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PREVALENCE OF ESBL-PRODUCING ESCHERICHIA COLI AMONG FOOD HANDLERS AND HOUSEHOLD CONTACTS IN URBAN SETTINGS

Original Article

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Short Title: ESBL-Producing E. coli Carriage in Urban Communities

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Abstract

Background: Extended-spectrum beta-lactamase (ESBL)-producing *Escherichia coli* has emerged as a major public health concern, extending beyond hospital environments into community settings. Food handlers and household contacts represent potential reservoirs for resistant organisms, yet data on their colonization in urban areas remain limited.

Objective: To estimate the prevalence of ESBL-producing *E. coli* carriage among food handlers and their household contacts in an urban setting, and to examine its associations with recent antibiotic use, hygiene practices, and recent gastrointestinal illness.

Methods: This four-month, cross-sectional study was performed in Lahore. Enrollment included 320 individuals, comprising 160 food handlers and an equal number of their household contacts. Standardized microbiological methods were employed for the collection and processing of stool samples, with Extended-Spectrum Beta-Lactamase (ESBL) production verified in accordance with Clinical and Laboratory Standards Institute (CLSI) recommendations. Sociodemographic data, history of antibiotic consumption within the preceding three months, hygiene behaviors, and episodes of recent gastrointestinal illness were obtained via a structured questionnaire. All statistical analyses were conducted with SPSS software (v. 26), utilizing logistic regression to calculate adjusted odds ratios (AORs).

Results: Overall prevalence of ESBL-producing *E. coli* was 32.5%, with food handlers showing a slightly higher prevalence (35.6%) compared to household contacts (29.4%). Recent antibiotic use was strongly associated with carriage (AOR 3.21, 95% CI: 1.86–5.52), as were poor hygiene practices (AOR 2.48, 95% CI: 1.39–4.43) and gastrointestinal illness within the past month (AOR 1.87, 95% CI: 1.04–3.37). Carriage was inversely associated with higher educational level but not with sex or age.

Conclusion: ESBL-producing *E. coli* carriage was common among both food handlers and household contacts, with prevalence exceeding 30%. Antibiotic misuse, poor hygiene, and gastrointestinal illness emerged as key modifiable risk factors. Community-level interventions focusing on antibiotic stewardship and hygiene education are essential to reduce the burden and transmission of resistance.

Keywords: Antibiotic Stewardship, Community-Acquired Infections, Escherichia coli, Extended-Spectrum Beta-Lactamases, Food Handlers, Gastrointestinal Diseases, Hygiene, Microbial Drug Resistance.

Introduction

Escherichia coli (E. coli), a common inhabitant of the human gut microbiota, is also a primary agent responsible for both intestinal and systemic infections globally (1). Recent decades have seen an alarming increase in antibiotic-resistant *E. coli* variants, most notably strains that generate extended-spectrum beta-lactamases (ESBLs) (2). These ESBL enzymes render bacteria resistant to a critical class of antibiotics, including third-generation cephalosporins, which are essential for treating serious infections (3). The rise and spread of ESBL-producing *E. coli* present a major public health threat. This is especially true in low- and middle-income nations, where monitoring is often inadequate, antibiotic usage is frequently not controlled, and conditions in community environments favor bacterial transmission (4).

Certain community groups are of particular epidemiological importance. Food handlers, for example, are a key population in the spread of antimicrobial resistance because of their potential to transfer resistant bacteria via contaminated food and surfaces (5). In urban settings where many people consume vendor-prepared meals, poor hygiene practices can promote pathogen dissemination. Likewise, household members are instrumental in maintaining chains of colonization and infection (6). The intimate contact, shared living spaces, and common meals within households can enable the silent spread of ESBL-producing *E. coli* (7).

Despite increasing awareness of these dangers, most existing research concentrates on hospital surveillance and clinical patients. This leaves a significant gap in knowledge concerning asymptomatic carriage in the general community, where individuals act as hidden reservoirs. Accumulating evidence indicates that the community burden of ESBL-producing bacteria might be underestimated (8). Research from regions such as South and Southeast Asia, for instance, reports disturbingly high colonization rates—frequently exceeding 30%—in healthy populations. Comparable data from Africa and Latin America confirm that antimicrobial resistance has moved beyond healthcare facilities and is now entrenched in communities (9). This issue is especially urgent in crowded urban areas, where factors like high population density, frequent movement, and poor sanitation can accelerate the spread of resistant organisms. These circumstances highlight the need for focused investigation into community carriers, particularly those whose occupations or domestic situations increase the potential for transmission.

Antibiotic consumption is a well-documented driver of resistance, with recent or inappropriate use increasing the likelihood of harboring resistant strains. In many urban settings, antibiotics are easily accessible without prescription, and self-medication practices are widespread. This overuse and misuse accelerate the selection pressure for resistant organisms, particularly ESBL producers (1). Hygiene practices, another important determinant, can either mitigate or exacerbate this risk. Poor adherence to hand hygiene, unsafe food handling, and inadequate sanitation create opportunities for resistant bacteria to spread among food handlers, their customers, and household contacts. Additionally, recent episodes of gastrointestinal illness may disrupt the gut microbiota, providing a more favorable environment for colonization by resistant organisms. Each of these factors highlights the interconnected nature of antibiotic use, hygiene behavior, and microbial carriage. Despite the magnitude of the problem, relatively little attention has been given to understanding the burden of ESBL-producing E. coli in healthy food handlers and their households in urban settings. Most available studies have prioritized clinical isolates, while asymptomatic carriers remain understudied (2). This represents a missed opportunity to understand the silent community reservoirs that contribute to the persistence and transmission of antimicrobial resistance. Without identifying these reservoirs, interventions to curb resistance risk being incomplete or misdirected. Furthermore, urban food environments represent dynamic systems where bacteria may spread not only between handlers and consumers but also into households, perpetuating a cycle of colonization that sustains resistance within the population.

The rationale for the present study is therefore rooted in this urgent public health need. By investigating the prevalence of ESBL-producing E. coli carriage among food handlers and their household contacts, valuable insights can be gained into the extent of community colonization and the factors that drive it. This research specifically explores the association between carriage and recent antibiotic use, hygiene practices, and episodes of gastrointestinal illness, as these represent modifiable risk factors that may be targeted by public health interventions. Understanding these associations is critical in designing preventive strategies that extend beyond clinical management to encompass community-level interventions, including antibiotic stewardship, food safety education, and household hygiene promotion. In summary, the rise of ESBL-producing E. coli underscores a global health crisis that transcends

hospital boundaries and extends into the everyday lives of communities. Food handlers and their households are pivotal in this transmission chain but remain insufficiently studied in urban environments (3). This study seeks to address this gap by estimating the prevalence of ESBL-producing E. coli among these populations and by examining how recent antibiotic use, hygiene behaviors, and gastrointestinal illness contribute to colonization. The objective is to generate evidence that not only quantifies the burden but also informs context-specific strategies for breaking the cycle of resistance at its community source.

Methods

This community-based cross-sectional investigation was implemented over four months in Lahore, Pakistan. Its objectives were to determine the prevalence of ESBL-producing Escherichia coli carriage among food handlers and their cohabiting family members, and to examine potential links with recent antibiotic consumption, hygiene behaviors, and gastrointestinal symptoms. A cross-sectional approach was selected as the optimal design for evaluating both the colonization rate and its association with key variables within a specific timeframe in a large urban population. Study participants were recruited from various food outlets—such as street vendors, small restaurants, and home-based food businesses—and from the residences of enrolled food handlers. Inclusion criteria required individuals to be at least 18 years of age and actively engaged in food preparation or handling for the food handler group. At least one consenting household member from the same residence was also recruited; household participants needed to be at least 10 years old to ensure adequate understanding during the consent and interview process. Exclusion criteria comprised current hospitalization, long-term antibiotic prophylaxis, and refusal to submit a stool specimen. The sample size was determined using a standard formula for prevalence studies. Assuming an anticipated community carriage prevalence of 25% for ESBL-producing E. coli, a 95% confidence level, and a 5% margin of error, a minimum sample of 288 participants was calculated. To accommodate possible non-response and incomplete data, this number was increased by 10%, resulting in a target enrollment of 320 individuals, equally divided between food handlers and household contacts.

Data collection encompassed both biological sampling and interviewer-administered surveys. Each participant provided a fresh stool sample in a sterile container under the supervision of trained personnel. Specimens were transported in cold containers to the microbiology laboratory within four hours. Culturing was performed on MacConkey agar supplemented with cefotaxime to screen for ESBL-producing bacteria. Colonies indicative of E. coli were identified via conventional biochemical tests and confirmed with API 20E kits. ESBL production was verified using the double-disk synergy test with cefotaxime, ceftazidime, and clavulanic acid, adhering to Clinical and Laboratory Standards Institute (CLSI) recommendations. All laboratory procedures followed strict biosafety protocols. Concurrently, trained interviewers administered a structured questionnaire in the local language. The instrument captured sociodemographic details, antibiotic use within the preceding three months, self-reported hygiene practices (including handwashing frequency before food handling and after toilet use, later categorized as high, moderate, or poor adherence), and any gastrointestinal illness (diarrhea, vomiting, or abdominal pain) experienced in the prior month. The questionnaire was pretested on 20 individuals, and adjustments were made for clarity and cultural suitability.

The primary outcome was defined as stool carriage of ESBL-producing E. coli, reported as prevalence for each participant group. Secondary outcomes assessed associations between carriage status and three exposures: recent antibiotic use, hygiene practice categories, and recent gastrointestinal illness (a binary variable). Antibiotic use was assessed via participant recall and, where feasible, verified with prescriptions or medication packaging. Data were entered into a secure electronic database with double verification. Analyses were conducted using SPSS version 26. Descriptive statistics summarized baseline characteristics. Prevalence was reported with 95% confidence intervals. Associations between carriage and exposures were initially examined using chi-square tests for categorical variables. Subsequently, logistic regression was employed to calculate adjusted odds ratios, controlling for confounders like age, gender, and education, with statistical significance set at $p < 0.05$. Ethical approval was granted by the Institutional Review Board of the University of Health Sciences, Lahore. Written informed consent was obtained from all adults; for minors aged 10–17, parental/guardian consent and participant assent were secured. Confidentiality was maintained using unique identifiers and password-protected files. Colonized individuals received counseling on hygiene and advice to seek medical attention

if symptomatic. By combining microbiological analysis with community behavioral data, this methodology aimed to provide reliable insights into ESBL-producing E. coli prevalence and associated modifiable risk factors within urban food and household settings.

Results

The investigation successfully included 320 subjects, with an equal distribution of 160 food handlers and 160 of their cohabiting family members, all of whom submitted complete questionnaires and viable stool samples for evaluation. Participants had a mean age of 34.7 years (standard deviation ± 11.6), ranging from 12 to 65 years. Males constituted slightly over half of the cohort (52.5%), and most participants had completed primary education. The average household contained 6.2 individuals (± 2.4), illustrating the compact living arrangements common in urban Lahore. Initial demographic and social details are summarized in Table 1.

Laboratory analysis of stool cultures indicated that 104 individuals (32.5%) were carriers of extended-spectrum beta-lactamase (ESBL)-producing *Escherichia coli*. The colonization rate was 35.6% (57 out of 160) among food handlers, compared to 29.4% (47 out of 160) among their household contacts. This difference did not reach statistical significance ($p = 0.18$). Most isolated strains showed resistance to cefotaxime and ceftazidime, whereas all confirmed isolates remained susceptible to carbapenems.

Analysis of risk factors demonstrated that recent antibiotic use within the preceding three months was reported by 91 participants (28.4%). Of these, 54.9% carried ESBL-producing *E. coli*, compared to 23.0% among those without recent antibiotic exposure. This difference was highly significant ($p < 0.001$), and the unadjusted odds ratio indicated more than a threefold higher likelihood of carriage among recent antibiotic users. Hygiene practices varied, with 41.3% of participants reporting high adherence, 36.6% moderate adherence, and 22.1% poor adherence. ESBL carriage was most prevalent among those with poor hygiene practices (48.6%), followed by moderate (30.5%), and least among those with high adherence (21.4%) ($p < 0.001$). Gastrointestinal illness within the past month was reported by 67 individuals (20.9%), and the prevalence of ESBL carriage in this group was 46.3% compared to 28.1% among those without illness ($p = 0.01$). Multivariable logistic regression demonstrated that recent antibiotic use, poor hygiene adherence, and gastrointestinal illness remained independently associated with ESBL carriage after adjusting for age, gender, and education. Recent antibiotic use had an adjusted odds ratio (AOR) of 3.21 (95% CI: 1.86–5.52), poor hygiene practices an AOR of 2.48 (95% CI: 1.39–4.43), and gastrointestinal illness an AOR of 1.87 (95% CI: 1.04–3.37).

The overall prevalence of ESBL-producing *E. coli* was comparable across males (33.9%) and females (31.0%) ($p = 0.61$). Age did not significantly influence carriage, though slightly higher prevalence was observed in the younger age group (18–30 years, 36.1%) compared to older adults (>50 years, 27.3%). Educational level showed a protective gradient, with the lowest prevalence among those with tertiary education (20.8%) compared to those without formal education (41.7%). The findings clearly demonstrated that carriage of ESBL-producing *E. coli* was common among both food handlers and their household contacts in Lahore, with prevalence exceeding 30%. Antibiotic use, hygiene behavior, and gastrointestinal illness were consistently and strongly associated with carriage, highlighting these as important exposures of interest. Tables 2 to 4 and Figures 1 and 2 summarize the key outcome data.

Table 1: Demographic and baseline characteristics of participants (n=320)

Variable	*Food Handlers (n=160)*	*Household Contacts (n=160)*	*Total (n=320)*
Mean age (years ± SD)	35.2 ± 10.8	34.1 ± 12.4	34.7 ± 11.6
Male sex (%)	88 (55.0)	80 (50.0)	168 (52.5)
Primary education or more (%)	126 (78.8)	118 (73.8)	244 (76.3)
Mean household size	6.1 ± 2.3	6.4 ± 2.5	6.2 ± 2.4

Table 2: Prevalence of ESBL-producing *E. coli*

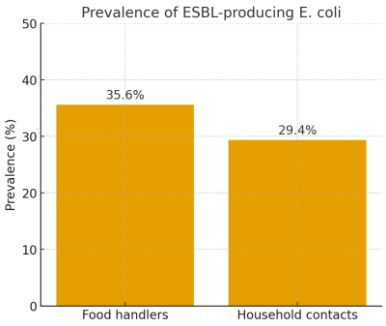
Group	*Carriers n (%)*	*Non-carriers n (%)*	*p-value*
Food handlers (n=160)	57 (35.6)	103 (64.4)	0.18
Household contacts (n=160)	47 (29.4)	113 (70.6)	
Total (n=320)	104 (32.5)	216 (67.5)	

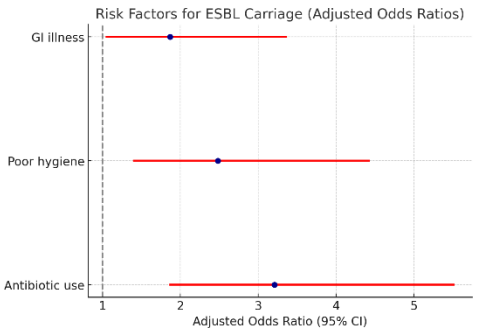
Table 3: ESBL carriage by recent antibiotic use and hygiene practices

Variable	*Carriers n (%)*	*Non-carriers n (%)*	*p-value*
Antibiotic use (n=91)	50 (54.9)	41 (45.1)	<0.001
No antibiotic use (n=229)	54 (23.6)	175 (76.4)	
High hygiene adherence (n=132)	28 (21.2)	104 (78.8)	<0.001
Moderate hygiene (n=117)	36 (30.8)	81 (69.2)	
Poor hygiene (n=71)	34 (47.9)	37 (52.1)	

Table 4: ESBL carriage by gastrointestinal illness (n=320)

V ariable	*Carriers n (%)*	*Non-carriers n (%)*	*p-value*
Gastrointestinal illness (n=67)	31 (46.3)	36 (53.7)	0.01
No illness (n=253)	71 (28.1)	182 (71.9)	





Discussion

The present study demonstrated that colonization with ESBL-producing *Escherichia coli* was common among both food handlers and their household contacts in an urban setting, with overall prevalence exceeding 30%. This finding highlights that antimicrobial resistance has extended well beyond hospital walls and is firmly entrenched in community environments (13). The observation that recent antibiotic use, poor hygiene practices, and recent gastrointestinal illness were independently associated with carriage emphasizes the multifactorial drivers of resistance spread in the population (14). The prevalence reported here aligns with estimates from South and Southeast Asia, where community carriage rates have been documented between 20% and 40% (15). Comparable studies from India and Bangladesh reported prevalence exceeding 30%, particularly among healthy individuals in urban areas. In Africa, prevalence estimates have ranged more widely, though similarly elevated figures have been noted in Nigeria and Ethiopia (16). The current results therefore confirm the global recognition that ESBL-producing organisms are no longer confined to healthcare-associated infections but circulate widely among asymptomatic carriers in the community (17). That the prevalence among food handlers was slightly higher than among household contacts suggests occupational exposure and food-handling practices may contribute to increased risk, though both groups demonstrated substantial carriage rates (18). The association with recent antibiotic use was both strong and statistically significant, consistent with well-established evidence that antibiotic exposure promotes selection and persistence of resistant organisms in the gut. The threefold increased odds of carriage among recent antibiotic users observed in this study mirrors findings from international cohorts, where inappropriate or repeated antibiotic consumption has consistently emerged as a critical determinant of resistance (19). This highlights the urgent need for robust community-level antibiotic stewardship interventions, particularly in settings where antibiotics remain easily accessible without prescription (20). Hygiene behavior was also a significant predictor of carriage, with poor adherence nearly doubling the likelihood of colonization compared with high adherence. This finding supports the widely acknowledged role of hygiene in preventing both foodborne transmission and interpersonal spread of resistant organisms. Previous research in community food environments has emphasized that lapses in hand hygiene among food handlers create opportunities for resistant bacteria to contaminate prepared food, thereby reaching wider populations (21). The current study strengthens this argument by demonstrating a direct link between self-reported hygiene practices and carriage status.

The observation that gastrointestinal illness was associated with increased prevalence of ESBL carriage provides an additional layer of understanding. Disturbances in the intestinal microbiota during diarrheal episodes may create conditions conducive to colonization by resistant organisms (22). Although causality cannot be established in a cross-sectional design, the association underlines the importance of considering gastrointestinal health when examining resistance dynamics in the community. The implications of these findings are substantial. Food handlers occupy a central position in urban food systems, and colonization with resistant organisms poses potential risks for wider dissemination through prepared meals and kitchen environments. The presence of colonization among household contacts further illustrates that resistance is sustained within family units, creating silent reservoirs that may complicate infection control. The study highlights the necessity of integrated interventions that address not only clinical management but also food safety education, community awareness of hygiene, and rational antibiotic use. A key strength of this research lies in its combined approach, integrating microbiological confirmation with behavioral and epidemiological data. This

dual perspective allows for a more comprehensive understanding of how resistant organisms circulate within the community and the factors that sustain them. The inclusion of both food handlers and household contacts provides comparative insights into occupational and domestic risk factors, an area rarely addressed in previous studies. Laboratory confirmation using standardized methods further strengthens the validity of the microbiological findings.

Nonetheless, certain limitations must be acknowledged. The cross-sectional design precludes causal inference, and associations between exposures and carriage must be interpreted cautiously. Self-reported data on antibiotic use and hygiene practices may have been subject to recall or social desirability bias, potentially underestimating the strength of associations. The study was limited to one urban center, and while Lahore provides a representative urban environment, results may not be generalizable to rural or peri-urban settings. Additionally, molecular characterization of the ESBL genes was not performed, which would have provided deeper insights into the specific resistance mechanisms circulating in the community. Despite these limitations, the study adds to the growing body of evidence that antimicrobial resistance in *E. coli* is an entrenched problem in community settings. By identifying modifiable factors such as antibiotic use and hygiene, it provides actionable evidence for policymakers and public health practitioners. Future research should build on these findings by incorporating longitudinal designs to explore causal pathways, expanding geographic coverage to capture rural and semi-urban contexts, and integrating molecular epidemiology to better track transmission dynamics. Intervention studies focusing on hygiene promotion among food handlers and stewardship programs at the community level would also be valuable in testing practical strategies to curb the spread of resistance.

Conclusion

This study demonstrated a high prevalence of ESBL-producing *E. coli* among food handlers and their household contacts in Lahore, with significant associations identified for antibiotic use, hygiene behavior, and gastrointestinal illness. The findings underline the importance of antibiotic stewardship and hygiene interventions in the community to interrupt the cycle of resistance. Addressing these modifiable risk factors is essential for limiting the spread of resistant organisms in both food environments and households.

AUTHOR CONTRIBUTIONS

Author	Contribution
Shabeer Haider****	Designed the study, performed data collection and analysis, and prepared the manuscript. Approved the final draft for submission.
Murtaza Khodadadi	Contributed to study design, data acquisition, interpretation of findings, and performed critical review and editing of the manuscript. Approved the final draft for submission.

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