

Systematic Review

# Urinary Tract Infections in Portugal: A Decade of Evidence on Uropathogens and Antimicrobial Resistance— A Systematic Review

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## Abstract

**Background:** Urinary tract infections (UTIs) are among the most common bacterial infections worldwide and represent a significant public health concern due to their high prevalence and increasing antimicrobial resistance. This study aimed to systematically review the epidemiology, uropathogens, and resistance patterns of UTIs in Portugal over the last decade. **Methods:** A systematic review was conducted in accordance with PRISMA 2020 guidelines. A literature search was performed in April 2026. A total of 425 records were identified. After removal of duplicates and preliminary exclusions, 121 records were screened by title and abstract. Following application of eligibility criteria, 41 full-text articles were assessed, of which 13 met the criteria for detailed eligibility assessment. Six studies met the inclusion criteria and were included in the final qualitative synthesis. **Results:** The included studies consistently reported a higher prevalence of UTIs in females and, in some cases, in older populations. *Escherichia coli* was identified as the predominant uropathogen across all studies, followed by *Klebsiella pneumoniae*, *Proteus* spp., and *Enterococcus* spp. A consistently high prevalence of antimicrobial resistance was observed, particularly against commonly used antibiotics such as ampicillin and trimethoprim–sulfamethoxazole. The presence of extended-spectrum  $\beta$ -lactamase (ESBL)-producing strains was also reported, especially in healthcare-associated infections, which exhibited higher resistance profiles compared to community-acquired infections. **Conclusions:** The available evidence suggests that UTIs in Portugal are predominantly caused by enterobacteria, particularly *Escherichia coli*. However, the limited number and heterogeneity of studies highlight the need for cautious interpretation. Further multicenter and methodologically robust studies are required to better characterize national epidemiological patterns and antimicrobial resistance trends.



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**Keywords:** urinary tract infection; antimicrobial resistance; Portugal; *Escherichia coli*; uropathogens; epidemiology

## 1. Introduction

Therefore, the aim of this systematic review is to analyze the scientific literature published over the last decade regarding the prevalence, main uropathogens, and antimicrobial

resistance patterns associated with urinary tract infections in Portugal. Urinary tract infections (UTIs) are among the most common bacterial infections worldwide, affecting millions of individuals annually and representing a major cause of medical consultations, antibiotic prescriptions, emergency department visits, and hospitalizations [1–3]. UTIs impose a substantial burden on healthcare systems due to their high incidence, recurrence rates, and associated healthcare costs. It is estimated that a considerable proportion of the population—particularly women—will experience at least one episode of UTI during their lifetime, with many developing recurrent infections requiring repeated medical intervention and antimicrobial therapy [4–6].

Clinically, UTIs encompass a broad spectrum of infectious conditions involving different anatomical regions of the urinary tract. These infections range from uncomplicated lower urinary tract infections, such as cystitis, to more severe upper urinary tract infections, including pyelonephritis and complicated urinary infections associated with systemic manifestations. UTIs may present with symptoms such as dysuria, urinary urgency, frequency, suprapubic pain, flank pain, and fever, although clinical presentation may vary according to patient age, immune status, and underlying comorbidities [4,7].

Certain populations are particularly vulnerable to UTIs and their complications. Elderly individuals, pregnant women, children, patients with diabetes mellitus, immunocompromised individuals, and patients requiring urinary catheterization or invasive urological procedures are at increased risk of infection and adverse outcomes [7–9]. In these groups, UTIs may contribute to increased morbidity, prolonged hospitalization, recurrent healthcare utilization, and, in severe cases, progression to bloodstream infection and sepsis. Furthermore, recurrent UTIs significantly affect quality of life and may lead to repeated antimicrobial exposure, further contributing to the development of antimicrobial resistance.

From a microbiological perspective, UTIs are predominantly caused by bacteria originating from the intestinal microbiota, reflecting the ascending route of infection that characterizes most urinary tract infections. Among the identified uropathogens, *Escherichia coli* remains consistently recognized as the predominant etiological agent in both community-acquired and healthcare-associated infections [1,2,4]. Other commonly implicated microorganisms include *Klebsiella pneumoniae*, *Proteus mirabilis*, *Enterococcus faecalis*, and *Staphylococcus saprophyticus*. The distribution of these uropathogens may vary according to patient characteristics, age group, clinical setting, previous antibiotic exposure, and the presence of urinary tract abnormalities or indwelling urinary devices.

In recent decades, the increasing prevalence of antimicrobial resistance among uropathogens has emerged as one of the major challenges in the management of UTIs worldwide. Resistance to antibiotics commonly used for empirical treatment, including fluoroquinolones, trimethoprim–sulfamethoxazole, and  $\beta$ -lactams, has been increasingly reported across different geographical regions and healthcare settings [2,10]. The emergence and dissemination of multidrug-resistant organisms, particularly extended-spectrum  $\beta$ -lactamase (ESBL)-producing Enterobacteriaceae, have substantially limited therapeutic options and complicated empirical treatment strategies.

The growing burden of antimicrobial resistance has important clinical and public health implications. Inappropriate empirical therapy may contribute to treatment failure, recurrent infection, prolonged disease duration, increased hospitalization rates, and higher healthcare costs. Additionally, the widespread use and misuse of antibiotics in both community and hospital settings continue to exert selective pressure favoring the emergence of resistant strains. Consequently, antimicrobial stewardship programs and continuous epidemiological surveillance have become essential components of modern infection control and public health strategies.

In Portugal, several studies have investigated the epidemiology of UTIs, focusing on the identification of etiological agents, resistance patterns, and temporal trends in antimicrobial susceptibility. However, the available evidence remains fragmented and heterogeneous, encompassing different populations, study designs, healthcare settings, and laboratory methodologies. Existing studies include hospital-based retrospective analyses, community laboratory investigations, and studies involving specific clinical populations, which limits direct comparison and the establishment of comprehensive national epidemiological trends.

Despite the recognized clinical relevance of UTIs and antimicrobial resistance, there remains a relative scarcity of systematically synthesized national data regarding the Portuguese context. Understanding local epidemiological patterns is particularly important because antimicrobial susceptibility profiles may vary significantly between countries, healthcare institutions, and community settings. Therefore, updated national evidence is essential to support evidence-based empirical treatment decisions, optimize antimicrobial stewardship strategies, and inform healthcare policies aimed at reducing the burden of antimicrobial resistance.

Given this context, a comprehensive and systematic synthesis of the available evidence is warranted to provide a clearer understanding of the epidemiological landscape of UTIs in Portugal. In the setting of increasing global antimicrobial resistance and evolving uropathogen profiles, identifying national microbiological trends may contribute to improved clinical management and more effective public health interventions.

Therefore, the aim of this systematic review is to analyze the scientific literature published over the last decade regarding the prevalence, main uropathogens, and antimicrobial resistance patterns associated with urinary tract infections in Portugal.

## 2. Materials and Methods

### 2.1. Study Design

A systematic literature review was conducted to identify, analyze, and synthesize the available evidence regarding the epidemiology, microbiological profile, and antimicrobial resistance patterns of urinary tract infections (UTIs) in the adult population in Portugal.

This review was developed and reported in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA 2020) guidelines [11]. The review process followed the standard PRISMA framework, including study identification, screening, eligibility assessment, and final inclusion (Table S1).

The methodological approach was designed to ensure transparency, reproducibility, and methodological rigor throughout all stages of the review process. The review focused on studies reporting epidemiological data, uropathogen distribution, and antimicrobial resistance patterns in both community and healthcare-associated urinary tract infections.

### 2.2. Protocol and Registration

This systematic review was not prospectively registered in an international database such as PROSPERO. Nevertheless, the review protocol, including the research question, eligibility criteria, search strategy, and planned methods for data extraction and synthesis, was defined a priori before the initiation of the literature search.

Although the absence of formal registration may represent a limitation regarding methodological transparency, all stages of the review were conducted according to established methodological recommendations for systematic reviews to ensure consistency and reproducibility.

### 2.3. Research Strategy

A comprehensive literature search was conducted in March 2026 using the following electronic databases: Scopus, PubMed/MEDLINE, and Web of Science.

The search strategy was developed to maximize sensitivity and identify studies related to urinary tract infections in the Portuguese context. Search terms were applied to titles, abstracts, and keywords using combinations of Medical Subject Headings (MeSH) and free-text terms whenever applicable.

The following search string was used:

("urinary tract infection\*" OR "urinary infection\*" OR "UTI") AND ("Portugal")

No initial restrictions regarding study design were applied during the database search in order to maximize the identification of potentially relevant studies. Filters related to language, publication type, and population characteristics were subsequently applied during the screening process according to the predefined eligibility criteria.

In addition to the electronic database search, the reference lists of all included studies were manually screened to identify additional relevant publications that may not have been retrieved through the primary search strategy.

The search process was independently reviewed to ensure consistency in study identification and selection.

### 2.4. Eligibility Criteria

- Population: Adult human population ( $\geq 18$  years);
- Intervention/Exposure: Not applicable, as observational studies addressing urinary tract infections were considered;
- Comparison: Not applicable;
- Outcomes: Epidemiological characteristics of UTIs, identification of uropathogens, and antimicrobial resistance patterns;
- Study design: Observational studies and relevant epidemiological investigations.

The inclusion criteria were as follows:

- Articles published in English;
- Studies published within the last 10 years;
- Studies conducted in Portugal or including Portuguese epidemiological data;
- Studies reporting data on urinary tract infections, uropathogens, or antimicrobial resistance;
- Full-text availability.

The exclusion criteria included:

- Duplicate records;
- Editorials, letters, conference abstracts, protocols, and commentaries;
- Studies unrelated to urinary tract infections;
- Studies without Portuguese data;
- Pediatric-only studies;
- Articles without accessible full text.

Studies involving mixed populations were included only when adult-specific data could be clearly identified and extracted.

### 2.5. Study Selection Process

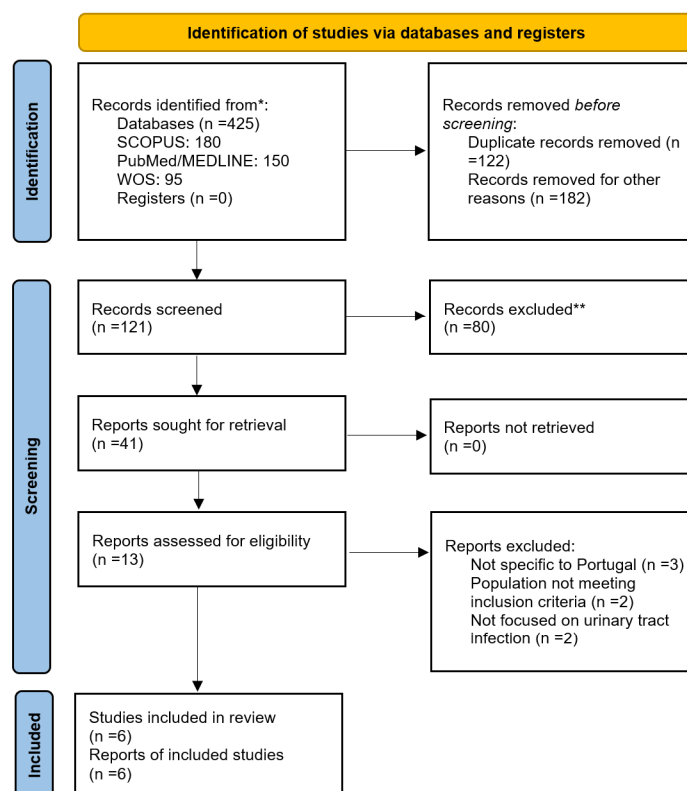
The study selection process was conducted according to the PRISMA 2020 recommendations [11].

After database searching, all retrieved references were screened for duplicates. Subsequently, titles and abstracts were independently screened to identify potentially eligible studies based on the predefined inclusion and exclusion criteria.

Studies considered potentially relevant were retrieved in full text and further assessed for eligibility. Full-text screening focused on study population characteristics, relevance to urinary tract infections, Portuguese epidemiological context, and reporting of microbiological or antimicrobial resistance data.

Disagreements regarding study eligibility were resolved through discussion and consensus among the authors.

The complete study selection process, including reasons for exclusion during full-text assessment, is summarized in the PRISMA flow diagram presented in Figure 1.



\*Consider, if feasible to do so, reporting the number of records identified from each database or register searched (rather than the total number across all databases/registers).

\*\*If automation tools were used, indicate how many records were excluded by a human and how many were excluded by automation tools.

**Figure 1.** PRISMA 2020 flow diagram of the study selection process.

## 2.6. Data Extraction

Data extraction was performed systematically using a predefined standardized framework developed for this review.

The following information was extracted from each included study:

- Author(s) and year of publication;
- Study design;
- Clinical setting and geographical context;
- Population and sample characteristics;
- Number of participants or urine samples analyzed;
- Main uropathogens identified;
- Reported antimicrobial resistance patterns;

- Key epidemiological findings and conclusions.

The extracted data were independently reviewed to ensure accuracy and consistency. Subsequently, the information was organized into comparative tables to facilitate qualitative synthesis and interpretation of findings across studies.

### 2.7. Data Synthesis

A qualitative synthesis of the included studies was conducted.

Due to substantial heterogeneity among studies regarding study design, population characteristics, clinical settings, microbiological methodologies, and reported outcomes, a quantitative meta-analysis was considered inappropriate and was therefore not performed.

The findings were synthesized descriptively, with emphasis placed on:

- Epidemiological patterns of urinary tract infections;
- Distribution of uropathogens;
- Antimicrobial resistance profiles;
- Differences between community-acquired and healthcare-associated infections.

The synthesis aimed to identify recurrent trends and clinically relevant findings within the Portuguese context while acknowledging the methodological variability across studies.

### 2.8. Risk of Bias Assessment

The methodological quality of the included observational studies was assessed using the Newcastle–Ottawa Scale (NOS).

This instrument evaluates study quality according to three major domains:

- Selection of study groups;
- Comparability of study populations;
- Assessment of outcomes.

Given the observational nature of the included studies and the heterogeneity of study designs and reported outcomes, the risk of bias assessment was used to support qualitative interpretation rather than quantitative weighting of evidence.

No formal certainty of evidence assessment, such as the GRADE approach, was performed due to the descriptive nature of the available evidence and the absence of sufficiently homogeneous data for quantitative synthesis.

## 3. Results

### 3.1. Study Selection

A total of 425 records were identified through database searching (Scopus, PubMed/MEDLINE, and Web of Science). After removal of duplicates and application of preliminary exclusion criteria (English language, human studies, adult population, and exclusion of non-relevant publication types), 121 records were retained for title and abstract screening. Of these, 80 were excluded for not meeting the inclusion criteria.

A total of 41 full-text articles were retrieved. Following initial full-text screening, 28 articles were excluded due to not meeting core inclusion criteria (e.g., absence of Portuguese data or lack of relevant outcomes).

The remaining 13 articles were assessed in detail for eligibility. Of these, 7 were excluded for the following reasons: not specific to Portugal ( $n = 3$ ), population not meeting inclusion criteria ( $n = 2$ ), and not focused on urinary tract infections ( $n = 2$ ).

Ultimately, 6 studies met all inclusion criteria and were included in the final qualitative synthesis.

The study selection process is presented in Figure 1.

### 3.2. Characteristics of the Included Studies

The main characteristics of the studies included in this review are summarized in Table 1.

**Table 1.** Characterization of the included studies.

Study	Year	Study Design	Setting	Population/Sample	Main Pathogens Identified	Key Findings
A1—Rising Threats and Evolving Trends: Five Years of Urinary Tract Infection Prevalence in a Portuguese Hospital [12].	2023	Retrospective observational study	Portuguese hospital	Urine cultures collected over 5 years	<i>Escherichia coli</i> , <i>Klebsiella pneumoniae</i> , <i>Enterococcus faecalis</i>	Increasing prevalence of UTIs over time with emerging antimicrobial resistance patterns
A2—Decoding Urinary Tract Infection Trends: A 5-Year Snapshot from Central Portugal [13].	2024	Retrospective study	Hospital in Central Portugal	Positive urine cultures over a 5-year period	<i>E. coli</i> , <i>K. pneumoniae</i> , <i>Enterococcus</i> spp.	Female predominance and significant variation in antimicrobial resistance trends
A3—Urinary Tract Infections in a Single Hospital in Central Portugal: A 5-Year Analysis [14].	2023	Retrospective observational study	Hospital setting	Urine samples analysed over 5 years	<i>E. coli</i> , <i>Klebsiella pneumoniae</i>	UTIs more frequent in women and elderly patients
A4—Incidence of Urinary Tract Infection After Cystography [15].	2019	Clinical observational study	Hospital diagnostic procedure	Patients undergoing cystography	<i>E. coli</i> predominantly	Low incidence of post-procedure UTIs
A5—Revisiting the Frequency and Antimicrobial Resistance Patterns of Bacteria Implicated in Community Urinary Tract Infections [16].	2022	Epidemiological study	Community laboratory data	Large dataset of urine cultures	<i>E. coli</i> , <i>Klebsiella</i> spp., <i>Proteus</i> spp.	Increasing antimicrobial resistance in community-acquired UTIs
A6—Urinary Tract Infections Caused by Community-Acquired Extended-Spectrum $\beta$ -Lactamase-Producing Enterobacteriaceae in a Level III Hospital: A Retrospective Study [17].	2017	Microbiological study	Clinical microbiology laboratory	Enterobacteriaceae isolates from urine samples	<i>E. coli</i> , <i>Klebsiella</i> spp., <i>Proteus</i> spp.	Enterobacteriaceae represent the main etiological agents of UTIs

The six studies included in the final analysis were conducted in Portugal and published between 2017 and 2024. Most studies employed retrospective observational designs, primarily based on microbiological analysis of urine cultures collected in hospital or community laboratory settings.

Three studies focused on hospital-based epidemiological trends of urinary tract infections, analyzing data collected over a five-year period. These studies consistently reported a higher prevalence of UTIs among female patients and older adults.

One study examined community-acquired urinary tract infections using a large dataset of urine cultures from a clinical laboratory, highlighting an increasing frequency of antimicrobial resistance among common uropathogens.

Two studies focused on specific clinical contexts, including post-procedural infections (cystography) and infections caused by ESBL-producing Enterobacteriaceae.

Across all studies, *Escherichia coli* was consistently identified as the predominant uropathogen, followed by *Klebsiella pneumoniae*, *Proteus* spp., and *Enterococcus* spp.

Several studies also reported antimicrobial resistance patterns, particularly among Enterobacteriaceae isolates.

## 4. Discussion

The studies included in this review provide an updated overview of the epidemiology, microbiological profile, and antimicrobial resistance patterns associated with urinary tract infections (UTIs) in Portugal over the past decade. Although the number of eligible studies remains limited, the available evidence reveals recurrent epidemiological and microbiological trends across different clinical settings, supporting the relevance of UTIs as a persistent public health concern.

A higher prevalence of UTIs among female patients was reported across most hospital-based studies [A1, A2, A3]. This finding is consistent with the well-established anatomical and physiological characteristics that predispose women to urinary tract infections, including a shorter urethra and closer proximity between the urethral and perianal regions, facilitating bacterial ascension and colonization. In addition, several studies identified a higher incidence among older adults, particularly within hospital environments [A2, A4]. Aging is associated with multiple factors that may increase susceptibility to infection, including immunosenescence, urinary retention, hormonal changes, increased prevalence of chronic diseases, institutionalization, and greater exposure to urinary catheterization and previous antibiotic therapy. These observations are in agreement with findings reported in international epidemiological studies [18–22].

From a microbiological perspective, all included studies identified *Escherichia coli* as the predominant uropathogen in both community-acquired and healthcare-associated infections [A1–A6]. Other commonly isolated microorganisms included *Klebsiella pneumoniae*, *Proteus* spp., and *Enterococcus* spp., although with substantially lower prevalence [A2, A5]. The predominance of enterobacteria is consistent with the recognized role of the gastrointestinal microbiota as the principal reservoir of uropathogenic microorganisms. The ability of uropathogenic *E. coli* strains to adhere to uroepithelial cells, form biofilms, and evade host immune responses may partially explain their continued predominance in urinary infections [23–28]. Furthermore, the relatively stable microbiological distribution observed across the included studies suggests that the etiological profile of UTIs in Portugal generally follows patterns reported in other European and international settings.

An important finding of this review concerns the increasing prevalence of antimicrobial resistance among uropathogens. Several studies reported elevated resistance rates to commonly prescribed antibiotics used in empirical therapy, particularly ampicillin and trimethoprim–sulfamethoxazole, and, in some settings, fluoroquinolones [A3, A5]. These resistance patterns are clinically significant because they may compromise first-line empirical treatment strategies, contribute to therapeutic failure, prolong symptoms, and increase healthcare utilization and costs. In addition, the emergence and dissemination of extended-spectrum  $\beta$ -lactamase (ESBL)-producing strains, particularly among *Escherichia coli* and *Klebsiella pneumoniae* isolates [A4, A6], represents a major challenge for antimicrobial management due to reduced therapeutic options and the potential need for broader-spectrum antibiotics. These findings mirror the growing global concern regarding antimicrobial resistance in urinary pathogens and reinforce the urgent need for antimicrobial stewardship interventions [29–33].

Differences between community-acquired and healthcare-associated infections were also evident throughout the included studies. Hospital-based investigations generally reported higher frequencies of multidrug-resistant organisms and more complex resistance profiles compared with community-derived data [A2, A4, A6]. This observation likely reflects the selective pressure associated with prolonged healthcare exposure, recurrent antibiotic use, invasive procedures, and contact with resistant nosocomial microorganisms. The findings support the importance of adapting empirical treatment strategies according to the clinical setting and local epidemiological surveillance data. Moreover, they emphasize

the critical role of infection prevention and control practices, particularly in hospital and long-term care environments, in limiting the dissemination of resistant pathogens [31–36].

Some studies also highlighted the relevance of clinical and procedural risk factors associated with UTIs, including prior healthcare exposure and invasive diagnostic procedures such as cystography [A3, A5]. Although procedure-associated infections appear to occur at relatively low frequencies, these infections remain clinically relevant because they may disproportionately affect vulnerable patients, including older adults and individuals with multiple comorbidities. Appropriate aseptic techniques, careful patient selection, and post-procedural monitoring therefore remain important preventive strategies [34–36].

The findings synthesized in this review also highlight the growing complexity of UTI management in contemporary clinical practice. Increasing antimicrobial resistance, the emergence of multidrug-resistant organisms, and variations in resistance profiles across healthcare settings complicate empirical treatment selection and may require more individualized therapeutic approaches. In this context, local epidemiological surveillance becomes particularly important, allowing clinicians to adapt antibiotic prescribing practices according to regional microbiological trends and resistance patterns [37–41].

The heterogeneity of the included studies should be acknowledged when interpreting these findings. The studies differed substantially in terms of study design, sample size, population characteristics, clinical setting, laboratory methodologies, and outcome reporting. This variability limited direct comparability between studies and precluded quantitative synthesis through meta-analysis. Nevertheless, the inclusion of studies from both hospital and community settings provides a broader perspective on the epidemiology and resistance patterns of UTIs in Portugal.

Several limitations of this review should also be considered. First, the relatively small number of eligible studies reflects the limited availability of nationally focused research specifically addressing UTIs in Portugal. Second, although multiple databases were searched and manual reference screening was performed, some relevant studies may not have been identified. Third, methodological heterogeneity among studies may affect the generalizability of the findings. Additionally, although a risk of bias assessment was conducted using the Newcastle–Ottawa Scale, no formal certainty-of-evidence grading system such as GRADE was applied.

Despite these limitations, this review provides a relevant and updated synthesis of the available evidence regarding UTIs in Portugal. The findings demonstrate relatively stable microbiological patterns dominated by enterobacteria while simultaneously revealing a concerning trend of increasing antimicrobial resistance, particularly in healthcare-associated infections. These results reinforce the importance of maintaining robust epidemiological surveillance systems, strengthening antimicrobial stewardship programs, promoting rational antibiotic use, and developing evidence-based clinical guidelines adapted to local epidemiological realities.

## 5. Conclusions

Urinary tract infections remain one of the most frequent bacterial infections encountered in clinical practice and continue to represent a significant burden on healthcare systems in Portugal. The evidence synthesized in this review indicates that enterobacteria, particularly *Escherichia coli*, remain the predominant uropathogens in both community-acquired and healthcare-associated infections, in agreement with international epidemiological patterns.

The included studies also demonstrate a concerning prevalence of antimicrobial resistance among the identified pathogens, including the presence of extended-spectrum  $\beta$ -lactamase (ESBL)-producing strains. Resistance to commonly prescribed empirical thera-

pies represents an important clinical challenge, potentially contributing to treatment failure, recurrent infections, prolonged hospitalization, and increased healthcare costs. These findings reinforce the importance of continuously updating empirical treatment strategies according to local microbiological surveillance data.

Differences between community-acquired and healthcare-associated infections were also evident, with hospital-associated infections generally presenting more complex resistance profiles and a greater prevalence of multidrug-resistant organisms. This observation highlights the relevance of context-specific clinical management and emphasizes the need for effective infection prevention and control strategies, particularly within healthcare environments.

Although the number of available Portuguese studies remains limited and methodological heterogeneity restricts direct comparability between investigations, the consistency of the observed microbiological patterns and resistance trends provides clinically relevant insights into the national epidemiological landscape of urinary tract infections.

The findings of this review further support the urgent need to strengthen antimicrobial stewardship programs, optimize rational antibiotic use, and maintain robust epidemiological and microbiological surveillance systems capable of monitoring evolving resistance patterns over time. In parallel, future research should prioritize multicenter and methodologically standardized studies involving broader and more representative populations to improve the quality and comparability of national data.

Overall, this systematic review highlights the growing clinical and public health importance of urinary tract infections and antimicrobial resistance in Portugal. Integrating epidemiological surveillance, microbiological evidence, and evidence-based therapeutic decision-making will be essential to improve patient outcomes and support more effective strategies for the prevention and management of urinary tract infections in the coming years.

**Supplementary Materials:** The following supporting information can be downloaded at: <https://www.mdpi.com/article/10.3390/bacteria5020030/s1>, Table S1: PRISMA 2020 Checklist.

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