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Department of Community Medicine

Antimicrobial Resistance Patterns of Bacterial Isolates Recovered from Urine Samples Among Diabetic Patients at Al-Jemaih Diabetic Center, Dongola, Northern State, Sudan, 2026

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September 2026

1. Introduction

1.1 Background Information

Diabetes mellitus (DM) is a major chronic disease that increases susceptibility to a range of infections. Diabetes is associated with impaired host defence, altered urinary tract function and increased glucose availability in urine, all of which may contribute to urinary tract infection (UTI) and bacteriuria. The World Health Organization reported that the number of people living with diabetes increased substantially worldwide between 1990 and 2022, with the largest increases occurring in low- and middle-income countries. [1]

Antimicrobial resistance (AMR) occurs when microorganisms no longer respond to antimicrobial medicines and it can complicate the treatment of bacterial infections. Reliable culture and antimicrobial susceptibility testing are therefore important components of clinical microbiology and AMR surveillance. WHO emphasizes strengthening bacteriology laboratory capacity and standardized AMR surveillance. [2,3]

Urinary tract infection is an important clinical problem among people with diabetes. In Sudan, a cross-sectional study conducted at Khartoum Hospital among 200 diabetic patients found bacteriuria/UTI in 19.5% of participants. Escherichia coli was the most frequent isolate (56.4%), followed by Klebsiella pneumoniae (23.0%), and multidrug resistance was observed among a proportion of isolates. [4]

More recent Sudanese studies have also demonstrated bacterial isolation and antimicrobial resistance among diabetic patients. A 2022 study in Khartoum State reported significant asymptomatic bacteriuria in 16.7% of 120 asymptomatic diabetic patients and identified Staphylococcus aureus, Pseudomonas aeruginosa, E. coli, Enterococcus faecalis and Citrobacter koseri among the isolates. [5] A 2023 study in Shendi, Sudan, examined 100 diabetic patients with UTI and reported E. coli and Klebsiella as common isolates, with variable susceptibility to tested antibiotics. [6]

Despite these findings, evidence from Dongola and the Northern State remains limited. Local information is needed because the bacterial spectrum and antimicrobial susceptibility pattern may vary between facilities and geographical settings. Generating local data at Al-Jemaih Diabetic Center may help describe the organisms recovered from urine samples of diabetic patients and their resistance patterns, and may provide baseline information for clinical management, infection prevention and future AMR surveillance.

1.2 Problem Statement

Diabetic patients are vulnerable to urinary bacterial infections, while antimicrobial resistance may limit effective treatment. Sudanese studies from Khartoum and Shendi have documented bacterial urinary isolates and resistance to commonly used antimicrobial agents. [4–6] However, there is insufficient published evidence describing the bacterial isolates and their antimicrobial resistance patterns among diabetic patients attending Al-Jemaih Diabetic Center in Dongola, Northern State. The absence of local data may make it difficult to characterize the local resistance pattern and to compare it with findings from other Sudanese settings. This study is therefore proposed to determine

the bacterial isolates recovered from urine samples and describe their antimicrobial susceptibility and resistance patterns among diabetic patients attending the center in 2026.

1.3 Rationale

Diabetic patients are at increased risk of urinary tract infection, and infections caused by resistant organisms are more difficult and more costly to treat, and are associated with a higher risk of treatment failure and complications such as pyelonephritis and recurrent infection. Empirical antibiotic treatment in many health facilities, including Al-Jemaih Diabetic Center, is still largely guided by general prescribing habits rather than by local microbiological evidence, because facility-specific data on the causative organisms and their susceptibility patterns are not available.

The reviewed Sudanese literature shows that bacterial isolates and antimicrobial resistance patterns among diabetic patients differ between Khartoum, Khartoum State and Shendi, which suggests that resistance patterns are not uniform across the country and may be influenced by local prescribing practices, patient characteristics and infection control conditions. No published study was identified that describes this pattern in Dongola or the wider Northern State, so clinicians at Al-Jemaih Diabetic Center currently have no local reference to guide the choice of empirical antimicrobial therapy for diabetic patients with suspected UTI.

Generating local evidence on the bacterial spectrum and resistance pattern at this center is therefore expected to support more rational, evidence-based prescribing, to help reduce inappropriate antibiotic use and the further emergence of resistance, and to provide baseline data that can be used by the center and by future antimicrobial resistance surveillance efforts in the Northern State. The findings may also be of value to the Department of Community Medicine, the Ministry of Health and other researchers as a reference point for future comparative and follow-up studies.

1.4 Research Questions

- What percentage of urine samples from diabetic patients attending Al-Jemaih Diabetic Center show significant bacterial growth?
- Which bacterial species are recovered most frequently?
- What are the antimicrobial susceptibility and resistance patterns of the recovered isolates?
- What percentage of the recovered isolates meet the applied definition of multidrug resistance?
- Are selected participant characteristics associated with significant bacterial growth?

2. Objective

General Objective

To determine the antimicrobial resistance patterns of bacterial isolates recovered from urine samples among diabetic patients attending Al-Jemaih Diabetic Center, Dongola, Northern State, Sudan, in 2026.

Specific Objectives

- To determine the proportion of urine samples yielding significant bacterial growth among the studied diabetic patients.
- To identify the bacterial species isolated from urine samples of the study participants.
- To describe the antimicrobial resistance patterns of the isolated bacteria and identify isolates showing multidrug resistance where the tested panel permits classification.

3. Summaries of Three Very Similar Published Studies

3.1 Hamdan et al. – Khartoum, Sudan (2015)

Hamdan and colleagues conducted a cross-sectional study at Khartoum Hospital from March to September 2013 among 200 diabetic patients, irrespective of UTI symptoms. Clean-catch midstream urine was cultured and antimicrobial susceptibility was assessed. Significant bacteriuria was defined as ≥10^5 CFU/mL of a single bacterial species. Thirty-nine participants (19.5%) had UTI/bacteriuria. E. coli was the predominant isolate (22/39; 56.4%), followed by K. pneumoniae (9/39; 23.0%), E. faecalis (5/39; 12.8%) and P. mirabilis (3/39; 7.6%). Gentamicin showed 100% susceptibility among the Gram-negative isolates in that study, while resistance to several other agents was documented. Multidrug resistance was observed in 11 of 39 isolates (28.2%). [4]

Relevance to the proposed study: this is the closest Sudanese published study to the proposed research because it examined diabetic patients, urine cultures, bacterial identification and antimicrobial susceptibility. The proposed study extends the evidence to Dongola and the Northern State and will use a current standardized AST interpretation framework.

3.2 Ahmed et al. – Khartoum State, Sudan (2022)

Ahmed and colleagues conducted a descriptive prospective cross-sectional study among 120 asymptomatic diabetic patients in selected diabetic hospitals and centers in Khartoum State from July to October 2022. Clean-catch midstream urine was cultured on CLED agar and isolates were identified by conventional microbiological procedures. AST was performed using the Kirby–Bauer disc diffusion method on Mueller–Hinton agar. Significant asymptomatic bacteriuria was detected in 20/120 participants (16.7%). S. aureus was the commonest isolate (40%), followed by P. aeruginosa (25%), E. coli (15%), E. faecalis (15%) and C. koseri (5%). Resistance was reported to several tested agents, including nalidixic acid, cefotaxime, gentamicin, imipenem and ciprofloxacin. [5]

Relevance to the proposed study: it provides recent Sudanese evidence for urine culture and AST among diabetic patients and shows that resistance patterns can differ from those reported in older studies. The proposed study includes both symptomatic and asymptomatic participants as encountered at the study center rather than restricting the population to asymptomatic patients.

3.3 Abdelgader et al. – Shendi, Sudan (2023)

Abdelgader and colleagues conducted a hospital-based cross-sectional study in Shendi, Sudan, among diabetic patients with UTI. One hundred urine samples were collected, and 76 yielded bacterial isolates. The study reported E. coli as the most frequent isolate (30.2%), followed by Klebsiella (26.3%), with other Gram-negative and Gram-positive organisms also recovered. Antimicrobial susceptibility testing was performed by the Kirby–Bauer method. The authors reported variable susceptibility and resistance to the antimicrobial agents tested. [6]

Relevance to the proposed study: Shendi is geographically closer to Dongola than Khartoum and the study population and laboratory approach are similar. The proposed study will provide corresponding data from the Northern State and will apply current CLSI interpretive standards where applicable.

3.4 Gap Identified from the Reviewed Sudanese Studies

The reviewed Sudanese studies demonstrate that bacterial urinary isolates and antimicrobial resistance occur among diabetic patients, but the available evidence is concentrated in Khartoum State and Shendi. No published study identified during the literature search was found that specifically describes antimicrobial resistance patterns of urine bacterial isolates among diabetic

patients at Al-Jemaih Diabetic Center in Dongola. This geographical and facility-level gap provides the basis for the proposed study.

4. Materials and Methods

4.1 Study Design

A retrospective descriptive laboratory-based study will be conducted using existing medical and laboratory records of diabetic patients who attended Al-Jemaih Diabetic Center during the selected retrospective study period and had urine culture and/or antimicrobial susceptibility results recorded. No new urine specimens will be collected.

4.2 Study Area

The study will be conducted at Al-Jemaih Diabetic Center in Dongola, Northern State, Sudan. Existing medical records, laboratory registers and urine culture/antimicrobial susceptibility records will be reviewed after obtaining the required ethical and administrative permissions.

4.3 Study Period

This study will review eligible existing medical and laboratory records from 1 January 2024 to 22 October 20 Research activities, including data extraction, analysis, report writing and final submission, will follow the offi timetable.

4.4 Study Population

The study population will consist of existing medical and laboratory records of diabetic patients who attended Al-Jemaih Diabetic Center from 1 January 2024 to 22 October 2026 and had a urine culture result and, where available, antimicrobial susceptibility testing results.

4.5 Inclusion Criteria

Records from patients who attended Al-Jemaih Diabetic Center during the selected retrospective study period.

- Records containing a urine culture result and, where available, antimicrobial susceptibility testing results.
- Records containing sufficient information for the main study variables.

4.6 Exclusion Criteria

- Records without a documented diagnosis of diabetes mellitus.
- Records with missing or insufficient laboratory information for the main outcome.
- Duplicate records for the same patient/specimen.

4.7 Sample Size Determination

The sample size was estimated using the single-population proportion formula. A previous Sudanese study reported bacteriuria/UTI in 19.5% of diabetic patients [1]. Using p = 0.195, a 95% confidence level (Z = 1.96) and a 5% margin of error (d = 0.05):

n = Z^2 x p(1-p) / d^2 = (1.96)^2 x 0.195 x 0.805 / (0.05)^2 = 242 records

An allowance of 10% (approximately 25 records) will be added for incomplete or unusable records, giving an adjusted target of approximately 267 records. If fewer eligible records are available during the full study period, all eligible records will be included and the limitation reported.

Minimum calculated sample size = 242 records; with a 10% allowance for incomplete records, the adjusted target is approximately 267 eligible records.

4.8 Sampling Technique

A consecutive record-sampling approach will be used. All eligible records meeting the inclusion criteria will be identified from the available medical and laboratory registers for 1 January 2024 to 22 October 2026 and included consecutively. If fewer than the adjusted target are available, all eligible records will be included and the final number reported.

4.9 Data Extraction

Data will be extracted retrospectively from existing medical records, laboratory registers and urine culture/AST records using a structured data-extraction form. Variables will include age, sex, residence, type and duration of diabetes, urinary symptoms where documented, recent antibiotic use where documented, urine culture result, bacterial species and antimicrobial susceptibility results. A unique study code will be assigned to each eligible record; patient names will not be entered into the analytical dataset.

4.10 Review of Existing Urine Records

- No new urine specimen will be collected. Existing urine culture records will be reviewed, including specimen date, culture result, organism identification and available colony-count information. Only records meeting the approved eligibility criteria will be extracted.

4.11 Definition of Antimicrobial Resistance and MDR

For individual antibiotics, isolates will be categorized as susceptible, intermediate or resistant according to the current CLSI breakpoints applicable to the organism and antimicrobial tested. [7] Where the antimicrobial panel contains sufficient categories for formal classification, multidrug resistance (MDR) will be described using the international definition of acquired non-susceptibility to at least one agent in three or more antimicrobial categories. [9] If the available panel is insufficient for this category-based definition, the study will report antibiotic-specific resistance patterns without over-interpreting MDR.

4.12 Study Variables

Variable	Type	Operational definition / measurement
Age	Independent	Age in completed years, obtained from participant/record.
Sex	Independent	Male / Female.
Residence	Independent	Urban / Rural / other recorded category.
Type of diabetes	Independent	Type 1 / Type 2 / other documented type.
Duration of diabetes	Independent	Years since diagnosis.
Urinary symptoms	Independent	Dysuria, frequency, urgency, suprapubic pain, loin pain, fever or other relevant symptom.
Recent antibiotic use	Independent	Use of systemic antibacterial therapy within previous 14 days.

Variable	Type	Operational definition / measurement
Previous UTI	Independent	History of diagnosed UTI, where available.
Comorbidity	Independent	Selected documented conditions such as hypertension or chronic kidney disease.
Urine culture result	Dependent	No growth / significant bacterial growth / mixed or contaminated growth.
Bacterial species	Dependent	Species identified by laboratory methods.
Antimicrobial susceptibility	Dependent	S / I / R according to current CLSI criteria.
MDR status	Dependent	Category-based MDR where sufficient antimicrobial categories are tested.

4.13 Data Quality Control

- A standardized data-extraction form and codebook will be used. Extracted records will be checked for completeness and internal consistency, a sample of entries will be checked against the original source, duplicate records will be removed, and missing values will be recorded as missing rather than invented.
- No research assistants will recruit participants or collect new specimens. Personnel involved in data extraction will be oriented on the approved data-extraction form, confidentiality requirements and record-handling procedures.
- Existing records will be assigned study codes during data extraction. No new urine containers or specimens will be handled as part of this retrospective study.
- The laboratory records will be checked for completeness and consistency of recorded culture and antimicrobial susceptibility results; no new culture or susceptibility testing will be performed by the study team.
- Where the laboratory record identifies the method and interpretive standard used for AST, these details will be recorded. Historical susceptibility categories will be retained as reported.
- Data entry will be checked for completeness, duplicate records and inconsistent values against the original records.

4.14 Data Analysis

Data will be entered, cleaned and analyzed using SPSS. Descriptive statistics will include frequencies, percentages, means and standard deviations as appropriate. The proportion of culture-positive samples will be calculated. Bacterial isolates will be summarized by species and antimicrobial susceptibility results will be presented as frequencies and percentages. Associations between categorical participant characteristics and culture positivity will be assessed using the chi-square test. A p-value <0.05 will be

considered statistically significant. If the sample and number of outcome events are adequate, multivariable logistic regression may be used to explore independent associations.

4.15 Ethical Clearance

Ethical approval and administrative permission will be obtained before accessing the records. Because this is a retrospective record review, a waiver of individual informed consent may be requested from the ethics committee where permitted. All extracted information will be coded, kept confidential and used only for the approved research purpose; names and direct identifiers will not be entered into the analytical dataset.

4.16 Potential Benefits and Risks

There is no guaranteed direct benefit to individual patients because no new clinical intervention is provided. The main foreseeable risk is a breach of confidentiality, which will be minimized through coded data, restricted access and secure storage. There is no specimen-collection risk because the study uses existing records.

4.17 Dissemination of Findings

The completed research report will be submitted to the Department of Community Medicine according to the official timetable. Findings may also be presented in the graduation research seminar and, subject to approval, may be considered for scientific dissemination.

5. Research Plan

The study will proceed through: proposal preparation → proposal presentation and approval → ethical and administrative clearance → identification and extraction of eligible retrospective records → data cleaning → statistical analysis → writing of results and discussion → final report preparation → electronic submission → review/corrections → final discussion.

Activity	Main output
Proposal preparation	Complete research proposal according to Department guidelines.
Proposal presentation	Presentation, feedback and required revisions.
Ethical and administrative clearance	Ethics approval and permission from study site/laboratory.
Data extraction from existing records	Completed extraction of eligible retrospective records.
Review of existing laboratory records	Recorded culture and antimicrobial susceptibility results.
Data analysis	Cleaned dataset, tables and statistical analysis.
Results and discussion	Draft results, interpretation and discussion.
Final report	Complete graduation research report.
Submission and review	Electronic submission, examination/review and corrections.
Final discussion	Final presentation/discussion of the research.

6. Time-line

No.	Activity	Official period
1	Submission of research proposals	20–24 September 2026
2	Presentation of research proposals	27 September–01 October 2026
3	Data extraction from existing records	04–22 October 2026
4	Data analysis	25 October–05 November 2026
5	Writing results and discussion	08–19 November 2026
6	Writing final report	22 November–03 December 2026
7	Electronic submission of research to Department of Community Medicine	06–10 December 2026
8	Research examination/review	13–24 December 2026
9	Research modification/correction	27–31 December 2026
10	Research discussion/defense	03–04 January 2027

7. Budget Breakdown

Item	Estimated Cost (SDG)
Printing and questionnaire	300
Transportation	130
Data entry, analysis and stationery	200
Training and field materials	140
Contingency	200
Total	970

8. References

1. Hamdan HZ, et al. Urinary tract infections and antimicrobial sensitivity among diabetic patients at Khartoum, Sudan. Ann Clin Microbiol Antimicrob. 2015;14:26.
2. Ahmed AM, et al. Detection of asymptomatic bacteriuria and antimicrobial susceptibility testing among diabetic patients in Khartoum State. SAR J Pathol Microbiol. 2022;3(6):85–91.
3. Abdelgader LMA, et al. Determination of bacteriological profile and antimicrobial susceptibility among diabetic patients with urinary tract infections in Shendi, Sudan. SAR J Pathol Microbiol. 2023;4(3):24–29.
4. World Health Organization. Antimicrobial resistance. Fact sheet. 2024.
5. Clinical and Laboratory Standards Institute. M100: Performance Standards for Antimicrobial Susceptibility Testing. 36th ed. CLSI; 2026.
6. Magiorakos AP, et al. Multidrug-resistant, extensively drug-resistant and pandrug-resistant
7. Professor Abdelgader Ali. Lecture on Sample Size Determination. Research Methodology Course.

9. Annexes

Annex I: Informed Consent Form

Study purpose: to review existing urine culture and antimicrobial susceptibility records of diabetic patients. Consent/waiver procedures will follow the decision of the ethics committee; a waiver may be requested because the study is retrospective and uses existing records.

Participant code	Signature/thumbprint	Date

Annex II: Data Extraction Form

Item	Response
Study ID / Date	
Age / Sex	
Residence	
Type and duration of diabetes	
Urinary symptoms	Yes / No; specify: _____
Previous UTI	Yes / No / Unknown
Antibiotic use in previous 14 days	Yes / No / Unknown
Relevant comorbidity	

Annex III: Laboratory Result Form

Test / Field	Result
Study ID / Specimen date	
Culture	No growth / Significant growth / Mixed growth
Organism identified	
Colony count (CFU/mL)	
Antimicrobial susceptibility	S / I / R
MDR status	Yes / No / Not classifiable
Laboratory remarks	