor health-care-seeking behavior. Patients who had no condom use were more than 6 times more likely to acquire *N. gonorrhoeae* compared to those who had frequently condom users during sexual intercourse (AOR: 4.50; 95%CI: 1.42– 11.46). Similar results were seen in studies conducted in Jimma, Ethiopian (24), Gambella, Ethiopia (22), and Hawassa, Ethiopia (8). But this study is in contrast to another study conducted in Jimma, Ethiopia (29) reported an association between gonorrhea infection and condom use. The possible reason could be inappropriate condom use, which may increase the risk of transmission of *N. gonorrhoeae* through contact with infected genital secretions to a mucosal surface.

The highest prevalence of *N. gonorrhoeae* infection was observed among participants from the government health institutions 26/276 (9.42%), non-governmental health institutions 3/88 (3.41%) while none of the study participants were positive for *N. gonorrhoeae* in the private clinics 0/20. The variation in the prevalence of *N. gonorrhoeae* among government health institutions and private clinics could be due to low income and severely ill symptomatic STI women attending government health institutions. Similarly, government health institutions are afforded to serve a large number

of women, and the highest number of women allocated here is 276/384. In the current study women who had multiple sexual partners have a 2.6 times increased chance of being infected with *N. gonorrhoeae* compared to those who had no multiple sexual partners (AOR: 2.68; 95%CI: 1.18- 6.09). This result is supported by studies reported from Gambella, Ethiopia (22), South Africa (30), Tanzania (31), and Ghana (32). This might be due to risky cultural practices such as polygamy and levirate marriage and drug and alcohol use lead to unprotected sexual activities. In this study also, women who used alcohol before sexual intercourse were 2.7 times more likely to be infected with *N. gonorrhoeae* compared to those who did not use alcohol before sexual intercourse (AOR: 2.70; 95%CI: 1.13- 6.45). This finding is supported by similar study result reported at Bahir Dar (33), Gambella (22), and Gondar in Ethiopia (23) and Kenya (34). Alcohol use will result in loss of consciousness and fear, increased courage to have risky sexual behavior like unprotected sex and having multiple sex partners, and lead to sexual violence.

In this study, 100% resistance to penicillin (95%CI: 85.4 -100) and tetracycline (95%CI: 85.4- 100) were recorded which is in line with the 100% resistance reported to penicillin and tetracycline in Gambella, Ethiopia (22), Hawassa, Ethiopia (8), Bahir Dar, Ethiopia (33), Accra, Ghana (35), and Cotonou, Benin (36). Such resistance might be due to intrinsic resistance or drugs being intensively used, inexpensive, and easily available outside the hospitals, antibiotics being sold without a prescription for self-medication, and the emergence of penicillin-resistant beta-lactamase-producing strains.

In the current study, 93.1% of *N. gonorrhoeae* isolates were susceptible to ceftriaxone (95%CI: 75.8- 98.80). This result is in line with 95.8% in Gondar, Ethiopia (37); 90.6% in Canada (38), and 92.5% in India (39). But it was lower than 100% in Gambella, Ethiopia (22); and Hawassa, Ethiopia (8). This variation may be due to the time of the study Gambella and Hawassa's study was conducted before the treatment guideline was changed from ciprofloxacin to ceftriaxone. The possible reason for the high susceptibility of this drug is due to the expensive, absence of medication without a prescription less likely to use, or not easily available outside the hospital because administered by intravenous route.

In this study multidrug resistance *N. gonorrhoeae* isolates were very high 65.4%. This result is in line with the study result of 60.1% in India (40), 65.5% in India (41), and 71% in South Africa (42). But the current study result is higher than the study reported in Johannesburg, South Africa (30%) (43). The possible reason for the emergence of MDR is unrestricted access to antimicrobials, inappropriate selection and overuse of antibiotics and further, genetic mutations within the organism have contributed to increased drug resistance in *N. gonorrhoeae*.

**Conclusion and Recommendation**

The findings of this study revealed that the prevalence of *N. gonorrhoeae* is higher in the study area. Regarding antimicrobial agents, most isolates showed high susceptibility to ceftriaxone, cefixime, and cefotaxime; however, 100% resistance to penicillin and tetracycline was observed. A high percentage multi-drug resistance was also observed in the majority of the isolates. The prevalence of *N. gonorrhoeae* was significantly associated with being rural residents, HIV Serostatus, no condom use, and having multiple sexual partners. The high prevalence of *N. gonorrhoeae* infection revealed the need for regular screening and treatment of women of reproductive age and their partners. Ceftriaxone is the drug of choice to treat *N. gonorrhoeae* infections. Further, molecular studies are needed to characterize the molecular epidemiology and drug-resistance genes of *N. gonorrhoeae* isolates.

**Abbreviations**

AMR: Antimicrobial resistance; ART: Anti-retroviral treatment; DGIs: Disseminated gonococcal infections; STD: Sexually transmitted disease; STI: Sexually transmitted infection; WHO GASP: WHO Global Gonococcal Antimicrobial Surveillance Program

**Authors' contributions**

HA conceived and designed the study, performed laboratory tests, collected data, performed data analysis, and wrote up this manuscript. MT and TD assisted with the designing, analysis, interpretation of data, and critical review of the manuscript. All authors read and approved the final version of the manuscript for publication.

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**Competing interests**

The authors declare that they have no competing interests.

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