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Original Research Article

Determinants of Acute Malnutrition among Under Five Children in Aravalli District of Gujarat, India: A Community-Based Case-Control Study

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ABSTRACT

Introduction: Children with acute malnutrition or wasting have a higher risk of mortality and morbidity compared to healthy children. Wasting is widespread in India, and Gujarat state is one of the highly prevalent states. Understanding local risk factors is crucial for early identification and timely management of acute malnutrition. This study aims to identify the potential risk factors of wasting among under five (U5) children in one of the high burden districts of Gujarat.
Methods: This community-based case-control study was conducted from January to October 2017 in Aravalli district. Cases were defined as children with weight-for-height z score (WHZ)≤2SD, while controls were WHZ >2SD based on WHO standards. Sociodemographic characteristics, maternal characteristics, child characteristics, feeding practices, sanitation and hygiene practices, and household food security were exposure variables. Crude odds ratio with 95% confidence intervals were calculated.
Results: A total of 132 children, 66 cases and 66 controls were enrolled. Risk factors associated with wasting were: difficulty in breathing (COR 8.89, 95% CI: 1.08-73.86), cold (COR 2.36, 95% CI: 1.12-4.97), fever (COR 3.25, 95% CI: 1.39-7.56), unavailability of hand washing place (COR 2.7, 95% CI: 1.30-5.60), unavailability of toilet (COR 2.93, 95% CI: 1.39-6.17), open disposal of child stools (COR 3.52, 95% CI: 1.61-7.69) and household food insecurity (COR 2.37, 95% CI: 0.96-5.86).
Conclusion: Present study identified childhood illness, inadequate WASH practices, and household food insecurity as significant contributory factors of wasting in U5 children in Aravalli district.

Keywords: wasting, acute malnutrition, under-five children, determinants

INTRODUCTION

Malnutrition is a public health problem affecting millions of children all over the world. [1,2] The World Health Organization (WHO) classifies malnutrition as undernutrition, overweight, obesity, and inadequate vitamins or minerals. [3] Globally around 45% of deaths among under five (U5) children are attributed to undernutrition. [3] Undernutrition is characterized by three conditions, wasting, stunting and underweight. [3] Amongst these conditions, wasting or acute malnutrition is a major contributory factor for child mortality. [4] Globally, in 2018, an estimated 7.3% prevalence (49 million) U5 children were wasted. [4]

World Health Assembly has endorsed the six global nutrition targets for 2025. [5] One of them is reducing and maintaining childhood wasting to less than 5%. [6] Currently, India is off track in

achieving this target. According to National Family Health Survey-4 (NFHS), the prevalence of wasting is 21% in India [7] and it varies across states. NITI (National Institution for Transforming India) Aayog State Nutrition Dashboard, classified the states based on wasting prevalence as low, medium and high. [8] Some of the low prevalence states are Mizoram (6.10%), Manipur (6.80%) and Nagaland (11.20%); medium prevalence states are Assam (17.00%), Arunachal Pradesh (17.30%) and Uttar Pradesh (17.90%) and high prevalence states are Jharkhand (29%), Gujarat (26.40%) and Maharashtra (25.60%). [9]

Gujarat being a high prevalent state, 23 out of 33 districts, have more than 5% of wasted children. [9] Further, NFHS data of 2005-06 and 2015-16 for the state indicated increased prevalence from 19% to 26% in the past one decade, [8,9] which is a matter of great concern.

Multiple risk factors contribute to wasting. Factors such as inadequate feeding practices, food insecurity, lack of sanitation and hygiene practices, and poor access to healthcare are directly linked to wasting. [6] Other risk factors reported are socioeconomic inequalities, low parental education, climate change, and lack of government policies. [10-13] In addition to these, recent studies indicate infections as a potential risk factor. [14,15] Infections and inadequate diet are interlinked as both increases the risk of wasting.

Despite following Government of India's guidelines on the management of wasting, Gujarat experienced persistently high levels of wasted children over a decade. Thus, it is of interest to identify local risk factors, which as help in developing preventive strategies, early identification and timely management. This study aims to identify the potential risk factors of wasting among under five (U5) children in one of the high burden districts of Gujarat.

METHODS

Study design and setting

A community-based case control study from January to October 2017 was conducted in Aravalli district, Gujarat. Aravalli, with a population of 9.5 million is divided into six blocks. Of the six blocks we purposively (greater number of children compared to other blocks of the district) selected two blocks, Meghraj and Modasa. Further, six Primary Health Centre (PHC) villages (Modasa- Tintoi, Sinavada, and Dadhaliya) and (Meghraj- Sangal, Rellavada and Isari) were selected for screening children.

Ethical approval was obtained from the Institutional Ethics Committee, Indian Institute of Public Health Gandhinagar (IIPHG). Data collection permission was provided by Commissionerate of Health, Medical Services and Medical Education, Government of Gujarat. Written informed consent was taken from the participants before collecting any information.

Study Participants

All children U5 years were screened using WHO 2006 child growth standards for acute malnutrition. [16] Based on weight-for-height z-scores (WHZ), children were identified as cases and controls. Children with WHZ ≤2SD were defined as cases, while controls were those with WHZ >2SD. Additionally, children with any kind of medical complications, physical deformities, mental retardation, physical challenges, serious illnesses or born as preterm were excluded.

We calculated sample size using OpenEpi, version 3, statistical software with the following assumptions: proportion of controls with exposure (infection) to be 20%, 95% confidence interval (CI), 80% power of the study, and control to case ratio of 1:1 to detect an odds ratio of 3. Thus, the minimum sample size required for the study was 128 (64 cases and 64 controls).

Data collection and procedure

A team of the research assistant (qualified in nutrition) and filed investigator (qualified in social work) collected data with the support from local health workers. Data collection was planned in three stages:

visit 1- screening of children (using anthropometry) for enrollment, visit 2- questionnaire administration to caretakers of enrolled children, and visit 3- stool sample collection for biomarkers of environmental enteropathy.

Screening: Children from the selected PHCs were screened using anthropometric (height/length and weight) parameters. Length/height of children was measured with a Seca measuring board (with maximum length/height 100 cm and accuracy of 0.1 cm) and weight was measured with Seca digital weighing machine (with a maximum weight of 12 kg and accuracy of 0.05 kg). Two readings were obtained for each measurement and the mean of two measurements was used for the analysis. After applying the exclusion criteria, children were enrolled in the study for further data collection. After screening, the research team was blinded- the principal investigator developed separate codes for all enrolled cases and controls.

A semi-structured questionnaire was administered to collect data from caregivers (mothers/other caregivers) of children under various domains related to the aim of the study. The tool was first developed in English and was later translated into the local language (Gujarati).The questionnaire was divided into the following domains: general information; sociodemographic characteristics; maternal characteristics; child characteristics; Infant and Young Child Feeding (IYCF) practices; Water Sanitation and Hygiene (WASH) practices and household food security (FANTA). [17]

Stool samples were collected from a subset of children who were randomly selected from total enrolled children. Soon after collection, samples were transported in dry ice from field area to institutional laboratory within 24 hours of collection and were stored at -80°C till estimation. These samples were analyzed for two biomarkers- Alpha-1 anti-trypsin (intestinal inflammation) and Regenerating Gene 1β (epithelial regeneration)as described by Kosek et al. [18]

Laboratory Analysis

Stool samples for Alpha-1 anti-trypsin was analyzed using COBAS INTEGRA Tina-quant α1-Antitrypsin ver.2 cassette and Regenerating Gene 1β with Human lithostathine-1-beta ELISA kit.

Data analysis

Collected data were analyzed using STATA version 15.1. Findings were reported as frequencies and percentages. The association between outcome and exposure variables was analyzed using Chi-square or Fisher Exact tests. The risk was estimated using the odds ratio with 95% CI.

Variables of the study

The dependent variable was acute malnutrition (WHZ ≤2SD).IYCF practices, childhood illness, WASH and household food security affecting children's nutritional status were considered as independent variables.

RESULTS

Of 227 children screened from six PHC villages, 132 were randomly selected as cases (n=66) and controls (n=66). The background characteristics of the participants are presented in Table 1. The characteristics such as gender, community, family type, income and feeding practices were equally distributed among cases and controls. While, child's age, maternal age of marriage and birth order were significantly different between the two groups.

Table 2 presents the association of various risk factors for acute malnutrition. We explored IYCF practices, childhood illnesses, WASH practices and household food insecurity as potential risk factors. Of total participants, 92.42% in cases and 95.50% in controls were exclusively breastfed for six months. We did not find any evidence of an association between IYCF practices and acute malnutrition.

There appears some evidence of an association between childhood illness and acute malnutrition. Childhood illness such as- breathing difficulties, cold and fever were more prevalent among cases than controls. Children with reported breathing

difficulties had 8.96times the odds of becoming acutely malnourished compared to those with no breathing difficulties (COR 8.89, 95% CI: 1.08 to 73.86, p=0.03). Similarly, children who reported cold had 2.36 (95% CI: 1.12 to 4.97, p=0.01) and who reported fever had 3.25 (95% CI: 1.39 to 7.56, p=0.004) times odds of becoming a case compared to those with no such illnesses.

Further, we found evidence of an association between various WASH practices and acute malnutrition. Appropriate WASH practices were less prevalent in cases than controls. Children living in houses with no handwashing and toilet facilities had 2.7 (95% CI: 1.30 to 5.60, p=0.005) and 2.93 (95% CI 1.39 to 6.17, p=0.003) times higher odds than children living in houses with these facilities respectively. Similarly, relative to families who practiced disposing child stools in latrine, families who practiced stool disposal in the open area had 3.52 (95% CI: 1.61 to 7.69, p=0.001) times higher odds of having an acutely malnourished child.

We also found a weak association between household food insecurity and acute malnutrition. Relative to households who were food secure, households with food insecurity had 2.37 (95% CI: 0.96 to 5.86, p=0.052) times higher odds of having an acutely malnourished child.

A total of 60 samples (30 cases and 30 controls) were randomly selected to assess intestinal biomarkers in the stool. Table 3 shows biomarkers Alpha-1 anti-trypsin (mg/dl) and Regenerating Gene 1β(ng/mL). Mann-Whitney U test was used to compare the quantitative variables. There was no evidence of a difference in the median values between cases and controls.

Table 1: Background characteristics of the participants (n=132)

Characteristics	Cases n= 66 (%)	Controls n= 66 (%)	p value
Child age			
≤24 months	34 (51.5)	45 (68.2)	0.051*
>24 months	32 (48.48)	21 (31.82)	
Gender			
Male	36 (54.5)	34 (51.54)	0.727
Female	30 (45.45)	32 (48.48)	
Community			
SC	7 (10.6)	11 (16.6)	0.630
ST	33 (50)	35 (53)	
OBC	22 (33.3)	17 (25.8)	
General	4 (6.1)	3 (4.5)	
Type of family			
Nuclear	16 (24.2)	13 (19.7)	0.528
Extended Family	50 (75.8)	53 (80.3)	
Per capita income			
<1000	37 (56.06)	43 (65.15)	0.563
1000-3000	25 (37.88)	20 (31.30)	
>3000	4 (6.06)	3 (4.55)	
Maternal age of marriage			
< 18 years	18 (27.3)	7 (10.6)	0.015*
≥18 years	48 (72.7)	59 (89.4)	
Ever breastfed			
Yes	61 (92.4)	63 (95.5)	0.095
No	5 (7.6)	1 (1.5)	
Don't know	0	2 (3)	
Initiation of breastfeeding			
≤24 hours	46 (69.69)	53 (80.30)	0.448
>24 hours	20 (30.30)	13 (19.69)	
Colostrum feeding			
Yes	52 (78.8)	56 (84.8)	0.659
No	14 (21.21)	10 (15.15)	
Birth order			
1	25 (37.88)	24 (36.66)	0.023*
2	31 (46.97)	18 (27.27)	
3	7 (10.61)	14 (21.21)	
4	3 (4.55)	10 (15.15)	

Evidence of association based on p value [<0.001 (very strong****), <0.01 (strong***), <0.05 (good**), 0.5-0.1 (weak*) and >0.1 (insufficient)]

Table 2: Risk factors for acute malnutrition

Factors	Cases (n=66)	Controls (n=66)	COR (95% CI)	p value
IYCF practices				
Exclusive breastfeeding				
<6 months	5	3	1.72 (0.39 to 7.51)	0.718
≥6 months	61	63	Reference	
Childhood illness				
Diarrhea within 24 hours				
Yes	3	3	1 (0.194 to 5.145)	1
No	63	63	Reference	
Difficulty in breathing in the past 2 weeks				
Yes	8	1	8.96 (1.08 to 73.86)	0.03**
No	58	65	Reference	
Cold in the past 2 weeks				
Yes	31	18	2.36 (1.12 to 4.97)	0.01**
No	35	48	Reference	
Fever in the past 2 weeks				
Yes	26	11	3.25 (1.39 to 7.56)	0.004***
No	40	55	Reference	
WASH Practices				
Hand washing place				
No	39	23	2.70 (1.30 to 5.60)	0.005***
Yes	27	43	Reference	
Toilet facilities				
No	46	29	2.93 (1.39 to 6.17)	0.003***
Yes	20	37	Reference	
Disposal of child stools				
Open	50	31	3.52 (1.61 to 7.69)	0.001***
Latrine	16	35	Reference	
Household food insecurity				
Food insecure	18	9	2.37 (0.96 to 5.86)	0.052*
Food secure	48	57	Reference	

COR: crude odds ratio, evidence of association based on p value [<0.001 (very strong****), <0.01 (strong***), <0.05 (good**), 0.5-0.1 (weak*) and >0.1 (insufficient)]

Table 3: Intestinal biomarkers among cases and controls

Biomarkers	Median		p value
	Cases (n=30)	Controls (n=30)	
α1-Antitrypsin(mg/dl)	16.97	16.76	0.18
Reg1β Gene (ng/mL)	0.93	0.94	0.81

DISCUSSION

Wasting is a strong predictor of mortality in U5 children. [19] We found evidence of an association between exposures such as -childhood illness, WASH practices, household food insecurity, and outcome wasting.

Under childhood illnesses, we observed breathing difficulty, cold, and fever are risk factors for acute malnutrition, whereas diarrhea did not demonstrate any association. Our finding is consistent with other case-control studies conducted in India. [20,21] A study conducted in Udupi (Karnataka) revealed higher odds of infection among cases; [20] authors suggested a high prevalence of infection in malnourished children because of poor immune response as a result of insufficient nutrition. Similar findings were also observed in a study carried out in North West Ethiopia. [22]

Our finding of no association between diarrhea and wasting is in contrast with another study conducted in Bangladesh, suggesting the direct impact of diarrhea. [23] This could be because in our study, the overall prevalence of diarrhea was low in both cases and controls. However, diarrhea has been reported to have a two-way impact on different forms of undernutrition as it can affect and cause poor nutrient absorption. [24]

Clean WASH practices are major factors for better nutritional outcome among U5 children. WASH practices included unavailability of the toilet, hand washing place and disposal of child stool in open. Our results demonstrated that inadequate WASH practices increased the risk of acute malnutrition in children. A case-control study from Central India reported that inadequate WASH practices enhance the

susceptibility of infection in children and infection influences acute malnutrition. [21] This is consistent with previous studies done in India and Ethiopia. [25,26]

Other than childhood illnesses and WASH practices, household food insecurity also plays a role in acute malnutrition. Our findings are in line with other studies. [23,26] Household food insecurity adversely affects food consumption in relation to quantity and quality among U5 children. [27] The odds of a child being acutely malnourished are reported to be higher in food-insecure households. [28]

In addition, environmental contaminant stimulates environmental enteric dysfunction (EED) which affects mucosal permeability and thus nutrient absorption through an altered intestinal villous structure. [29] Evidence from Bangladesh and Peru suggest that intestinal biomarkers play a critical role in gut health. [30] We did not find any difference in the median value of biomarkers between cases and controls.

Strength and Limitations

This was a community-based case control study; hence the results can be generalized to the wider population of Aravalli district. The findings would be helpful to local health providers, who are managing the acute malnutrition program in Aravalli district. However, there are some limitations, as with most of the case-control studies, recall bias could have influenced the exposure status. Due to small sample size, multivariate analysis was not explored. However, risk estimates are interpreted carefully.

CONCLUSION

We identified childhood illnesses, poor WASH practices and household food insecurity as local risk factors of childhood wasting in Aravalli district. Frequent monitoring of children with illnesses can lead to early identification and thereby timely management of wasting. Additionally, preventive strategies should focus on addressing poor WASH practices and household food insecurity.

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Conflicts of interest: none

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