Wide dissemination of colistin-resistant Escherichia coli with the mobile resistance gene mcr in healthy residents in Vietnam

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The study was approved by the Ethics Committees of Osaka University (yakujin 29-8) and Thai Binh University of Medicine and Pharmacy (no. 773.1). All participants provided written informed consent. For any participant younger than 18 years, written informed consent was obtained from the respective parents.

As shown in Table 1, most of the stool specimens were culture positive on a selective-medium plate (CHROMagar™ COL-APSE). Among these colonies, colistin-resistant Escherichia coli (CR-E) that exhibited MICs of colistin between 8 and 16 mg/L were detected in 69 out of 98 specimens tested. The proportion of households that had members carrying CR-E was also quite high at 80.6% (29 positive, out of 36 households tested). Furthermore, almost all colistin-resistant isolates possessed mcr-1 and/or mcr-3, except one that did not contain mcr-1 to -5, as determined by PCR.

PFGE analysis of CR-E isolates showed that, within a household, the members of five households carried a similar strain, but between households there were no similar strains (Figure S1, available as Supplementary data at JAC Online).

Resistance profiles of CR-E to other antibiotics varied between 0 and 11, out of the 14 antibiotics tested (ampicillin, cefoxitin, cefotaxime, ceftazidime, meropenem, streptomycin, kanamycin, gentamicin, ciprofloxacin, nalidixic acid, tetracycline, chloramphenicol, fosfomycin and trimethoprim/sulfamethoxazole). The average number of antibiotics to which isolates were resistant was 5.6. The rate of MDR, defined as resistance to at least one antibiotic drug in three or more antibiotic classes,6 of CR-E isolates was determined to be 92.8% (64/69). There were no carbapenem- or fosfomycin-resistant CR-E isolates (Table S1).

In contrast to the studies conducted on colistin-resistant bacteria in food animals, there have been only limited studies on the prevalence of colistin-resistant bacteria with mcr in healthy individuals. However, one recent study focused on mcr-1-carrying bacteria in the faecal samples of chicken farmers in Vietnam.7 This study reported that 25% of farmers were colonized with mcr-1-carrying bacteria that grew on non-selective medium. However, this protocol may have the potential to lose CR-E strains owing to the abundant susceptible bacteria in stool specimens. As a result, it is difficult to obtain the true prevalence of colistin-resistant bacteria in stool specimens. In the current study, we utilized the selective medium, CHROMagar™ COL-APSE, for identifying colistin-resistant bacteria. The advantage of this method lies in its ability to detect the presence of colistin-resistant bacteria, regardless of their number.

The results of this study revealed a surprisingly high dissemination of CR-E harbouring mcr in the faecal microbiota of residents of a rural community in Vietnam. In particular, it was remarkable from a public health point of view, since most participating households had CR-E carriers.

Colistin is one of the most commonly used antibiotics in chickens and pigs in Vietnam.8,9 The amount of colistin used per kg of live animal per week is as high as 14 mg for chickens and 57 mg for pigs.9 Such a high amount of colistin consumption by animals in Vietnam may facilitate the wide dissemination of CR-E in residents of rural communities. To the best of our knowledge, this is the first...
report of an extremely high prevalence of CR-E in residents and households.

Concordance between CR-E isolates was assessed by PFGE. The results showed that an expansion of specific clones was not observed at this high prevalence of CR-E. However, since more than 95% of CR-E isolates had \textit{mcr-1}, the horizontal transfer of \textit{mcr-1} among bacteria, under colistin abuse in the agricultural sector, and dissemination of these bacteria in humans via food, seems reasonable.

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**Transparency declarations**

None to declare.

**Supplementary data**

Figure S1 and Table S1 are available as Supplementary data at JAC Online.

**References**


**Table 1.** Characteristics of participant residents and CR-E in their stool specimens

<table>
<thead>
<tr>
<th>No. of households</th>
<th>Range of participants per household</th>
<th>Average number of participants per household</th>
<th>Total number of participants</th>
<th>Age range (years)</th>
<th>Median age (years)</th>
<th>Number of males</th>
</tr>
</thead>
<tbody>
<tr>
<td>36</td>
<td>1–6</td>
<td>2.7</td>
<td>98</td>
<td>2–81</td>
<td>46</td>
<td>44 (44.9%)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Number of specimens tested (one per participant)</th>
<th>Number of positive culture specimens on CHROMagar™ COL-APSE</th>
<th>Number of \textit{E. coli} isolates that grew on CHROMagar™ COL-APSE</th>
<th>Number of colistin-resistant \textit{E. coli} isolates (MIC &gt;2 mg/L)</th>
<th>Number of \textit{mcr}-positive \textit{E. coli} isolates</th>
<th>\textit{mcr} status</th>
</tr>
</thead>
<tbody>
<tr>
<td>98</td>
<td>88 (89.8%)</td>
<td>83 (84.7%)</td>
<td>69 (70.4%)</td>
<td>68</td>
<td>64</td>
</tr>
</tbody>
</table>

\textit{mcr-1} \textit{mcr-3} \textit{mcr-1/3}