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Relationship between the dietary consumption patterns and prevalence of enteric bacterial pathogens in patients with acute gastrointestinal infections in Kirkuk, Iraq

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Abstract

Enteric bacterial infection is one of the leading issues of national health in Kirkuk, Iraq, where various eating patterns and environment conditions can affect the spread of the disease. This analytical, cross-sectional research was done on the period between January and December 2025 in primary healthcare centers and large hospitals in Kirkuk Province, to investigate the connection between dietary habits, environmental, and the occurrence of enteric bacterial pathogens in patients with acute gastrointestinal symptoms. Consecutive sampling was done to recruit 150 in patients with acute diarrhea. A structured questionnaire was used to gather sociodemographic, dietary, environmental, and clinical data, and stool samples were processed with the help of the conventional method of microbiological culture and biochemical identification. Of the 150 samples that were tested; 102 (68.0 %) of the samples had positive bacterial pathogens. *Escherichia coli* was the most commonly identified pathogen (34.3 %), then *Salmonella spp*. (23.5 %), and the *Shigella spp*. (17.6 %). Important correlations were found between prevalence of infections and the frequent consumption of fast-foods ($p = 0.004$), consumption of undercooked meat ($p < 0.001$) and consumption of poorly washed vegetables ($p < 0.001$). Other environmental factors that had a significant association with infection were untreated sources of water ($p = 0.002$), poor hand hygiene ($p < 0.001$) and improper food storage ($p = 0.01$). Multivariate logistic regression analysis showed that there were independent predictors of bacterial infection, namely, rare handwashing (OR = 3.8), untreated water (OR = 3.5), unwashed vegetables (OR = 3.1), and undercooked meat (OR = 2.7). These results indicate the key importance of behavioral and environmental factors, which can be modified to decrease the burden of enteric infections.

Keywords: Enteric Bacterial Infection; Dietary Patterns; Environmental Factors; Hygiene Practices; Cross-Sectional Study; Iraq

1. Introduction

Enteric bacterial infections are still a significant public health problem in most developing nations such as Iraq where they are a significant factor in morbidity and mortality, especially in children below five years of age and elderly persons. These infections may be of varying clinical manifestations that may include mild diarrhea and life threatening illness and may have severe complications in case of improper management. Pathogenic bacteria are mostly transmitted with contaminated water and foodstuff, and this issue is further aggravated by poor eating habits which include eating under cooked meat, raw fruits and vegetables, and high-risk fast foods, as well as poor personal hygiene and environmental sanitation[1].

The scientific evidence shows that dietary practices, food handling habits and food storing procedures are strongly associated with the occurrence of enteric bacterial pathogens in society. Indicatively, the risk of infection has been linked to frequent intake of fast foods and meat that has been cooked improperly, but regular handwashing, utilization of treated water, and good storage of food materials have an important role in reducing this risk. Regardless of this

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information, there is a paucity of studies that specifically concentrates on the effects of diet and environmental variables on enteric infection in the Iraqi setting especially in socially and demographically diverse areas like Kirkuk[2].

Studies on the association between the dietary consumption patterns, environmental cleanliness, and the occurrence of enteric bacterial pathogens are necessary so as to establish independent risk factors that lead to infection. The purpose of this study was to determine these associations in patients who present themselves to the primary healthcare center and the large hospital with acute gastrointestinal symptoms in Kirkuk, which is located in Iraq. Multivariate statistical analysis has been used to identify the most significant predictors of diet and environment. The results should offer evidence-based recommendations on the public health measures, foster safe food handling and hygiene, and eventually decrease the rate of the enteric bacterial infections in the community[3].

2. Materials and Methods

2.1. Study Design and Target Population

This research was carried out as analytical cross-sectional research in the period between January and December 2025 in a number of primary healthcare centers and leading hospitals in Kirkuk Province, Iraq. In the selection of the location, Kirkuk is a demographically and socially diverse region including urban and rural areas, which is a good place to study how diet and environmental conditions affect the occurrence of enteric bacterial pathogens. The research was aimed at patients visiting medical organizations with the symptoms of acute enteric infection. To achieve uniformity in the identification of cases, a unified clinical definition of acute diarrhea (more than 3 loose or watery stools in 24 hours and less than 14 days) was used[4].

2.2. Sample Size and Inclusion/Exclusion Criteria

The researchers used the consecutive sampling technique to select 150 participants who were eligible based on the patients who visited the chosen healthcare institutions within the study duration to reduce the selection bias. A sample size was determined using the prevalence of enteric infections in the local community which has an estimated prevalence with a 95 % confidence level and a margin of error of five percent. Inclusion criteria included patients of any age coming with acute diarrhea or suspicious of Enteric infection (abdominal pain, fever, vomiting), living in Kirkuk Province at least one year to be able to reflect local dietary practices, and to provide written informed consent (or parental consent in the case of minors). The exclusion criteria were the use of antibiotics within the two weeks before sample collection to prevent interference of microbiological results, chronic gastrointestinal diseases including inflammatory bowel disease, and hospitalization in the past month to minimize the chance of presence of hospital-acquired infections[5].

2.3. Collection of Dietary, Demographic, and Environmental Data

The data were gathered through structured and standard questionnaire that was designed based on the available scientific literature and guidelines suggested by the World Health Organization. Content validity was checked by the instrument through the review of experts in the field of public health and microbiology. The interviews were carried out face-to-face by approved researchers and a pilot study with 30 non-sample participants was carried out to test clarity and consistency. The variables were collected in the form of demographic (age, sex, education level, monthly income, and residence type: urban/rural), dietary (frequency of fast food consumption; intake of vegetables and fruits washed/unwashed, intake of sweetened drinks, intake of fermented foods, intake of meat and poultry properly cooked/undercooked/packaged foods), environmental and hygienic (source of drinking water, handwashing behavior, hygiene of kitchen utensils, food storage type, contact with domestic animalsand health-related presence) [6].

2.4. Isolation and Identification of Enteric Bacteria

Stool samples were placed in sterile containers and transferred to the laboratory within two hours after collection or placed in suitable transport media in case of necessity. Microbiological test was carried out as per the normal lab practices. The specimen was grown on selective and differential media that can support the growth of the most common enteric bacterial pathogens and incubated at 37 °C during 18-24 hours. Colony morphology and microscopic examination were used to identify the preliminary ones with definitive identification being done using standard biochemical tests. Whenever necessary investigative tests were done to ascertain accuracy of diagnosis [7].

2.5. Statistical Analysis

The analysis of data was done with the help of a known statistical computer program. Frequencies and percentages were used to show categorical variables, whereas mean of standard deviation was used to show continuous variables. The Chi-square test was employed to evaluate the relations between categorical variables and the t-test of independent samples was applied to compare the means. Logistic regression analysis was applied to define independent factors which were associated with infection. The p-value of less than 0.05 was taken as significant.

3. Results

3.1. Sociodemographic Characteristics of the Study Population

The number of patients included in the analysis was 150, and they all came in with acute gastrointestinal symptoms. The mean age was 23.8 ± 16.4 years.

Table 1 Sociodemographic characteristics of participants (n = 150)

Variable	Category	n	%
Age group	<5 years	35	23.3
	6–15 years	28	18.7
	16–30 years	36	24.0
	31–50 years	31	20.7
	>50 years	20	13.3
Gender	Male	82	54.7
	Female	68	45.3
Residence	Urban	92	61.3
	Rural	58	38.7
Income level	Low	87	58.0
	Moderate/High	63	42.0

As it was demonstrated in Table 1, children below the age of five years represented the highest proportion (23.3%). The sample consisted of 54.7 % males. Most participants were urban dwellers (61.3%) and of low-income families (58), which has possible socioeconomic impact on the risk of infection.

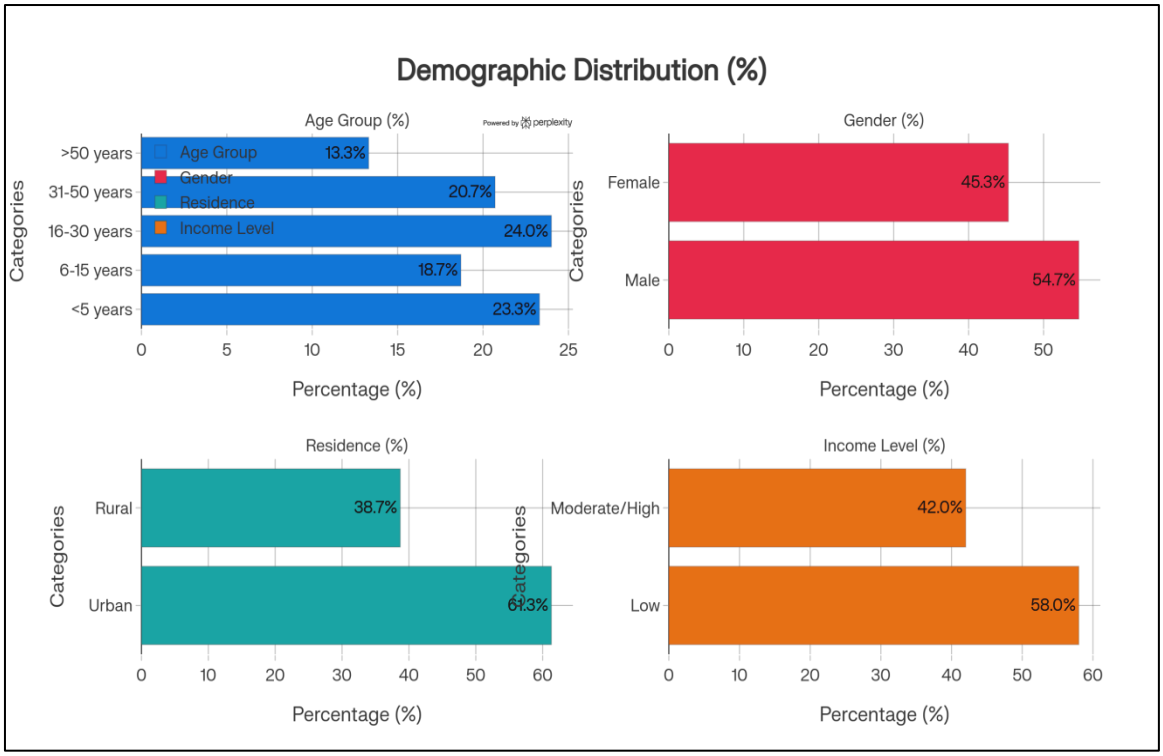

Figure 1 Illustrates the age distribution of participants

3.2. Distribution and Prevalence of Enteric Bacterial Pathogens.

A total of 150 stool samples were analysed with 102 (68%) samples positive of the presence of pathogenic bacteria..

Table 2 Distribution of isolated enteric pathogens (n = 102 positive samples)

Pathogen	n	%
Escherichia coli	35	34.3
Salmonella spp.	24	23.5
Shigella spp.	18	17.6
Klebsiella pneumoniae	15	14.7
Pseudomonas aeruginosa	10	9.8

E. coli was the most common pathogen (34.3%), followed by *Salmonella spp*. (23.5%), as it could be seen in Table 2. The opportunistic organisms like *P. aeruginosa* were found in 9.8 % of cases. The food- and waterborne pathogens dominate in the study population, as shown by this distribution.

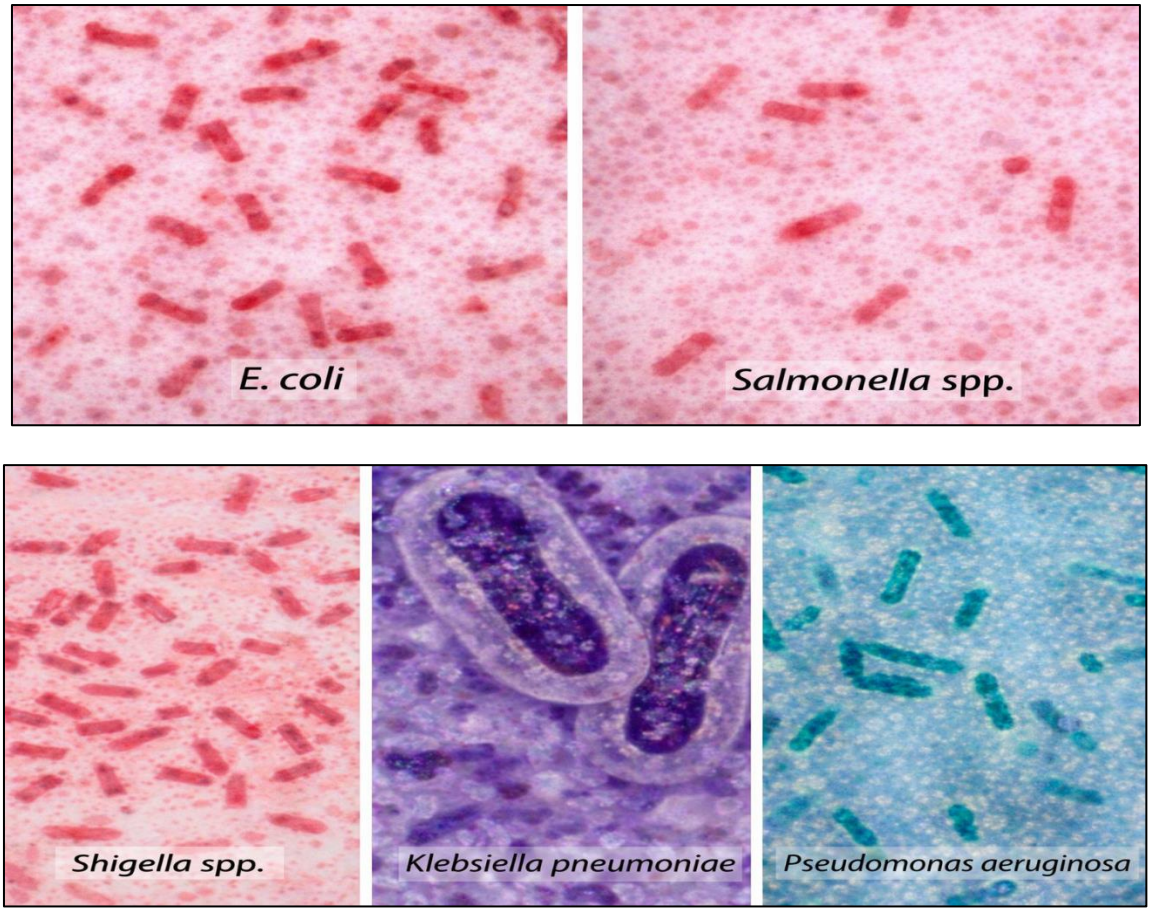

Figure 2 The proportional distribution of isolated bacteria

3.3. Association Between Dietary Factors and Bacterial Infection

3.3.1. Fast Food Consumption

Table 3 Association between fast-food intake and infection prevalence

Frequency	Infection (%)	p-value
Rarely	52%	
1–2 times/week	66%	
≥3 times/week	81%	0.004

The association between regular consumption of fast-food and bacterial infection is statistically significant (p = 0.004) as shown in Table 3. The prevalence of infections rose gradually as frequency of consumption rose.

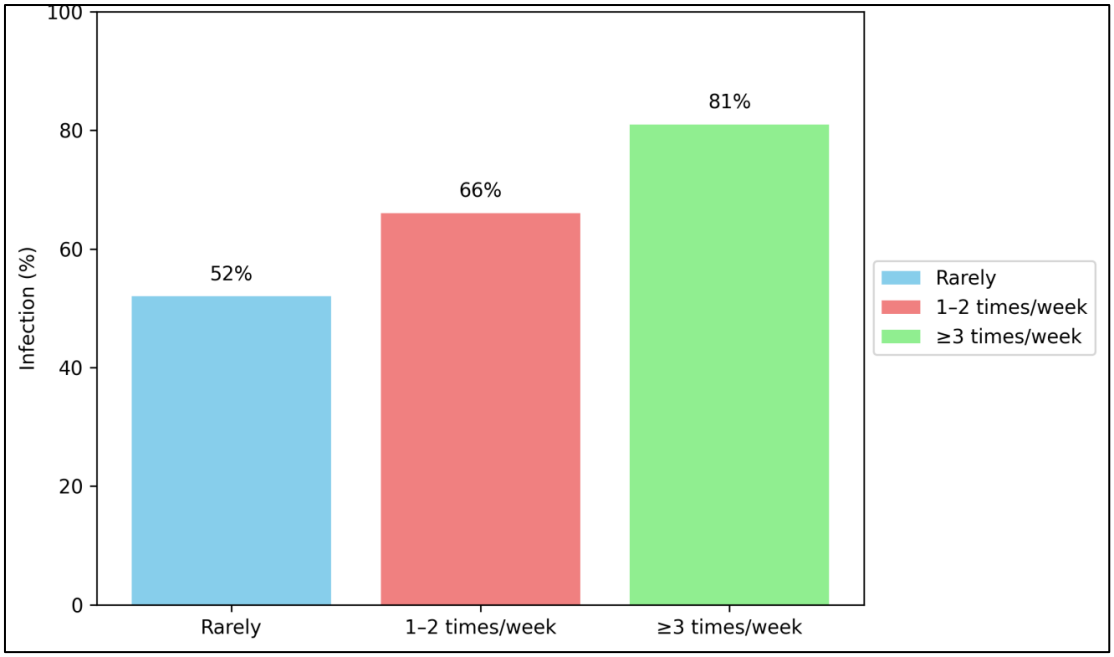

Figure 3 Illustrates this dose–response relationship

3.3.2. Consumption of Undercooked Meat

Table 4 Infection prevalence according to meat cooking status

Meat preparation	Infection (%)	p-value
Well-cooked	58%	
Undercooked	83%	<0.001

According to Table 4, participants with undercooked meat were the most infected (83%) in comparison with those with meat that was cooked well (58%).

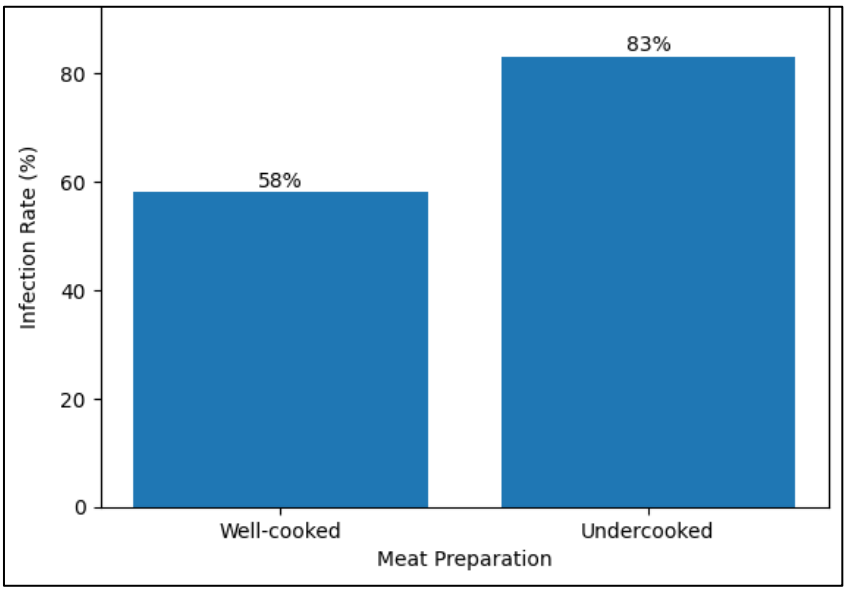

Figure 4 Infection rate by meat preparation method

3.3.3. Consumption of Unwashed Vegetables

Table 5 Infection prevalence according to vegetable hygiene

Vegetable washing practice	Infection (%)	p-value
Properly washed	55%	
Improperly washed	86%	<0.001

Washing of vegetables improperly was greatly linked to infection ($p < 0.001$), which proved to be one of the most powerful dietary risk factors

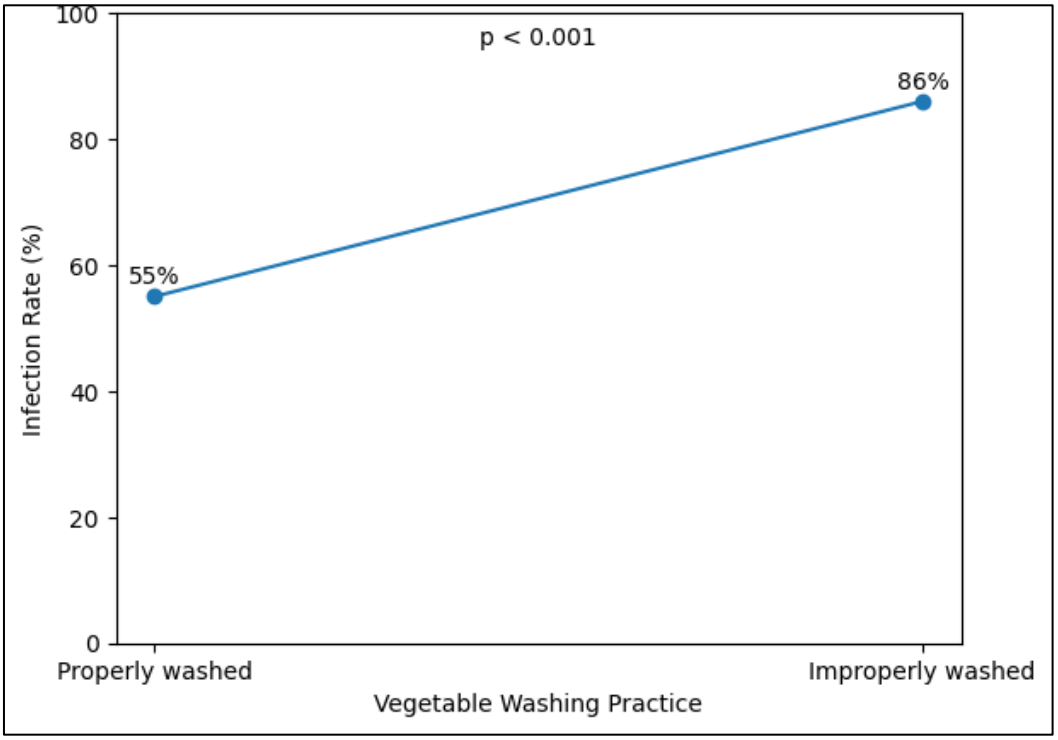

Figure 5 Infection rate by vegetable washing practice

3.4. Environmental and Hygiene Factors

Table 6 Association between environmental factors and infection

Variable	Category	Infection (%)	p-value
Water source	Treated municipal	57%	
	Well water	73%	
	Untreated water	88%	0.002
Handwashing	Always	49%	
	Sometimes	68%	
	Rarely	87%	<0.001
Food storage	Refrigerated	60%	
	Room temperature	82%	0.01

As shown in Table 6, untreated water and poor hand hygiene were found to have significant correlation with the prevalence of infections. The rate of infection was almost twice amongst participants who seldom washed their hands as compared to those who maintained perfect hand hygiene.

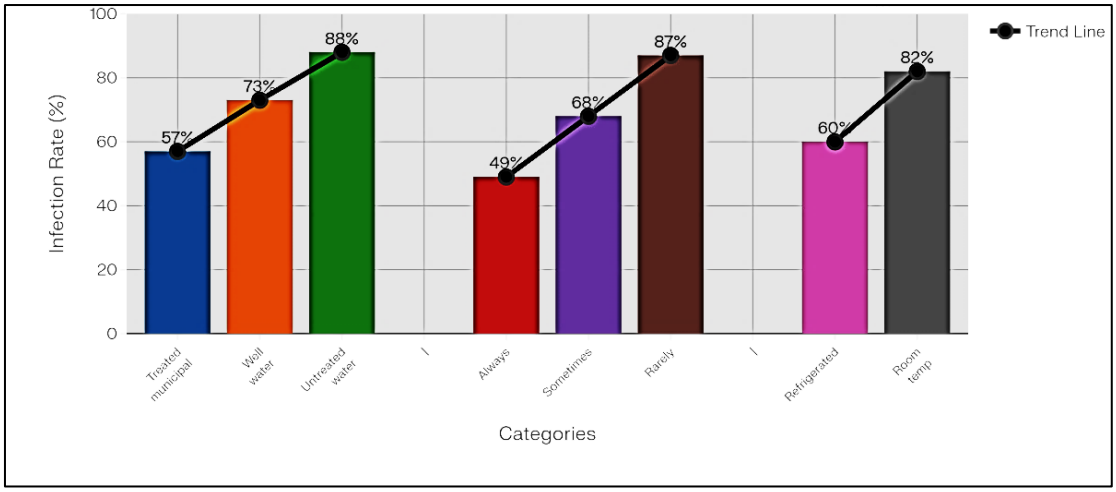

Figure 6 Infection Rates: Water, Handwashing, and Food Storage Comparison

3.5. Multivariate Logistic Regression Analysis

Table 7 Independent predictors of bacterial infection

Variable	OR	95% CI	p-value
Unwashed vegetables	3.1	1.6–5.9	0.001
Undercooked meat	2.7	1.4–5.1	0.003
Untreated water	3.5	1.7–7.0	0.001
Rare handwashing	3.8	1.9–7.3	<0.001
Fast food ≥3/week	2.0	1.1–3.8	0.02

Hand hygiene, which was not taken care of, and untreated water continued to be the most potent independent predictors of infection after a control was made against confounding factors. Those with a low level of hand wash were 3.8 times prone to developing bacterial infection. Figure 5 indicates the adjusted odds ratios and its 95% confidence intervals.

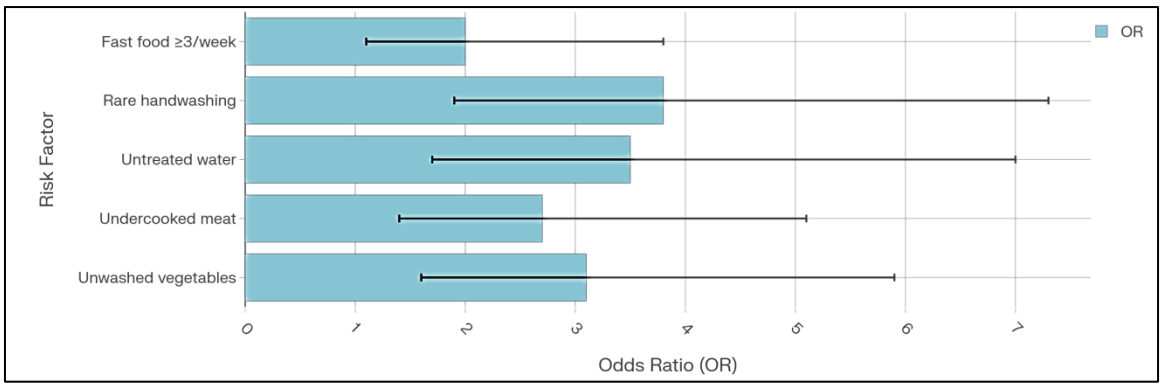

Figure 7 Odds Ratios (OR) with 95% Confidence Intervals for Identified Risk Factors

4. Discussion

The highlights of this research are that modifiable behavioral and environmental determinants are very critical in framing the epidemiology of enteric bacterial infections in Kirkuk. The trend of distant pathogens indicates the dominant food- and waterborne routes of transmission, which are highly dependent on the hygiene practices, food preparation patterns and water safety standards. These factors also often interact in a complex socio-environmental

context in developing settings that is defined by urban-rural inequalities, uneven sanitation systems, and socioeconomic obstacles[8].

The nutrition habits seem to serve not only as personal lifestyle but also as epidemiologically pertinent exposure pathways[9]. The consumption of fast foods and foods cooked outside the home set up in a frequent basis could render one susceptible to contamination due to improper preservations, cross-contamination, or loss of temperature[10]. This kind of practice is of special concern especially in areas whereby there might be laxity in the regulation of food establishments. The results of the observed relations support the biological plausibility argument that inadequate thermal treatment of animal products allows the survival of pathogenic bacteria, and as a result, the risk of gastrointestinal infection[11].

Equally, fresh vegetables can be considered a highly recorded means of facilitation by enteric pathogens in case they come into contact with contaminated irrigation water, soil, or handling surfaces. Poor hygiene during washing might not be efficient to eliminate microbial pollutants[12], particularly in case of water quality impairment. These relationships bring out the intersecting relationship between dietary and environmental risks, which imply that food safety cannot be discussed without considering water and sanitation quality[13].

In this research, it was revealed that environmental hygiene became a predominant factor, and its central role should be underlined by the basics of safe water supply and hand hygiene in breaking the fecal-oral chains of transmission[14]. Specifically, handwashing is a low-cost, high-impact intervention, whose effects are well-established in terms of the prevalence of diarrheal disease. It has an independent predictive significance which indicates that the personal hygiene actions can have a protective influence in the cases of another exposure to the environment factors. This observation is consistent with international models of the promotion of hygiene as one of the pillars of preventive care of enteric diseases[15].

The multivariate analysis also shows that the risk factors are independent but not just a reflection of underlying socioeconomic status[16]. This implies that behavior change and environmental adjustments may result in quantifiable decreases in infection burden, even in the absence of the implementation of mass-structural adjustments[17]. But these results should be taken in light of the fact that they are only constrained by a cross sectional study where temporal association and causality cannot be conclusively determined[18].

The general findings of the research are as follows: an integrated public health strategy of food safety education, better water treatment, distribution systems, and sustained hygiene promotion campaigns[19] are in support of the study. Enteric infections in Kirkuk can only be effectively dealt with through clinical and preventive measures aimed at dealing with the antecedent determinants of exposure. The interventions of this nature will most likely generate a substantial amount of community level health benefits and long-term decrease in the burden of gastrointestinal diseases[20].

5. Conclusions

Enteric bacterial infections in Kirkuk are strongly determined by the modifiable behavioral and environmental factors. Poor hygiene standards, water contamination and unsafe food handling contribute to the risk of infection and handwashing and clean water are effective in preventing infections. These causes do not depend on the socioeconomic status, which emphasizes that safe food, water, and hygiene activities can be significantly effective in decreasing infections. It is suggested that the management of enteric infections should be through a combined program of education, water management, and hygiene awareness.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

Statement of informed consent

Informed consent was obtained from all individual participants included in the study.

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