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Nutritional Outcome Indicators among Under Five Children Associated with Households Environmental and Water Sanitation Practices: A Cross-sectional Study in Southern Nepal

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Abstract:

Introduction: Nutritional outcomes in children under five are influenced by household environmental and water sanitation practices. This study aimed to assess the relationship between these practices and nutritional outcomes (HAZ, WAZ, and WHZ) in Lakshminiya Rural Municipality, Nepal.

Materials and Methods: A community-based cross-sectional study was conducted from March to June 2021. The study included 308 children aged 6 to 59 months, selected using multistage random sampling. Data were collected through face-to-face interviews with mothers or primary caregiver and anthropometric measurements. Household sanitation indicators, such as improved sanitation, toilet conditions, waste disposal, and drinking water storage, were assessed. Data analysis was performed using SPSS 25, employing bivariate and multiple regression analyses to examine associations between household practices and nutritional outcomes.

Results: The study found that improved household sanitation was positively associated with HAZ and WAZ. Improved toilet presence was also significantly correlated with WAZ and HAZ, while the association with WHZ was not significant. Cleanliness around toilets showed no significant associations with any of the nutritional indicators. Waste disposal practices, such as composting or burning, had an inverse relationship with WAZ. Covered drinking water storage was positively associated with WAZ but had no significant effect on HAZ or WHZ.

Conclusions: Improved sanitation and covered drinking water storage are positively associated with better nutritional outcomes, particularly in HAZ and WAZ. These findings suggest the need for policies that promote improved sanitation and water storage practices to enhance child nutrition in rural Nepal.

Keywords
Household environment, nutritional outcomes, under-five children, water sanitation

INTRODUCTION

Malnutrition among children under five remains a significant public health concern in low- and middle-income countries, including Nepal. It is a leading cause of childhood morbidity and mortality, adversely affecting growth and overall development [1]. Nutritional outcomes are closely linked to environmental and water sanitation practices, as these factors significantly impact public health [2]. Poor sanitation and contaminated water sources are major contributors to malnutrition, particularly in low-income regions [3]. Inadequate access to clean water and proper sanitation increases the risk of waterborne diseases, such as diarrhea, which impairs nutrient absorption and can lead to stunted growth and wasting in children [4]. Additionally, unsanitary environments promote the spread of parasitic infections, contributing to micronutrient deficiencies and chronic malnutrition [5]. Studies show that improved sanitation facilities and access to safe drinking water are essential for reducing malnutrition and enhancing health outcomes [6]. Research indicates that combining water, sanitation, and hygiene (WASH) interventions with nutrition programs leads to significant improvements in child growth and nutritional status [2]. Therefore, addressing environmental sanitation and water quality is crucial for enhancing nutrition outcomes, especially in vulnerable populations. In particular, poor hygiene practices and inadequate sanitation contribute to the high incidence of infections, particularly diarrheal diseases, which hinder nutrient absorption and exacerbate conditions such as stunting, wasting, and underweight [7].

Diarrheal diseases are a leading cause of child mortality worldwide, particularly in Southern Nepal, where inadequate water, sanitation, and hygiene (WASH) practices not only exacerbate these diseases but also contribute significantly to malnutrition among children under five [8, 9]. While many studies have explored the link between poor environmental conditions and malnutrition in children, limited research specifically addresses the impact of water, sanitation, and hygiene (WASH) practices on nutritional outcomes in Southern Nepal. This gap calls for a detailed investigation into how WASH practices affect key nutritional indicators such as stunting, wasting, and underweight conditions in children under five. Although the direct effects of dietary intake on child health are well-documented, the indirect impact of WASH conditions on malnutrition remains underexplored, emphasizing the need for further research. This study seeks to fill this gap by examining the relationship between environmental sanitation practices and nutritional outcomes in this vulnerable population. By utilizing the Ecological Model of Health, which emphasizes the interplay between individuals and their environments, the research provides a comprehensive analysis of the diverse causes of undernutrition in the region [10].

MATERIALS AND METHODS

Study design and setting

This study employed a community-based cross-sectional design and was conducted in Lakshminiya Rural Municipality from March 11 to June 30, 2021. Lakshminiya Rural Municipality, situated in the Dhanusa district of Province No. 2, Nepal, spans seven wards across 31 square kilometers. Predominantly agricultural, the local economy suffers from limited diversification, impacting economic resilience. Infrastructural challenges further hinder access to modern facilities, education, healthcare, and sanitation services. These factors are particularly relevant to understanding nutritional outcomes among under-five children, as environmental conditions and water sanitation practices directly influence their health and well-being.

Participants, sampling and sample size

Under five children aged 6 months to 59 months residing in Lakshminiya rural municipality were considered as participants for this study. Sample size was calculated taking prevalence of malnutrition as 76.7% of children suffered from any form of malnutrition i.e. weight for age (underweight) or height-for-age (stunting) or weight-for-height (wasting) [11]. Calculated by formula 4PQ/L2. P=prevalence of malnutrition (taking as 25%), Q= 100-P, L= Allowable error (5%) =4*25*75/5*5= 300 children. Inclusion criteria included: those children were present at the time of household visit and not seriously ill, whereas exclusion criteria included children having cerebral palsy, congenital malformation, HIV infection or any other chronic morbidity and suffering from serious illness. Families who did not give consent were excluded. Multistage random sampling was used. Wards in rural municipalities were randomly selected first, and then 15 households in each ward were randomly selected for the study. Mothers or other caretakers of children under five years at the time of the household visit were interviewed for data collection. If any household had two children under five, the youngest was selected as the study subject. If there were no children under five in a household, the adjacent household with children under five was included. In total, 308 children were included in the study.

Data collection procedure and study variables

Face to face interview was conducted with mother of eligible children using paper based semi-structured questionnaire. Anthropometric measurements (weight and recumbent length/height) of the children were taken. For weight, a digital scale was used for accurate measurement with minimal clothing. The height measurement was taken on flooring that was not carpeted and against a flat surface such as a wall.

The dependent variable of this study was anthropometric measurement (HAZ, WAZ and WHZ) of under five children. Nutritional outcome indicators, HAZ, WAZ and WHZ were calculated through WHO Anthro plus 1.0.4 software. The independent variables considered were the gender, types of family, religion, number of family members, age of child. Additionally, household environmental and water sanitation practice indicators included: household with improved sanitation (improved vs unimproved), household with improved toilet (improved vs unimproved), cleanness around toilet (clean vs unclean), waste disposal practice (composting/burning/ used for farming vs open dumping), and storage of drinking water (covered vs not covered).

Data management and statistical analysis

The collected data were entered into Microsoft Excel, 2013 and were converted into Statistical Package for Social Sciences (SPSS 25 version) for data analysis. Descriptive data were presented as frequency, percentage, mean and standard deviation. The data's normality was evaluated using the Kolmogorov-Smirnov test, resulting in a significance level of 0.156. Outliers were subsequently removed, and the collinearity between predictors was assessed using the Variance Inflation Factor (VIF), with values ranging from 1.00 to 1.03. The association between independent and outcome variable was analyzed using multiple regression analysis to identify the significant factors. Statistical significance was tested with 95% confidence interval and a value of $p<0.05$ was considered significant.

Table 2| Household environmental and water sanitation practice and nutritional outcome indicators of under five children (n=308)

Environmental sanitation Indicators	Number (%)
Household with improved sanitation	
Improved	158 (51.3 %)
Unimproved	150 (48.7%)
Household with improved toilet	
Improved	170 (55.2%)
Unimproved	138 (44.8%)
Cleanness around toilet	
Clean	232 (75.3%)
Unclean	76 (24.7%)
Waste disposal practice	
Open dumping	167 (54.2%)
Burning	67 (21.8%)
Used in Farm	50 (16.2%)
Composting	24 (7.8%)
Storage of Drinking water	
Covered	206 (66.9%)
Not covered	102 (33.1%)
Nutritional Outcome Indicators	**Mean (SD)**
Weight-for age z score	-1.54 (1.49)
Weight-for-height z score	-0.70 (1.54)
Height-for-age z score	-1.82 (1.63)

Ethical Consideration

It was obtained from the Institutional Review Committee (IRC) of Janaki Medical College (IRC-JMC, Ref: 28/IRC/2077/078), Nepal. Written consent was obtained from the municipalities of Dhanusha district. The purpose of the study and the procedure was well explained and written informed consent was gained for publication as well before starting the data collection. The participants were also informed that their participation was voluntary, and can withdraw at any moment. Moreover, they were assured regarding their anonymity, and the confidential treatment of their responses. Those children identified as malnourished were given proper nutritional counselling and were also advised to seek treatment for the condition.

RESULTS

Table 1 shows demographic and demographic and household level characteristics of under five children. Out of 308 participants, more than half (53.2%) were male, 57.7% belongs to joint family and majority (92.9%) followed Hindu religion. Mean and standard deviation for age, weight and height respectively were 2.53(1.36) years, 10.67 (3.68) kg and 80.44 (13.67) cm. Median size of family were 6 ranges from 1 to 12.

Table 1| Demographic and household characteristics of under five children (n=308)

Characteristics	Number (%)
Gender	
Male	164 (53.2%)
Female	144 (46.8%)
Types of family	
Nuclear	131 (42.5%)
Joint	177 (57.5%)
Religion	
Hindu	286 (92.9%)
Muslim	22 (7.1%)
Child parameters	**Mean (SD)**
Age (years)	2.53 (1.36)
Weight (kg)	10.67 (3.68)
Height (cm)	80.44 (13.67)
Family Size [median (range)]	6 (1-12)

Table 2 depicts the household environmental and water sanitation practice and nutritional outcome Indicators of under five children. More than half of the household had improved sanitation (51.3%), improved toilet (55.2%), and less than one fourth (24.7%) toilet were seen dirty or unclean. Regarding waste disposal practices, more than half of the household's practices open dumping (54.2%) followed by burning (21.8%) and few involved in composting (7.8%). Further, two third (66.9%) of the household covered their drinking water when storage.

Table 3| Multiple regression analysis for household environmental and water sanitation practice associated with nutritional outcome indicators among under five children

Indicators	WAZ [β (95%CI)]		WHZ [β (95%CI)]		HAZ [β (95%CI)]	
	Unadjusted	Adjusted	Unadjusted	Adjusted	Unadjusted	Adjusted
Household with improved sanitation						
Improved	0.05(1.83, 0.78)	0.05(0.49, 0.17)	**0.14 (0.04, 0.50) ***	***0.10 (0.01, 0.41)***	**0.61(0.57, 0.95) ****	**0.44(0.31, 0.81) ****
Unimproved	1.00	1.00	**1.00**	1.00	1.00	1.00
Household with improved toilet						
Improved	**0.38(0.11, 0.69) ****	**0.17(0.09, 0.78) ***	**0.45(0.08, 0.62) ****	0.34(-0.01, 0.33)	**0.27(0.01, 0.45) ****	**0.20(0.01, 0.39) ****
Unimproved	1.00	1.00	1.00	1.00	1.00	1.00
Cleanness around toilet						
Clean	0.42(-0.24, 0.53)	0.51(-0.21, 0.56)	0.01(-0.67, 0.66)	0.14(-0.57, 0.74)	0.09(-0.72, 0.04)	0.02(-0.52, 0.32)
Unclean	1.00	1.00	1.00	1.00	1.00	1.00
Waste disposal practice						
Burning/Farming /Composting	**-0.12(-0.71, -0.04)***	**-0.11(-0.68, -0.01) ***	-0.06(-0.89, 0.25)	-0.04(-0.78, 0.35)	0.03(-0.24, 0.48)	0.01(-0.32, 0.41)
Open Dumping	1.00	1.00	1.00	1.00	1.00	1.00
Storage of Drinking water						
Covered	**0.05(0.02, 0.18) ***	**0.04(0.01, 0.24) ***	0.07(-0.64, 0.57)	0.03(-0.62, 0.58)	0.09(-0.72, 0.04)	0.09(-0.72, 0.55)
Not covered	1.00	1.00	1.00	1.00	1.00	1.00

WAZ: Weight-for age z score; WHZ: Weight-for-height z score; HAZ: Height-for-age z score; Adjusted for socio demographic and households' characteristics
****indicates p<0.05; **indicates p<0.001.***

Mean and standard deviation Z scores of weights for age, weight for height and height for age respectively were -1.54(1.49), -0.70 (1.54) and -1.82 (1.63).

Results for multiple regression analysis showing relationship between household environmental and water sanitation practices with nutritional outcomes among children under five are presented in Table 3. Results indicate that households with improved sanitation positively impact nutritional outcomes, particularly in HAZ and WHZ, with relatively lower coefficients in the adjusted analysis as (HAZ: β=0.44; 95%CI=0.31-0.81) and (WAZ: β=0.10; 95%CI=0.01-0.41). Furthermore, the presence of improved toilet had positive correlation with WAZ (β=0.17;95%CI=0.09-0.78) and HAZ (β=0.20; 95%CI=0.01-0.39), although there was insignificance correlation for WHZ (β=0.34; 95%CI=-0.01-0.33). In contrast, cleanness around toilets showed insignificant associations across the indicators. Moreover, waste disposal practices such as burning or farming or composting had inverse effects on WAZ (β=-0.11; 95%CI=-0.68, to -0.01). Finally, covered drinking water storage was positively associated with WAZ (β=0.04; 95%CI=0.01-0.24), while HAZ and WHZ showed no significant effects.

DISCUSSION

The study found that improved household sanitation positively impacted nutritional outcomes, particularly Height-for-Age Z-scores (HAZ) and Weight-for-Age Z-scores (WAZ). This finding is consistent with research which indicated that better sanitation facilities reduce the incidence of diarrheal diseases, a major contributor to undernutrition in children [12]. Similarly, in contrast, a study showed that merely having access to improved sanitation does not guarantee better health outcomes unless accompanied by health education and behaviour changes [13]. This suggests that while sanitation is crucial, it should be integrated with comprehensive health education strategies to maximize its benefits. Similarly, our finding suggested that an improved toilet was positively correlated with WAZ and HAZ, although the association with Weight-for-Height Z-scores (WHZ) was not significant. This finding aligns that access to improved toilet facilities significantly contributes to better growth outcomes in children by preventing exposure to pathogens [14]. Studies emphasize that while sanitation is vital, nutritional outcomes, particularly WHZ, may be influenced more heavily by dietary practices and the availability of nutritious food [15]. This indicates the need for multi-sectoral approaches to address malnutrition holistically. Our study found no significant associations between the cleanliness around toilets and nutritional indicators. This outcome may seem unexpected, given that hygiene practices are commonly linked to health outcomes. However, previous research supports this finding, indicating that while cleanliness is essential for preventing disease transmission, its direct impact on nutritional outcomes can be less pronounced when sanitation infrastructure is inadequate [16]. Moreover, a

study highlighted that social and behavioral factors often mediate the effectiveness of hygiene practices [17]. Therefore, promoting clean environments alone may not be sufficient without addressing underlying structural and behavioral issues. We also found that the waste disposal practices, such as burning or composting, had an inverse relationship with WAZ. This suggests that poor waste management could exacerbate malnutrition issues. Research has shown that improper waste disposal leads to environmental contamination, which can increase the risk of infections that affect nutritional status [18]. Furthermore, a study demonstrated that effective waste management practices contribute to healthier living conditions, positively influencing children's growth outcomes [19]. Therefore, improving waste disposal methods could be a crucial component of interventions aimed at enhancing nutritional outcomes. The study also revealed that covered drinking water storage was positively associated with WAZ, although it did not significantly affect HAZ or WHZ. This finding is in line with the research which found that proper water storage practices help reduce contamination and subsequent illness, thereby supporting better nutritional outcomes [20]. However, the lack of significant effects on HAZ and WHZ indicates that while water quality is important, other factors such as dietary diversity and food security also play a vital role in child nutrition [21]. Addressing water storage alone, therefore, may not suffice in combating undernutrition, necessitating a more comprehensive approach.

The findings of the study not only highlight the importance of improved sanitation in influencing nutritional outcomes but also emphasize the need for comprehensive strategies that consider the various ecological factors that incorporates individual behaviors, interpersonal dynamics, community engagement, and policy support impacting child health as provoked by Ecological Model of Health [10].

Limitations This study has several limitations that should be acknowledged. First, the cross-sectional design restricts the ability to establish causal relationships between environmental and water sanitation practices and nutritional outcomes, as it only provides a snapshot in time. Second, reliance on self-reported data from caregivers may introduce bias or inaccuracies in reporting household sanitation practices and nutritional behaviors. Third, the study's focus on a specific rural municipality may limit the generalizability of the findings to other regions of Nepal, where cultural and environmental factors may differ. Additionally, potential confounding variables, such as socioeconomic status and dietary diversity, were not fully controlled for, which may affect the nutritional outcomes of the children studied. Despite these limitations, the findings have important implications for public health policies and programs aimed at improving child nutrition in Nepal. The positive association between improved sanitation and better nutritional outcomes highlights the need for integrated interventions that address both health education and sanitation infrastructure. Policymakers should prioritize investments in sanitation facilities and promote proper waste disposal methods to mitigate the adverse effects of poor sanitation on child health. Furthermore, health education programs targeting caregivers should emphasize the importance of safe water storage and hygienic practices. By addressing these key areas, stakeholders can make significant strides in reducing malnutrition rates and improving the overall health and well-being of children under five in rural communities.

CONCLUSION

This study highlights the pivotal role of improved household sanitation in enhancing nutritional outcomes among children under five, particularly in terms of Height-for-Age Z-scores (HAZ) and Weight-for-Age Z-scores (WAZ). It underscores the necessity of integrating sanitation interventions with comprehensive health education and behavior change initiatives to maximize their impact. Furthermore, the findings reveal that addressing waste disposal practices and ensuring clean drinking water storage are critical for promoting child nutrition, while also emphasizing the need for multi-sectoral strategies that consider ecological factors, community engagement, and policy support. To further advance this research, future studies should explore the longitudinal effects of integrated WASH and nutrition interventions, assess the influence of dietary practices on growth outcomes, and examine how socio-cultural factors may mediate the relationship between environmental sanitation and child health.

ADDITIONAL INFORMATION AND DECLARATIONS

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Conflict of interest: The authors declare no conflict of interest.

Author Contributions: Concept and design: DKG and DRP; data collection and statistical analysis: PKS, DRP and PS; writing of the manuscript: PS; monitoring and supervising the research, finalizing the manuscript: DKG, PKS and PS. All authors contributed to interpretation of results, literature review, and revision of the manuscripts, edit and agreed with the contents of the final manuscript.

Data Availability: The datasets used and analyzed for the study are available from the corresponding author upon reasonable request.

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