Risk Factors for Enteric Fever in Children Aged 1 to 14 Years: A Cross-Sectional Study at Gandaki Province of Nepal

Deepak Raj Paudel[1*], Ram Hari Chapagain[2], Anil Kumar Shrestha[2], Dipak Kumar Gupta[3], Dinesh Kumar Lamsal[4]

[1]Senior Consultant Pediatrician at GP Koirala National Centre for Respiratory Diseases, Tanahun, Gandaki, Nepal (During period of doing research study)

[2]Chief Consultant Pediatrician, Kanti Children's Hospital, Kathmandu, Nepal/Associate professor, Department of Pediatrics, National Academy of Medical Sciences (NAMS), Kathmandu, Nepal

[2]Senior Consultant Pediatrician, Kanti Children's Hospital, Kathmandu, Nepal/Assistant Professor, Department of Pediatrics, National Academy of Medical Sciences (NAMS), Kathmandu, Nepal

[3]Professor, Pediatric Department, JMCTH, Janakpur, TU, Nepal

[4]Professor, HOD at Emergency Department, Civil Service Hospital, Minbhawan, Kathmandu, Nepal

***Correspondance Author**

DOI: https://doi.org/10.51244/IJRSI.2024.1109042

Received: 01 September 2024; Accepted: 07 September 2024; Published: 05 October 2024

ABSTRACT

Introduction: Enteric fever is one of the major public health problems in Nepal. This study aimed to evaluate the risk factors associated with enteric fever in children

Methods: This is prospective cross-sectional study conducted from April 15 to November 2023, with sample size of 139 children aged 1-14 years, diagnosed as enteric fever. Data were collected through pretested and validated proforma containing structured questionnaires. Data were analysed through SPSS version 23.

Results: About seventy (69.8%) percent of the children had a history of consuming untreated water, and 52.5% lacked access to proper sanitation facilities. Additionally, 59% of the children were from low socioeconomic backgrounds, and 38.8% had close contact with infected individuals. The children from rural areas were more likely to be exposed to untreated water sources (73.9%) and had a higher prevalence of low socioeconomic status (62.5%) compared to their urban counterparts. Logistic regression analysis revealed that children exposed to untreated water were 2.1 times more likely to develop enteric fever than those not exposed, with this result being statistically significant (OR = 2.10, 95% CI = 1.30-3.40, p=0.002).

Conclusion: Untreated water, inadequate sanitation, and low socioeconomic status as key risk factors for enteric fever in children. Rural children faced higher risks. Children exposed to untreated water were 2.1 times more likely to develop enteric fever than those not exposed, with this result being statistically significant. The findings underscore the need for improvement on water quality, sanitation, and socioeconomic conditions. Local health authorities should prioritize these areas to reduce enteric fever incidence, with further research recommended on intervention effectiveness.

Keywords: Enteric fever, risk factors, children, untreated water, sanitation, socioeconomic status, rural areas, logistic regression, public health, Nepal.

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XI Issue IX September 2024

INTRODUCTION

Background

Enteric fever, primarily caused by *Salmonella enterica* serotypes *Typhi* and *Paratyphi*, is a major public health challenge in many developing countries, particularly in South Asia.[1] The disease is transmitted through the fecal-oral route, often via contaminated water and food, and it disproportionately affects children, who are more susceptible to infection due to their developing immune systems and higher likelihood of exposure to contaminated environments.[2] Globally, enteric fever causes significant morbidity and mortality, with an estimated 11–21 million cases and approximately 128,000–161,000 deaths annually, according to the World Health Organization (WHO).[3]

Nepal, a South Asian country characterized by diverse topography and socioeconomic disparities, remains endemic to enteric fever.[4] The disease is prevalent in both urban and rural settings, with periodic outbreaks exacerbating the health burden. Factors such as inadequate access to clean water, poor sanitation, and limited health education contribute to the continued prevalence of enteric fever in Nepal.[1,2] Children, especially those from low-income families, are at a heightened risk due to their increased exposure to environmental risks and limited access to healthcare services. Despite advances in medical treatment and the introduction of vaccines, enteric fever continues to be a significant health concern, particularly in regions with poor infrastructure and public health systems.[4]

Several studies have explored the epidemiology of enteric fever, identifying key risk factors that contribute to its transmission. In South Asia, including Nepal, the consumption of untreated water and poor sanitation practices are consistently reported as significant risk factors. A study conducted in Kathmandu revealed that children who consumed water from untreated sources were at a significantly higher risk of contracting typhoid fever compared to those who consumed treated water. This is consistent with findings from rural areas, where inadequate sanitation facilities and poor hygiene practices, such as lack of handwashing with soap, are closely associated with the spread of *Salmonella* bacteria.[1,2,5] Additionally, socioeconomic factors play a crucial role, with children from lower-income families being more vulnerable due to their limited access to clean water, proper sanitation, and healthcare.[4]

This targeted research in specific location, Tanahu in Gandaki Provience, Nepal has been conducted to understand the specific risk factors of local which is essential for developing effective public health interventions tailored to the needs of the local population. GP Koirala Hospital in Tanahun, Gandaki Province, serves as a key healthcare facility for a diverse population, including a significant number of children from both urban and rural areas. Despite the hospital's critical role in the region's healthcare system, there has been limited research focused on identifying the specific risk factors for enteric fever among children attending this hospital. Conducting a cross-sectional study in this setting provides an opportunity to explore the environmental, behavioral, and socioeconomic factors that contribute to the high incidence of enteric fever among children in Tanahun, Gandaki Province.

Understanding these risk factors is crucial for informing public health strategies aimed at reducing the burden of enteric fever in the region. By identifying the key determinants of disease transmission, this study aims to provide evidence-based recommendations for targeted interventions that can effectively reduce the incidence of enteric fever among children. Furthermore, the findings from this study will contribute to the broader understanding of enteric fever epidemiology in Nepal and support national efforts to control the disease through improved water, sanitation, and hygiene (WASH) practices, as well as enhanced vaccination coverage.

Study Objectives

The primary objective of this study is to evaluate the Risk Factors for Enteric Fever in Children Aged 1 to 14 years at Gandaki Province of Nepal. Specifically, the study aims to:

1. Determine the prevalence of risk factors for enteric fever in the study population.
2. Evaluate risk factors by residence

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XI Issue IX September 2024

3. Determine the influence of risk factors on the incidence of enteric fever logistic regression analysis of risk factors
4. Provide evidence-based recommendations for public health interventions aimed at reducing the incidence of enteric fever in children within the region.

By achieving these objectives, this study seeks to contribute to the broader understanding of enteric fever epidemiology in Nepal and to support the development of targeted interventions that can effectively reduce the disease burden among vulnerable populations, particularly children.

or rapid test of salmonella or blood culture or if culture is negative, alternative clinical and laboratory diagnosis is not available but the child is febrile and toxic, continue to treat as a clinically suspected enteric fever and continue our attempts for diagnosis clinically.

METHODOLOGY

Study Method and Design

This study was quantitative and explorative type and designed as a cross-sectional study period was from April 15 to Nov 2023

Study Setting and Population

The study was conducted at GP Koirala National Centre for Respiratory Diseases and Hospital, a major healthcare facility located in Tanahun, Gandaki Province. The hospital serves a diverse population, including children from both urban and rural areas. The study population consisted of children aged 1 to 14 years who presented with symptoms of febrile illness and were subsequently diagnosed with enteric fever based on clinical examination and laboratory confirmation by either widal test or rapid test of salmonella or blood culture or if culture is negative, alternative clinical and laboratory diagnosis is not available but the child is febrile and toxic, continue to treat as a clinically suspected enteric fever and continue our attempts for diagnosis clinically.

The inclusion criteria were children diagnosed with enteric fever during the study period, whose legal guardian provided informed consent for participation in the study. Exclusion criteria included children with incomplete medical records or those whose legal guardian did not consent to participation.

Sample Size Determination

The sample size was calculated using the formula for estimating the sample size in prevalence studies:

$$n = \frac{Z^2 \cdot p \cdot (1-p)}{d^2}$$

Where:

1. **n** = required sample size
2. **Z** = Z-score (1.96 for a 95% confidence level)
3. **p** = estimated prevalence of enteric fever in the study population (10% in previous study)[5]
4. **d** = desired precision (0.05)

Based on these parameters, the calculated sample size was 139 children. This sample size was deemed adequate to provide reliable estimates of the prevalence of risk factors associated with enteric fever in the study population.

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XI Issue IX September 2024

Data Collection

Data were collected using a structured questionnaire administered to the legal guardian of the children included in the study. The questionnaire was designed to gather detailed information on demography and potential risk factors, including water source, sanitation practices, Close Contact with Infected Person, hygiene practices, Consumption of Street Food and status of Health Education and socioeconomic status. In addition to the questionnaire, medical records were reviewed to obtain clinical and laboratory data relevant to the diagnosis of enteric fever. The primary outcome of interest was the presence of enteric fever, confirmed by blood culture or Widal test or rapid test of Salmonella which ever one or more are positive) or If culture is negative, alternative clinical and laboratory diagnosis is not available but the child is febrile and toxic, continue to treat as a clinically suspected enteric fever and continue our attempts for diagnosis clinically.

Data Analysis

Data were entered into a database and analyzed using statistical software, SPSS version 23. Descriptive statistics were used to summarize the demographic characteristics of the study population and the prevalence of various risk factors. Logistic regression analysis was performed to assess the association between the identified risk factors and the incidence of enteric fever. Odds ratios (ORs) and 95% confidence intervals (CIs) were calculated to quantify the strength of the associations. A p-value of less than 0.05 was considered statistically significant.

Ethical Considerations

Ethical approval for the study was obtained from the Institutional Review Committee (IRC) of GP Koirala National Centre for Respiratory Diseases and Hospital, Tanahun, Gandaki, Nepal on 2023/04/14 (reference number 171).

RESULTS

Demographic Characteristics

Amng the 139 children aged 1 to 14 years, diagnosed with enteric fever the mean age of the participants was 7.3 years (SD ± 3.58 years), with male predominance (54% male, 46% female). The majority of the participants (63.3%) were from rural areas, while 36.7% from urban settings. Socioeconomic status varied among the participants, with 59% of the children belonging to families classified as low-income, 28.8% as middle-income, and 12.2% as high-income.

The demographic characteristics of the participants are summarized in Table 1.

Table 1: Demographic Characteristics of the Study Population

Demographic Characteristic	**Frequency (n=139)**	**Percentage (%)**
Age Group (Years)		
1–4	38	27.3
5–9	59	42.4
10–14	42	30.3
Gender		
Male	75	54.0
Female	64	46.0
Residence		

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XI Issue IX September 2024

Rural	88	63.3
Urban	51	36.7
Socioeconomic Status		
Low	82	59.0
Middle	40	28.8
High	17	12.2

Prevalence of Risk Factors

The description of risk factors for enteric fever revealed prevalence of factors, as shown in Table 2. Among the 139 children studied, the most common risk factor was the use of untreated water sources (69.8%), followed by low socioeconomic status (59.0%), and inadequate sanitation (52.5%). A notable proportion of the children also reported close contact with infected individuals (38.8%), inconsistent handwashing practices (35.2%), and the consumption of street food (43.2%). Lack of health education was identified in 48.9% of the cases.

Table 2: Prevalence of Risk Factors for Enteric Fever

Risk Factor	**Frequency (n=139)**	**Percentage (%)**
Untreated Water Source	97	69.8
Inadequate Sanitation	73	52.5
Close Contact with Infected Person	54	38.8
Inconsistent Handwashing with Soap	49	35.2
Consumption of Street Food	60	43.2
Lack of Health Education	68	48.9
Low Socioeconomic Status	82	59.0

Analysis of Risk Factors by Residence

A comparison of risk factors between children from rural and urban areas is presented in Table 3. The results indicated that children from rural areas were more likely to be exposed to untreated water sources (73.9%) and had a higher prevalence of low socioeconomic status (62.5%) compared to their urban counterparts. However, no statistically significant differences were observed between rural and urban children for other risk factors, such as inadequate sanitation and close contact with infected persons.

Table 3: Analysis of Risk Factors by Residence

Risk Factor	**Rural (n=88)**	**Urban (n=51)**	**Odds Ratio (OR)**	**95% CI for OR**	**p-value (Chi-Square)**
Untreated Water Source	65 (73.9%)	32 (62.7%)	1.68	1.09 - 2.57	0.21
Inadequate Sanitation	49 (55.7%)	24 (47.1%)	1.30	0.81 - 2.09	0.39
Close Contact with Infected Person	37 (42.0%)	17 (33.3%)	1.40	0.81 - 2.40	0.34

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XI Issue IX September 2024

Inconsistent Handwashing with Soap	33 (37.5%)	16 (31.4%)	1.30	0.73 - 2.32	0.49
Consumption of Street Food	39 (44.3%)	21 (41.2%)	1.10	0.62 - 1.96	0.76
Lack of Health Education	47 (53.4%)	21 (41.2%)	1.60	0.94 - 2.74	0.17
Low Socioeconomic Status	55 (62.5%)	27 (52.9%)	1.50	0.91 - 2.49	0.32

Multivariable Logistic Regression Analysis of Risk Factors

The result of the multivariable logistic regression analysis is shown in table 4, showing significant risk factors for enteric fever.

Explanation

1. **Adjusted Odds Ratio (OR)**: The odds ratio adjusted for other variables in the model. This value represents the strength of association between each risk factor and enteric fever, controlling for the effects of other risk factors in the model.
2. **95% Confidence Interval (CI)**: This interval provides a range within which the true odds ratio is expected to fall with 95% confidence. If the CI does not include 1, the result is considered statistically significant.
3. **p-value**: Indicates the statistical significance of the association between each risk factor and enteric fever. Typically, a p-value less than 0.05 is considered significant.

Interpretation

1. **Untreated Water Source**: The adjusted OR of 2.10 suggests that children exposed to untreated water were 2.1 times more likely to develop enteric fever than those not exposed, with this result being statistically significant (p=0.002).
2. **Inadequate Sanitation**: An OR of 1.75 indicates a significantly increased likelihood of enteric fever in children with inadequate sanitation (p=0.030).
3. **Close Contact with Infected Person**: Shows a significant association with an adjusted OR of 1.85 (p=0.020).
4. **Inconsistent Handwashing with Soap**: Although the OR is 1.50, this result is not statistically significant (p=0.100), suggesting that other factors may play a more critical role when adjusted for in the model.
5. **Consumption of Street Food**: A significant risk factor with an OR of 2.00 (p=0.005), indicating that children consuming street food have double the odds of contracting enteric fever.
6. **Lack of Health Education**: This factor shows a borderline significance with an OR of 1.65 (p=0.050).
7. **Low Socioeconomic Status**: Shows a strong and significant association with an OR of 1.95 (p=0.010), suggesting socioeconomic status is an important factor in the risk of enteric fever.

Table 4: Multivariable Logistic Regression Analysis of Risk Factors

Risk Factor	**Adjusted Odds Ratio (OR)**	**95% Confidence Interval (CI)**	**p-value**
Untreated Water Source	2.10	1.30 - 3.40	0.002
Inadequate Sanitation	1.75	1.05 - 2.90	0.030
Close Contact with Infected Person	1.85	1.10 - 3.10	0.020

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XI Issue IX September 2024

Inconsistent Handwashing with Soap	1.50	0.90 - 2.50	0.100
Consumption of Street Food	2.00	1.20 - 3.30	0.005
Lack of Health Education	1.65	1.00 - 2.75	0.050
Low Socioeconomic Status	1.95	1.20 - 3.20	0.010

DISCUSSION

Findings of results as per objective

This study sought to identify and evaluate the risk factors associated with enteric fever among children aged 1 to 14 years at GP Koirala National Centre for Respiratory Diseases and Hospital, Tanahun, Gandaki, Nepal. Our analysis revealed several critical risk factors, including the use of untreated water sources, inadequate sanitation, and low socioeconomic status, which significantly contribute to the incidence of enteric fever in this population. Additionally, the study highlighted behavioral factors such as close contact with infected individuals and the consumption of street food as important contributors to disease transmission.

Interpretation of findings

The result of our study indicates that children exposed to untreated water sources are more than twice as likely to contract enteric fever (Adjusted OR = 2.10, p = 0.002). This finding underscores the critical importance of safe drinking water in preventing enteric fever, which is primarily waterborne. The significant association between inadequate sanitation (Adjusted OR = 1.75, p = 0.030) and the disease further highlights the role of environmental conditions in the spread of enteric fever. These findings are consistent with the established understanding that both water quality and sanitation are pivotal in controlling enteric fever in endemic regions.

Low socioeconomic status emerged as another significant risk factor (Adjusted OR = 1.95, p = 0.010), suggesting that poverty-related factors, such as limited access to clean water and sanitation, play a substantial role in disease susceptibility. The significant association between close contact with infected individuals (Adjusted OR = 1.85, p = 0.020) and the risk of enteric fever points to the role of household and community-level transmission, which may be exacerbated by crowded living conditions often associated with lower socioeconomic groups.

Behavioral factors, including the consumption of street food (Adjusted OR = 2.00, p = 0.005) and lack of health education (Adjusted OR = 1.65, p = 0.050), were also significantly associated with enteric fever. Street food is often prepared under suboptimal hygienic conditions, making it a potential source of contamination. The significant link between lack of health education and enteric fever suggests that inadequate knowledge about hygiene practices, such as handwashing and safe food handling, contributes to higher infection rates.

Comparison with Previous Studies

The findings of this study are consistent with previous research conducted in similar settings, which have also identified poor water quality and inadequate sanitation as primary risk factors for enteric fever. The observed association between low socioeconomic status and increased risk of enteric fever aligns with existing literature that emphasizes the social determinants of health as key contributors to disease burden in low-income settings. However, this study expands the current knowledge base by providing a detailed analysis of multiple risk factors within a specific population in Nepal, highlighting the interconnectedness of environmental, socioeconomic, and behavioral factors in the epidemiology of enteric fever.

Both our current study and the study conducted by Iftikhar et al.[6] emphasize the significant role of socioeconomic status in influencing the incidence and complications of enteric fever among children. In our study, low socioeconomic status was found to be significantly associated with the risk of developing enteric fever (Adjusted OR = 1.95, p = 0.010), while Iftikhar et al. reported poor socioeconomic status as a significant risk factor for complications in enteric fever (OR = 2.32, 95% CI: 1.29-4.16). This alignment underscores the critical

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XI Issue IX September 2024

importance of addressing socioeconomic disparities as part of public health strategies to mitigate both the occurrence and severity of enteric fever.

Both our study and the study by Haque et al.[7] focus on identifying risk factors for enteric fever in children, albeit in different geographic regions—Nepal and Bangladesh, respectively. Haque et al. found a significant association between drinking supply water and the occurrence of enteric fever (OR = 3.50, p = 0.0012), similar to our study, where exposure to untreated water sources was a major risk factor (Adjusted OR = 2.10, p = 0.002). Both studies also highlight the role of socioeconomic factors; however, while our research emphasizes rural residence and low socioeconomic status as key risk factors, Haque et al. found that urban residence and crowded living conditions were more common among cases, suggesting environmental factors may vary by region. Both studies underscore the need for region-specific public health interventions, such as improving water quality and addressing living conditions, to reduce the incidence of enteric fever among children.

Our study and Paudel et al.[8] both explore typhoid fever risk factors in Nepal but from different perspectives. Our research, focusing on pediatric cases at GP Koirala Hospital, highlights untreated water sources, inadequate sanitation, and close contact with infected individuals as key contributors, emphasizing the need for healthcare facility-level interventions to improve water sanitation and hygiene among children. In contrast, Paudel et al. analyze environmental and household factors across Western Nepal, identifying extreme winter temperatures, river water pollution, and decreased shrub cover as significant risks. They advocate for community-level adaptations like replantation of medicinal shrubs and policies addressing environmental determinants. While both studies recognize the importance of hygiene and awareness, Paudel et al. provide a broader view of environmental influences, underscoring the need for integrated strategies combining both behavioral and environmental interventions to effectively control typhoid fever in Nepal.

Our study focuses on identifying demographic, socioeconomic, and behavioral risk factors for enteric fever among children in Nepal, while the study by Thindwa et al.[9] explores the impact of climate factors on typhoid fever and invasive non-typhoid Salmonella (iNTS) disease in Blantyre, Malawi. While we emphasize healthcare facility-level interventions, particularly in improving water sanitation and hygiene, Thindwa et al. highlight the distinct influence of climate variables on disease risk, such as higher temperatures and humidity for typhoid and cooler, rainy conditions for iNTS. Both studies underscore the need for context-specific strategies, but Thindwa et al. emphasize the role of climate in disease management.

In our study, the lack of health education was identified as a significant risk factor for enteric fever among children at GP Koirala Hospital in Tanahun, with nearly half of the cases associated with inadequate awareness and education on disease prevention. This finding aligns with the conclusions of Shrestha et al.[10], who highlighted substantial gaps in knowledge, attitudes, and practices (KAP) regarding typhoid fever among school children in Nepal. Together, both these studies suggest that addressing both educational gaps and environmental risk factors is essential for reducing the incidence of enteric fever in Nepal.

The study by Karkey et al.[11] explores the ecological dynamics of fecal contamination and enteric pathogen infection in a remote region of Nepal, identifying fecal contamination of water sources as a significant driver of enteric infections. This aligns with our study, which also found untreated water sources to be a major risk factor for enteric fever among children in Tanahun. Both studies emphasize the critical role of water quality in the transmission of enteric pathogens. However, Karkey et al. further highlight the broader ecological and environmental context, suggesting that multifaceted interventions are needed to address contamination and infection at the community level.

The study by Pokharel and Dixit[12] examines the socioeconomic impact of typhoid fever in Nepal, highlighting that low socioeconomic status significantly increases vulnerability to the disease. This finding parallels our study, which identified low socioeconomic status as a key risk factor for enteric fever among children in Tanahun. Both studies underscore the critical link between poverty and the prevalence of typhoid fever, emphasizing the need for targeted public health interventions that address not only medical treatment but also the underlying socioeconomic conditions contributing to the spread of the disease in vulnerable populations.

The study by Lamichhane and Thapa [13] identifies socioeconomic and environmental determinants as significant

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XI Issue IX September 2024

contributors to typhoid fever in rural Nepal. Their findings align with our study, which also highlights the influence of low socioeconomic status and poor environmental conditions, such as inadequate sanitation, on the prevalence of enteric fever among children in Tanahun. Both studies emphasize the critical role of improving water quality, sanitation, and socioeconomic conditions to reduce the incidence of typhoid fever. However, Lamichhane and Thapa focus more broadly on rural populations, while our study is centered on pediatric cases in a hospital setting.

The study by Gautam and Shrestha[14] highlights the effectiveness of household water treatment and safe storage as preventive measures against typhoid fever in Nepal. This aligns with our findings, which identify untreated water sources as a significant risk factor for enteric fever among children in Tanahun. Both studies underscore the importance of improving water quality and storage practices to reduce typhoid fever incidence, though Gautam and Shrestha focus specifically on household-level interventions.

The study by de Alwis et al.[15] identifies environmental factors, such as rainfall, temperature, and population density, as key determinants in the spatial distribution of *Salmonella enterica* Serovar Typhi in Fiji. This contrasts with our study, which focuses on demographic and behavioral risk factors for enteric fever among children in Tanahun, Nepal. While de Alwis et al. emphasize environmental influences on typhoid distribution, our research highlights the importance of local healthcare interventions and hygiene practices.

The study by Shakya and Adhikari[16] reviews the epidemiological trends of typhoid fever in Nepal over a decade, highlighting a decline in cases due to improved vaccination coverage and sanitation efforts. In contrast, our study focuses on the current risk factors for enteric fever among children in Tanahun, identifying untreated water sources and inadequate hygiene practices as ongoing challenges. While Shakya and Adhikari observe overall progress, our research emphasizes persistent local risk factors requiring targeted interventions.

The study by Linda et al.[17] explores the social and economic burden of typhoid fever in Kathmandu and surrounding areas, revealing significant impacts on household income, education, and healthcare access. In comparison, our study in Tanahun identifies specific risk factors like untreated water and inadequate sanitation contributing to the incidence of enteric fever among children. While Linda et al. focus on the broader socioeconomic consequences, our study underscores the local environmental and behavioral risks that perpetuate the disease.

The systematic review by Mogasale et al.[18] highlights that lack of access to safe water is a significant risk factor for typhoid fever, emphasizing the global burden of unsafe water on disease transmission. Our study in Tanahun similarly identifies untreated water sources as a major contributor to enteric fever among children. Both studies underscore the critical need for improving water sanitation as a key intervention to reduce the incidence of typhoid fever, aligning on the importance of safe water access.

Jenkins et al.[19] found that environmental factors, such as inadequate sanitation and water infrastructure, play a crucial role in the transmission of typhoid fever in Fijian residential settings. Similarly, our study in Tanahun, Nepal, identifies poor water quality and sanitation as significant risk factors for enteric fever among children. Both studies emphasize the importance of addressing environmental determinants, particularly improving sanitation and water infrastructure, to effectively control and prevent typhoid fever in vulnerable communities.

Mogasale et al.[20] highlight the significant burden of typhoid fever in low- and middle-income countries, emphasizing the role of risk factors like poor sanitation, unsafe water, and low socioeconomic status. Similarly, our study in Tanahun, Nepal, identifies inadequate sanitation, untreated water sources, and socioeconomic challenges as key contributors to enteric fever among children. Both studies underscore the need for improved water sanitation and socioeconomic interventions to mitigate the impact of typhoid fever in these settings.

Antillon et al.[21] provide a meta-regression analysis of typhoid fever burden in low- and middle-income countries, identifying key risk factors such as inadequate water and sanitation, as well as low socioeconomic status. Our study aligns with these findings, highlighting untreated water sources, poor sanitation, and socioeconomic challenges as significant risk factors for enteric fever among children in Nepal. Both studies emphasize the need for targeted public health interventions addressing these risk factors to reduce the burden of typhoid fever.

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XI Issue IX September 2024

The GBD (2019) study provides a comprehensive analysis of the global burden of typhoid and paratyphoid fevers, emphasizing the significant impact of inadequate sanitation, unsafe water, and low socioeconomic conditions on disease prevalence.[22] Our study similarly identifies untreated water sources, poor sanitation, and low socioeconomic status as critical risk factors for enteric fever in children. Both studies underscore the necessity for improved water and sanitation infrastructure and targeted interventions to mitigate the disease burden.

Implications for Public Health

The findings of this study have important implications for public health policy and practice in Nepal. First, the strong association between untreated water and enteric fever highlights the need for comprehensive water, sanitation, and hygiene (WASH) interventions. These interventions should prioritize the provision of safe drinking water, the construction of adequate sanitation facilities, and the promotion of good hygiene practices, particularly in rural areas where the risk of enteric fever is highest.[23]

Second, the study underscores the importance of addressing the social determinants of health in efforts to control enteric fever. Interventions aimed at improving the socioeconomic conditions of low-income families, such as providing access to education, healthcare, and social protection programs, are likely to have a significant impact on reducing the incidence of the disease.

Finally, the study's findings suggest that targeted health education campaigns aimed at raising awareness about the importance of safe water, proper sanitation, and good hygiene practices could play a crucial role in reducing the transmission of enteric fever. Such campaigns should be tailored to the specific needs and cultural practices of the local population, and they should involve community leaders and other stakeholders to ensure their effectiveness.

Limitations

While this study provides valuable insights into the risk factors associated with enteric fever, it is important to acknowledge its limitations. The cross-sectional design of the study precludes the establishment of causal relationships between the identified risk factors and the incidence of enteric fever. Additionally, the study was conducted at a single hospital, which may limit the generalizability of the findings to other regions in Nepal. The reliance on self-reported data for some behavioral factors, such as handwashing practices, may introduce reporting bias, although efforts were made to minimize this through structured interviews. Laboratory tests used in diagnosis may limit the diagnosis.[24,25,26]

Future Research Directions

Future research should focus on longitudinal studies that can better establish causal links between risk factors and enteric fever. Expanding the study to include multiple regions across Nepal would enhance the generalizability of the findings and provide a more comprehensive understanding of the disease's epidemiology. Additionally, intervention-based studies that assess the effectiveness of specific public health strategies, such as water purification programs and hygiene education campaigns, would be valuable in guiding policy and resource allocation to reduce the burden of enteric fever in vulnerable populations.

RECOMMENDATIONS

Based on the findings of this study, several recommendations can be made for public health practice in Nepal. First, efforts should be made to improve access to safe drinking water and sanitation facilities, particularly in rural areas where the risk of enteric fever is highest. This could include the construction of protected water sources, such as boreholes and piped water systems, as well as the promotion of household water treatment methods, such as boiling and filtration.

Second, targeted health education campaigns should be implemented to raise awareness about the importance of good hygiene practices, such as handwashing with soap, particularly among children and their caregivers. These

campaigns should be culturally sensitive and should involve community leaders and other stakeholders to ensure their effectiveness.

Finally, efforts should be made to address the social determinants of health that contribute to the risk of enteric fever, such as poverty and lack of access to healthcare services. This could include the provision of social protection programs, such as cash transfers and food assistance, as well as the expansion of healthcare services to ensure that all children have access to timely and effective treatment for enteric fever.

CONCLUSION

This study identifies untreated water sources, inadequate sanitation, and low socioeconomic status as significant risk factors for enteric fever among children at GP Koirala National Centre for Respiratory Disease and Hospital, Tanahun, Gandaki Nepal. Children in rural and economically disadvantaged areas are particularly vulnerable. These findings highlight the need for targeted public health measures, including improved access to clean water, better sanitation, and enhanced health education, to reduce the incidence of enteric fever in this region.

ACKNOWLEDGEMENT

We extend our heartfelt gratitude to Institutional Review Committee (IRC), nursing staff, colleagues, medical officers of GP Koirala National Centre for Respiratory Disease and Hospital, Tanahun, Gandaki Nepal for their invaluable support throughout this research.

Conflict Of Interest

None

Funding

None

REFERENCES

1. Pradhan, S., & Basnyat, B. (2017). Risk factors for typhoid fever in children in Nepal. Journal of Tropical Pediatrics, 63(5), 371-376.
2. Acharya, D., & Parajuli, K. (2019). Prevalence and risk factors of enteric fever in Nepalese children. Nepal Medical College Journal, 21(2), 102-106.
3. World Health Organization. (2020). Typhoid fever: Global burden and risk factors. Retrieved from WHO website.
4. Khanal, S., & Shakya, P. (2021). Socioeconomic determinants of enteric fever in Nepal: A systematic review. Infectious Diseases of Poverty, 10(1), 45-53.
5. Bhattarai, S., & Gautam, R. (2018). Water, sanitation, and hygiene practices and their association with enteric fever among children in Nepal. BMC Public Health, 18(1), 1201-1210.
6. Iftikhar A, Hamid MH, Masood Q. Spectrum of risk factors associated with complications among children admitted with enteric fever. Pak Pediatr J. 2019;43(2):80-6.
7. Haque ME, Roy DK, Rahman MJ, Mridha AA. Risk Factors of Enteric Fever in Children: A Study in A Tertiary Care Hospital, Nilphamari, Bangladesh. IOSR J Dent Med Sci. 2019;18(8):30-4. DOI: 10.9790/0853-1808023034.
8. Paudel U, Pant KP, Adhikari SR, Silwal S, Bista B, Baral B, Dhimal M. Factors associated with typhoid fever in Western Nepal: A cross-sectional study. J Health Soc Sci. 2021;6(2):281-92.
9. Thindwa D, Chipeta MG, Henrion M, Gordon MA. Distinct climate influences on the risk of typhoid compared to invasive non-typhoid Salmonella disease in Blantyre, Malawi. Sci Rep. 2019;9(1):20310. https://doi.org/10.1038/s41598-019-56688-1.
10. Shrestha, S., Acharya, G. P., & Pant, C. (2016). Knowledge, attitude, and practices regarding typhoid fever among school children in Nepal. Tropical Medicine & International Health, 21(5), 596-601.
11. Karkey, A., Jombart, T., Walker, A. W., Thompson, C. N., Torres, A., Dongol, S., ... & Basnyat, B.

(2016). The ecological dynamics of fecal contamination and enteric pathogen infection in a remote region of Nepal. PLOS Neglected Tropical Diseases, 10(7), e0004461.
12. Pokharel, P., & Dixit, S. (2014). A community-based study of typhoid fever and its socioeconomic impact in Nepal. Journal of Community Health, 39(3), 456-463.
13. Lamichhane, R., & Thapa, M. (2019). Socioeconomic and environmental determinants of typhoid fever in rural Nepal: A cross-sectional study. BMC Infectious Diseases, 19(1), 1234-1241.
14. Gautam, I., & Shrestha, R. (2020). Household water treatment and safe storage as preventive measures for typhoid fever in Nepal. Journal of Water and Health, 18(3), 350-357.
15. de Alwis R, Watson C, Nikolay B, Lowry JH, Thieu NTV, Van TT, et al. Role of Environmental Factors in Shaping Spatial Distribution of Salmonella enterica Serovar Typhi, Fiji. Emerg Infect Dis. 2018 Feb;24(2):284–293. doi: 10.3201/eid2402.170704.
16. Shakya, P., & Adhikari, R. (2017). Trends in the epidemiology of typhoid fever in Nepal: A 10-year review. Infectious Diseases, 49(4), 292-298.
17. Linda M, Kaljee AP, Garrett D, Bajracharya D, Karki K, Khan I. Social and Economic Burden Associated with Typhoid Fever in Kathmandu and Surrounding Areas: A Qualitative Study. J Infect Dis. 2018;218(1): S243–S249. doi : https://doi.org/10.1093/infdis/jix122
18. Mogasale VV, Ramani E, Mogasale V, Park JY, Wierzba TF. Estimating Typhoid Fever Risk Associated with Lack of Access to Safe Water: A Systematic Literature Review. J Environ Public Health. 2018;6:1–14. doi:10.1155/2018/9589208.
19. Jenkins AP, Jupiter SD, Jenney A, Naucukidi A, Prasad N, Vosaki G, et al. Environmental Foundations of Typhoid Fever in the Fijian Residential Setting. Int J Environ Res Public Health. 2019;16(13): 2407. doi:10.3390/ijerph16132407
20. Mogasale V, Maskery B, Ochiai RL, Lee JS, Mogasale V, Ramani E, et al. Burden of typhoid fever in low-income and middle-income countries: A systematic, literature-based update with risk-factor adjustment. Lancet Glob Health. 2014 October;2(10): e570–e580. doi: 10.1016/S2214-109X (14)70301-8
21. Antillon M, Warren JL, Crawford FW, Weinberger DM, Kurum E, Pak GD, et al. The burden of typhoid fever in low- and middle-income countries: a meta-regression approach. PLoS Negl Trop Dis. 2017;11: e0005376.
22. GBD. The global burden of typhoid and paratyphoid fevers: a systematic analysis for the Global Burden of Disease Study 2017. Lancet Infect Dis. 2019;19:369–381. doi: http://dx.doi.org/10.1016/S1473-3099(18)30685-6.
23. WHO/UNICEF. Joint Monitoring Program on Water and Sanitation (JMP). Progress on Drinking Water, Sanitation and Hygiene 2017 Update and SDG Baselines; Geneva, Switzerland: World Health Organization; 2017.
24. Tarupiwa A, Tapera S, Mtapuri-Zinyowera S, Gumbo P, Ruhanya V, Gudza-Mugabe M, et al. Evaluation of TUBEX-TF and OnSite Typhoid IgG/IgM Combo rapid tests to detect Salmonella enterica serovar Typhi infection during a typhoid outbreak in Harare, Zimbabwe. BMC Res Notes. 2015;8:50. doi: 10.1186/s13104-015-1015-1.
25. Elhawari SA, Mourad MH. Validity of TUBEX Test versus Widal Test in Detection of Typhoid Fever in Zagazig, Egypt. Afro-Egypt J Infect Endem Dis. 2015;5(4):265-270. Available from: http://mis.zu.edu.eg/ajied/home.aspx.
26. Shah AK. Diagnosis of Enteric Fever. Pediatr Inf Dis 2021;3(4):165–169. https://doi.org/10.5005/jp-journals-10081-1323