Research Article

Gender and Age-Dependent Etiology of Community-Acquired Urinary Tract Infections

Enrico Magliano,¹ Vittorio Grazioli,¹ Loredana De Florio,¹ Antonia Isabella Leuci,¹ Roberto Mattina,² Paolo Romano,² and Clementina Elvezia Cocuzza³

¹Bacteriological Laboratory, Centro Diagnostico Italiano, Via Saint Bon 20, 20147 Milan, Italy
²Department of Public Health, Microbiology and Virology, University of Milan, Via Pascal 36, 20166 Milan, Italy
³Department of Clinical and Preventive Medicine, University of Milano-Bicocca, Via Cadore 48, 20052 Monza, Italy

Correspondence should be addressed to Clementina Elvezia Cocuzza, clementina.cocuzza@unimib.it

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Urinary tract infections (UTIs) are among the most frequent community-acquired infections worldwide. Escherichia coli is the most common UTI pathogen although underlying host factors such as patients’ age and gender may influence prevalence of causative agents. In this study, 61,273 consecutive urine samples received over a 22-month period from outpatients clinics of an urban area of north Italy underwent microbiological culture with subsequent bacterial identification and antimicrobial susceptibility testing of positive samples. A total of 13,820 uropathogens were isolated and their prevalence analyzed according to patient’s gender and age group. Overall Escherichia coli accounted for 67.6% of all isolates, followed by Klebsiella pneumoniae (8.8%), Enterococcus faecalis (6.3%), Proteus mirabilis (5.2%), and Pseudomonas aeruginosa (2.5%). Data stratification according to both age and gender showed E. coli isolation rates to be lower in both males aged ≥60 years (52.2%), E. faecalis and P. aeruginosa being more prevalent in this group (11.6% and 7.8%, resp.), as well as in those aged ≤14 years (51.3%) in whom P. mirabilis prevalence was found to be as high as 21.2%. Streptococcus agalactiae overall prevalence was found to be 2.3% although it was shown to occur most frequently in women aged between 15 and 59 years (4.1%). Susceptibility of E. coli to oral antimicrobial agents was demonstrated to be as follows: fosfomycin (72.9%), trimethoprim/sulfamethoxazole (72.9%), ciprofloxacin (76.8%), ampicillin (48.0%), and amoxicillin/clavulanate (77.5%). In conclusion, both patients’ age and gender are significant factors in determining UTIs etiology; they can increase accuracy in defining the causative uropathogen as well as providing useful guidance to empiric treatment.

1. Background

Urinary tract infections (UTIs) are among the most frequent bacterial infections worldwide [1–5]. In 2000, according to the Urologic Diseases in America Project, UTIs accounted for more than 8 million office and 1.7 million emergency room visits, leading to around 350,000 hospitalizations [3]. In England and Wales, consulting rates in general practice for cystitis and other urinary infections were found to be of approximately 315 per 10,000 persons [4], whereas, in Italy, in 2002, 2.4% of a cohort of more than 450,000 people received a diagnosis of acute cystitis in primary care [5].

Although women, particularly those aged 16–64 years, are significantly more likely to experience UTIs than men [4], urinary infections frequently occur in both genders and across all age groups [3, 4]; specific populations such as pregnant women, the elderly or patients with spinal cord injuries, catheters, or diabetes are also at increased risk [6, 7].

Microbial etiology of UTIs has been regarded as well established, with E. coli being the causative pathogen in 50–80% of cases [8, 9]; other Enterobacteriaceae (Klebsiella, Proteus, Enterobacter) together with Enterococci, Streptococci, Staphylococci, and Pseudomonas spp. account for most of the remaining positive urine cultures [8]. Empiric antibiotic treatment is therefore commonly adopted. However, due to significant local differences in frequency of urinary agents, the emergence of new pathogens, and changes of antimicrobial resistance, periodic evaluation of pathogens...
epidemiology is recommended, in order to revise treatment
decisions [10]. Since underlying host factors may affect urinary
etiology and antibiotic susceptibility, specific patients groups
should be investigated in more details. Among risk factors,
patients’ gender and age can be easily accessible in sur-
veys performed at the microbiology laboratory where patients’
clinical features are less well known. The present
study was therefore conducted with the aim to assess UTI
etiology and antimicrobial susceptibility of a large number
of urinary pathogens isolated in an urban area of north of
Italy as well as to evaluate bacteria distribution according to
age and gender.

2. Methods
A retrospective study was performed at the Bacteriological
Laboratory of the “Centro Diagnostico Italiano” (CDI),
based in Milan (Italy), on all bacterial strains isolated
from consecutive urine samples received from outpatients
clinics of a high-populated urban area of North Italy,
between March 2008 and December 2009. Urine samples,
accompanied by microbiology request forms, were delivered
either directly to the CDI laboratory or through 7 collabo-
rating laboratories. All sample processing and patients’ data
collection were carried out centrally by the CDI laboratory.

CDI Laboratory follows Internal Quality Control pro-
cedures and participates to an External Program for Quality
Assessment with positive evaluations.

As part of the routine procedure, patients received
indications to avoid antimicrobials assumption during
the previous 7 days and instructions on urine sampling
(including cleaning of the genital area prior to midstream
specimen collection) and its transport to the laboratories
(within 2 hours of collection). Specimens from collaborating
laboratories were transported in Vacutainer tubes containing
boric acid at 1-2% as preservative. All samples were plated as
soon as possible and no later than 24 hours on Chromagar
Orientation-BD plates and incubated for 18–24 hours at
37°C. Criterion for defining significant bacteriuria (positive
samples) was the presence of ≥10^5 colony-forming units
(CFU)/mL of urine [11].

An automated BD Phoenix system (BD Biosciences,
USA) was used for the rapid bacteria identification and
for the determination of antimicrobial susceptibility [12].
Phoenix AST antimicrobials panels for Gram-negative
urinary pathogens, Gram-negative nonurinary pathogens,
Streptococci, and all other Gram-positive were used.

The statistical analysis was performed by the SAS System
version 9.2. The difference between females and males in
the frequency of positive samples of each agent was analyzed by
the chi-square test. The frequency of the positive samples of
each agent as a function of gender and age groups (≤14; 15–
29; 30–59; ≥60 years) was analyzed by the logistic regression,
including in the model the terms gender, age, and the gender
by age interaction.

3. Results
A total of 61 273 urine cultures were performed over a 22-
month period; of these 13 820 (22.6%) were found to be
positive for bacterial infection. Nearly 80% of all isolates were
from women (female to male ratio (F/M) = 3.8) and 58% from subjects aged 60 years or more. Cumulatively, the two
younger age groups accounted for 11.2% of total isolates.
Female to male ratio was highest in age group 15–29 years
(F/M = 5.2) and lowest in the youngest age group (F/M = 1.4).

Overall the most frequently encountered pathogen was
Escherichia coli (67.6%), followed by Klebsiella pneumoniae
(8.8%), Enterococcus faecalis (6.3%), Proteus mirabilis
(5.2%), Pseudomonas aeruginosa (2.5%), and Streptococcus agalactiae (2.3%) (Table 1), all accounting for around 90%
of total isolates. Gram-negative agents represented 90.8% of
urinary pathogens.

Frequency of isolation of all six main species was found to
be statistically different between females and males (Table 2):
E. coli, K. pneumonia, and S. agalactiae were more frequent

<table>
<thead>
<tr>
<th>Gram-negative</th>
<th>Gram-positive</th>
</tr>
</thead>
<tbody>
<tr>
<td>E. coli</td>
<td>Enterococcus spp.</td>
</tr>
<tr>
<td>K. pneumoniae</td>
<td>S. agalactiae</td>
</tr>
<tr>
<td>Proteus spp.</td>
<td>S. aureus</td>
</tr>
<tr>
<td>P. aeruginosa</td>
<td>Staphylococcus spp.</td>
</tr>
<tr>
<td>Enterobacter spp.</td>
<td></td>
</tr>
<tr>
<td>K. oxytoca</td>
<td></td>
</tr>
<tr>
<td>Citrobacter spp.</td>
<td></td>
</tr>
<tr>
<td>M. morganii</td>
<td></td>
</tr>
<tr>
<td>Providencia spp.</td>
<td></td>
</tr>
<tr>
<td>Other Gram-negative</td>
<td></td>
</tr>
<tr>
<td>All Gram-negative</td>
<td>12549 (90.8)</td>
</tr>
<tr>
<td>All Gram-positive</td>
<td>1271 (9.2)</td>
</tr>
</tbody>
</table>

Includes: 1. *spp pneumoniae* (1204 isolates) and *obaena* (13); 2. *P. mirabilis* (723) and *P. vulgaris* (11); 3. *E. aerogenes* (153) and *E. cloacae* (142); 4. *C. koseri* (180), *C. freundii* (42), *C. braakii* (3), and *C. youngae* (2); 5. *P. stuartii* (38) and *P. retgeri* (8); 6. *A. baumannii* (9), *S. marcescens* (8), and *S. maltophilia* (2); 7. *E. faecalis* (868) and *E. faecium* (11); 8. *S. saprophyticus* (21), *S. epidermidis* (4), *S. haemolytica* (2), and *S. warneri* (1).
Table 2: Distribution of the six more frequently isolated species according to patients’ gender.

<table>
<thead>
<tr>
<th>Organism</th>
<th>All (n = 13820)</th>
<th>Females (n = 10947)</th>
<th>Males (n = 2873)</th>
<th>P*</th>
</tr>
</thead>
<tbody>
<tr>
<td>E. coli</td>
<td>9344 (67.6)</td>
<td>7763 (71.0)</td>
<td>1581 (55.0)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>K. pneumonia</td>
<td>1217 (8.8)</td>
<td>995 (9.1)</td>
<td>209 (7.3)</td>
<td>0.002</td>
</tr>
<tr>
<td>E. faecalis</td>
<td>868 (6.3)</td>
<td>596 (5.4)</td>
<td>272 (9.5)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>P. mirabilis</td>
<td>723 (5.2)</td>
<td>465 (4.2)</td>
<td>258 (9.0)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>P. aeruginosa</td>
<td>345 (2.5)</td>
<td>149 (1.4)</td>
<td>196 (6.8)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>S. agalactiae</td>
<td>313 (2.3)</td>
<td>270 (2.5)</td>
<td>43 (1.5)</td>
<td>0.002</td>
</tr>
<tr>
<td>All other G−</td>
<td>933 (6.8)</td>
<td>651 (5.9)</td>
<td>282 (9.8)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>All other G+</td>
<td>90 (0.7)</td>
<td>58 (0.5)</td>
<td>32 (1.1)</td>
<td>0.001</td>
</tr>
</tbody>
</table>

*P value (chi-square) of the comparison between females and males.

in females, whereas E. faecalis, P. mirabilis, and P. aeruginosa were more common in men.

All the six most prevalent bacterial species, with the exception of K. pneumoniae, revealed statistically significant differences in isolation rates within the four chosen age groups (Table 3) with E. coli being less prevalent in the youngest subjects (58.9%) and more frequent in the age groups 15–29 (71.0%) and 30–59 years (71.0%).

Data stratification according to both gender and age showed that differences in frequency of isolation between females and males of E. faecalis and S. agalactiae were not consistent across all age groups (Table 3). Furthermore, E. coli isolation rates were shown to be lower in males aged ≥60 years (52.2%), whilst E. faecalis and P. aeruginosa were shown to be more prevalent in this group (11.6% and 7.8%, resp.), and in those aged ≤14 years (51.3%). Interestingly P. mirabilis prevalence was found to be highest (21.2%) in young males, aged ≤14 years.

Susceptibility to antimicrobials of main isolated uropathogens is shown in Table 4. E. coli susceptibility to orally active compounds ranged from 48.0% (ampicillin) to 97.0% (fosfomycin): susceptibility to trimethoprim-sulfamethoxazole (TMP-SMX) was 72.9%. Tested quinolones compounds resulted to be equally active against uropathogenic E. coli (ranging from 76.6% to 77.1%), and amoxicillin/clavulanic rate of activity (77.5%) was comparable to that of quinolones. Piperacillin was the parenteral antibiotic with the lowest rate of activity (51.9%) against E. coli; susceptibility of E. coli to gentamicin, ceftriaxone, and cefazolin ranged from 84.3% to 91%, while rates for piperacillin/tazobactam, amikacin, meropenem, and imipenem were higher (from 95.4% to 100%).

K. pneumoniae susceptibility to quinolones (93.0%–95.3%) and to TMP-SMX (89.8%) was higher in comparison to E. coli while fosfomycin activity resulted to be lower (81.0%). E. faecalis susceptibility to ampicillin and fosfomycin was high (96.1% and 100%, resp.), superior with respect to susceptibility to quinolones (71.9%–82.3%).

S. agalactiae susceptibility to levofloxacin was found to be 91.1% (data not shown).

4. Discussion

As urinary tract infection is a very common disease, its diagnosis and treatment have important implications for patients’ health, development of antibiotic resistance, and health care costs [1–5]. Surveillance of local UTI’s etiology as well as of antimicrobial susceptibility is considered useful to guide empirical therapy, as prevalence of pathogens and their features may vary with time and geographical area [10]. Attempts should also be made to increase prediction of causative uropathogens through the use of demographic and clinical available data.

The present retrospective study describes the distribution and antimicrobial susceptibility of bacterial species isolated from a large number of urinary samples collected over a 22-month period, as part of routine analyses, from unselected community patients (male and female of any age and clinical condition) living in a urban area in the north of Italy. The high number of available isolates allowed to stratify data according to patients’ gender and age and so to evaluate the association of such variables to UTI etiology.

As expected E. coli was the most frequently encountered species in our study. Percentage of E. coli isolation (67.6%) well compares with those reported from other outpatients surveys conducted in north (64.6%) [13] and south (68.0%) [14] of Italy. Other investigations conducted in Europe [15–19] found percentages of E. coli isolation ranging from 47.6% [16] to 85.9% [19], while, in North and Latin America, figures from 57.5% to 71.6% were reported [20, 21]. Unfortunately, true differences in local etiology are often difficult to establish due to large differences in study design, number of samples, and patients’ entry criteria as well as in data presentation, among different reports.

Other frequent isolates found in this study included K. pneumoniae, P. mirabilis, and E. faecalis, all having been reported to be highly prevalent species in UTIs [15, 16, 20], and P. aeruginosa and S. agalactiae whose frequency of isolation seems to be less constant across surveys. Isolation rates of Gram-positive bacteria other than E. faecalis and S. agalactiae were only 0.7%; S. aureus was responsible for 0.4% of these, a similar finding was observed by De Francesco et al. in north of Italy (0.9%) in year 2005 [13].

Our study, however, showed that prevalence of urinary pathogens following data stratification was not consistent across all age groups further divided by gender. Escherichia coli, for example, was found to be less prevalent in the youngest and oldest male subjects (51.3% and 52.2%, resp.) and more frequent in female patients aged 15 years or older.
Table 3: Distribution of urine pathogens according to age groups and gender. Data are reported as number of isolates and percentages (within brackets) of total patients in each age group.

<table>
<thead>
<tr>
<th>Organism</th>
<th>Gender</th>
<th>≤14 years</th>
<th>15–29 years</th>
<th>30–59 years</th>
<th>≥60 years</th>
<th>$P$</th>
</tr>
</thead>
<tbody>
<tr>
<td>All</td>
<td></td>
<td>703$^a$</td>
<td>841</td>
<td>4167</td>
<td>8109</td>
<td></td>
</tr>
<tr>
<td>Females</td>
<td></td>
<td>415</td>
<td>783</td>
<td>3615</td>
<td>6134</td>
<td></td>
</tr>
<tr>
<td>Males</td>
<td></td>
<td>288</td>
<td>58</td>
<td>552</td>
<td>1975</td>
<td></td>
</tr>
<tr>
<td>$E. coli$</td>
<td>All</td>
<td>414 (58.9)</td>
<td>597 (71.0)</td>
<td>2959 (71.0)</td>
<td>5374 (66.3)</td>
<td>0.0005$^b$</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>266 (64.1)</td>
<td>562 (71.8)</td>
<td>2591 (71.7)</td>
<td>4344 (70.8)</td>
<td>&lt; 0.0001$^c$</td>
</tr>
<tr>
<td></td>
<td>Male</td>
<td>148 (51.3)</td>
<td>35 (60.3)</td>
<td>368 (66.7)</td>
<td>1030 (52.2)</td>
<td></td>
</tr>
<tr>
<td>$K. pneumoniae$</td>
<td>Female</td>
<td>26 (6.3)</td>
<td>71 (9.1)</td>
<td>325 (9.0)</td>
<td>573 (9.3)</td>
<td>0.5626</td>
</tr>
<tr>
<td></td>
<td>Male</td>
<td>17 (5.9)</td>
<td>6 (10.3)</td>
<td>44 (8.0)</td>
<td>142 (7.2)</td>
<td></td>
</tr>
<tr>
<td>$E. faecalis$</td>
<td>All</td>
<td>14 (3.4)</td>
<td>42 (5.4)</td>
<td>222 (6.1)</td>
<td>318 (5.2)</td>
<td>0.9935</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>4 (1.4)</td>
<td>3 (5.2)</td>
<td>36 (6.5)</td>
<td>229 (11.6)</td>
<td></td>
</tr>
<tr>
<td>$P. mirabilis$</td>
<td>All</td>
<td>110 (15.6)</td>
<td>31 (3.7)</td>
<td>160 (3.8)</td>
<td>422 (5.2)</td>
<td>0.0055</td>
</tr>
<tr>
<td>$P. aeruginosa$</td>
<td>Female</td>
<td>21 (5.1)</td>
<td>6 (0.8)</td>
<td>19 (0.5)</td>
<td>103 (1.7)</td>
<td>&lt; 0.0001</td>
</tr>
<tr>
<td></td>
<td>Male</td>
<td>19 (6.6)</td>
<td>4 (6.9)</td>
<td>18 (3.3)</td>
<td>155 (7.8)</td>
<td></td>
</tr>
<tr>
<td>$S. agalactiae$</td>
<td>All</td>
<td>2 (0.3)</td>
<td>31 (3.7)</td>
<td>157 (3.8)</td>
<td>123 (1.5)</td>
<td>&lt; 0.0001</td>
</tr>
</tbody>
</table>

Table 4: Susceptibility rates to oral and parenteral antimicrobials of most common uropathogens isolated from urine samples.

<table>
<thead>
<tr>
<th>Organism (n; %)</th>
<th>CIP</th>
<th>LVX</th>
<th>NOR</th>
<th>NIT</th>
<th>SXT</th>
<th>AMP</th>
<th>AMC</th>
<th>FOS</th>
<th>PIP</th>
<th>TZP</th>
<th>CFZ</th>
<th>CRO</th>
<th>MRP</th>
<th>IMP</th>
<th>GEN</th>
<th>AMK</th>
</tr>
</thead>
<tbody>
<tr>
<td>$E. coli$ (9344;67.6%)</td>
<td>76.8</td>
<td>77.1</td>
<td>76.6</td>
<td>95.1</td>
<td>72.9</td>
<td>48.0</td>
<td>77.5</td>
<td>97.0</td>
<td>51.9</td>
<td>95.4</td>
<td>84.3</td>
<td>90.0</td>
<td>100</td>
<td>99.9</td>
<td>91.0</td>
<td>99.6</td>
</tr>
<tr>
<td>$K. pneumoniae$ (1204;8.7%)</td>
<td>93.6</td>
<td>93.0</td>
<td>95.3</td>
<td>35.1</td>
<td>89.8</td>
<td>0</td>
<td>81.4</td>
<td>81.0</td>
<td>61.8</td>
<td>92.3</td>
<td>78.3</td>
<td>87.9</td>
<td>99.7</td>
<td>99.9</td>
<td>92.9</td>
<td>97.1</td>
</tr>
<tr>
<td>$E. faecalis$ (868;8.3%)</td>
<td>71.9</td>
<td>82.3</td>
<td>—</td>
<td>96.1</td>
<td>—</td>
<td>96.1</td>
<td>—</td>
<td>100.0</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>$P. mirabilis$ (723;5.2%)</td>
<td>62.9</td>
<td>75.2</td>
<td>78.3</td>
<td>0</td>
<td>51.5</td>
<td>38.9</td>
<td>67.0</td>
<td>60.8</td>
<td>64.8</td>
<td>98.9</td>
<td>65.4</td>
<td>79.0</td>
<td>100</td>
<td>94.0</td>
<td>67.7</td>
<td>99.3</td>
</tr>
<tr>
<td>$P. aeruginosa$ (345;2.3%)</td>
<td>57.7</td>
<td>58.7</td>
<td>60.6</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>88.4</td>
<td>95.9</td>
<td>0</td>
<td>0</td>
<td>94.7</td>
<td>93.3</td>
<td>68.0</td>
<td>83.7</td>
</tr>
</tbody>
</table>

Note: CIP: ciprofloxacin; LVX: levofloxacin; NOR: norfloxacin; NIT: nitrofurantoin; SXT: trimethoprim-sulfamethoxazole; AMP: ampicillin; AMC: amoxicillin/clavulanic acid; FOS: fosfomycin; PIP: piperacillin; TZP: piperacillin/tazobactam; CFZ: cefazolin; CRO: ceftriaxone; MRP: meropenem; IMP: imipenem; GEN: gentamicin; AMK: amikacin.

(about 71%), $Proteus mirabilis$ prevalence was found to be highest (21.2%) in young males aged ≤14 years, whilst $S. agalactiae$ was mostly found in women aged between 15 and 59 years (approximately 4.0%).

Kiffer et al. [21] conducted a study comparable to ours, in terms of patient’s population (both males and females of any age), number of isolates (35 782), and selected age groups. They also found (1) a lower percentage of $E. coli$ isolation in patients younger than 13 years or older than 60 years (69.0% and 68.8%, resp.) as compared to the age group 13–60 years (79.7%); (2) a higher difference in $E. coli$ rates of isolation, between males and females, in the youngest (27.2%) and the oldest (25.8%) age groups with respect to the 13–60 years age group (8.9%); (3) a higher prevalence of $E. faecalis$ (16.4%) and $P. aeruginosa$ (14.7%) in males older than 60 years, approximately three and six times higher, respectively, as compared to females of the same age group; (4) $P. mirabilis$ to be the second leading cause of UTI in pediatric population.
Morré and Oskoi reported children UTIs. Although it is a common cause of urinary tract infections in boys, despite its low prevalence in the preadolescent female genital tract, _P. mirabilis_ has been described to be present in the preputial sac of boys, having been isolated in 22.6% of uncircumcised males of up to 14 years of age. This can support the role of _P. mirabilis_ as an important urinary pathogen in this group of patients. However, _P. mirabilis_ also seems to represent an important urinary pathogen in young females as supported by the high isolation rates in this group of patients observed in our study and by Kiffer et al. [21], in spite of its low prevalence in the preadolescent female genital tract flora.

Susceptibility of uropathogenic bacteria to antimicrobials agents is also known to vary among countries and over time. European Urology Association (EUA) Guidelines recommend trimethoprim/sulfamethoxazole (TMP/SMX) as first line drug for empirical therapy in community-acquired infections, when local rates of resistance of uropathogens to TMP are <10–20%.

In our survey, 72.9% of _E. coli_ isolates were susceptible to TMP/SMX. Comparable figures of _E. coli_ susceptibility to TMP/SMX were found in Italy by De Francesco et al. [28, 29], _E. coli_ susceptibility to fluoroquinolones in our study ranged from 76.6% (norfloxacin) to 77.1% (levofloxacin) which was similar to rates observed in Italy by De Francesco et al. [30]. _E. coli_ susceptibility to amoxicillin/clavulanate in our study was found to be low (48%) and comparable to other reports from Italy [11] and Europe [8, 16]. Susceptibility of _E. coli_ to amoxicillin/clavulanate in our study was higher (77.5%) than that observed for ampicillin and similar to what recently reported from Italy by Miragliotta et al. [71.6% overall, from 2001 to 2006] [14]. Although values may vary among reports, resistance rate of recently community isolated of _E. coli_ to TMP/SMX in Europe tends to be >20% [16], having also being reported higher than 30% [28, 29]. _E. coli_ susceptibility to fluoroquinolones ranges from 76.6% (norfloxacin) to 77.1% (levofloxacin) which was similar to rates observed in Italy by De Francesco et al. [28, 29]. _E. coli_ susceptibility to amoxicillin/clavulanate in our study was found to be low (48%) and comparable to other reports from Italy [11] and Europe [8, 16]. _E. coli_ susceptibility to amoxicillin/clavulanate in our study was higher (77.5%) than that observed for ampicillin and similar to what recently reported from Italy by Miragliotta et al. [71.6% overall, from 2001 to 2006] [14]. Although De Francesco et al. found even higher susceptibility rates (90%) [13] more in line with other recent reports from Europe [16, 19]. Among the oral antimicrobial compounds tested in our study fosfomycin exhibited the highest activity against _E. coli_ (97.0%). A comparable result was shown in a number of other studies conducted in Italy and Europe [8, 14, 16, 30] where _E. coli_ susceptibility to fosfomycin ranged between 90.8% [14] and 98.1% [16].

Susceptibility to oral antimicrobials of _P. mirabilis_ strains isolated in our study, was generally lower than that reported both in Italy and other countries. Susceptibility to ciprofloxacin and TMP/SMX of _P. mirabilis_ isolates in our study was of 62.9% and 51.5%, respectively, as compared to rates demonstrated by other authors ranging from 75.5% to 97.9% for ciprofloxacin and from 52.0% to 84.9% for TMP/SMX [8, 13–16]. Similarly, rates of _P. mirabilis_ susceptibility to ampicillin, amoxicillin/clavulanate, and fosfomycin were lower in this study (38.9%, 67.0%, and 68.8%, resp.), in comparison to those described in previous reports where ranges of susceptibility rates of 53.6%–83.9% to ampicillin, 79.6%–99.0% to amoxicillin/clavulanate, and 60.0%–96.9% to fosfomycin were reported [8, 13–16].

In conclusion, besides providing further data on the etiology of community-acquired UTIs and antimicrobial susceptibility of uropathogens in Italy, our results confirm that stratification of isolates from unselected patients on the basis of age and gender can improve the assessment of causative pathogens, providing guidance for empiric treatment and interesting clues to the understanding of UTIs etiopathology.

In particular, _P. mirabilis_ prevalence was found to be high both in boys (21.2%) and girls (11.8%) suggesting, as previously reported [30], that fosfomycin could represent a drug of choice for the therapy of children's UTIs, especially when considering its good antibacterial activity against both _E. coli_ and _P. mirabilis_ (higher as compared to β-lactams) and the concerns on fluoroquinolones use in children. For other patients’ subgroups, it was noted that frequently isolated bacterial species, such as _E. faecalis_ or _P. aeruginosa_ in older males, showed different antimicrobial susceptibilities as compared to _E. coli_, underlying the importance that empiric treatment should be based on epidemiological data which takes into account patients gender and age.

### Conflict of Interests

No competing interests are declared.

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[4] Royal College of General Practitioners, Office of Population Censuses and Surveys, Department of Health, _Morbidity_


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