

Original Article

Integration of Immunization and Health Care Services on the Nutritional Status of Children 6-59 Months of Age in Flood-Affected Areas of South Punjab

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ABSTRACT

Background: Child malnutrition remains a serious public health problem in many parts of the developing world, particularly in South and Southeast Asia and sub-Saharan Africa. The situation is exacerbated by natural disasters, particularly floods, which increase the risk of infectious diseases and worsen the nutrition crisis in vulnerable areas. In Pakistan, the 2018 National Nutrition Survey showed high levels of stunting, underweight and wasting among children under the age of five.

Objective: This study aimed to determine whether integration of immunization and health services can improve the nutritional status of children aged 6-59 months in flood-affected areas of South Punjab, Pakistan. **Methods:** This study used a mixed methods approach, combining a cross-sectional observational study with structured interviews. A sample of 384 children aged 6-59 months was selected through convenience sampling in flood-affected areas. Data were collected through surveys and interviews with families, focusing on maternal feeding practices and factors affecting child nutritional status. Statistical analysis was conducted using IBM SPSS version 25, including frequency distributions for categorical variables and Pearson correlations to determine the association between upper arm circumference (MUAC) and nutritional status, weight, and height. **Results:** Results showed significant correlations between MUAC and child nutritional status ($p=0.035$), MUAC and child weight ($p<0.001$), and MUAC and child height ($p<0.001$). Of the total 384 participants, 60.68% had MUAC more than 12.5 cm, while 39.32% had MUAC less than 12.5 cm. **Conclusion:** This study confirms the importance of integrating health and immunization services in addressing child malnutrition in disaster-prone areas. Findings show that factors such as parents' socioeconomic status, occupation, education and living environment are significantly related to children's nutritional status.

KEYWORDS

Child nutrition disorders, floods, immunization programs, malnutrition, Pakistan, public health

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INTRODUCTION

Childhood malnutrition remains a serious public health issue in many parts of the developing world, especially in South and Southeast Asia and sub-Saharan Africa [1,2]. Malnourished children are at greater risk of dying from contagious diseases, and malnutrition is the root cause of 45% of global fatalities in children younger than five years old [3–5]. Approximately 17 million people were completely wasted. In addition, 149 million children were stunted, and 462 million were underweight. Children under the age of five are disproportionately affected by malnutrition, and reports indicate that poverty and lack of education are key contributors. The situation is particularly dire in Pakistan, where the 2018 National Nutrition Survey showed that 40.2% of children were stunted, 28.9% were underweight, and 17.7% were wasting [6,7].

Natural disasters, particularly floods, exacerbate the malnutrition crisis in vulnerable regions. When floods or other emergencies occur, the situation worsens [4]. Floods are the most frequently reported natural disasters worldwide and significantly affect human health. Epidemiological research has linked floods in low-income rural regions to diseases such as diarrhea, cholera, respiratory infection, leptospirosis, and posttraumatic stress disorder [8]. However, data on how floods affect children's diets are scarce and location-specific. Studies have shown a strong correlation between the prevalence of malnutrition and high rates of stunted growth and mortality observed in poor nations, such as Pakistan. A study at the pediatric unit of Lady Reading Hospital (LRH), Peshawar, found that 30.1% of children under five years old were malnourished, with a mortality rate of 13.6% [9]. Research has demonstrated that malnourished children are at a greater risk of dying once infected, even though it has been contested whether malnutrition enhances the incidence of infection or increases the severity of the disease. The effects of malnutrition on the immune system may contribute to increased vulnerability to infections [10].

Given the complex interplay between malnutrition, infectious diseases, and natural disasters, the question arises: Can the integration of immunization and healthcare services improve the nutritional status of children aged 6–59 months in flood-affected areas of South Punjab, Pakistan? While previous research has established the importance of various interventions in preventing malnutrition, there is limited data on the efficacy of integrating immunization and healthcare services specifically in flood-affected regions [11]. The urgent need to address childhood malnutrition in Pakistan, particularly in areas prone to natural disasters, necessitates innovative approaches that combine multiple interventions.

The World Health Organization, the United Nations Children's Fund, and the World Bank estimated that routine childhood immunization programs prevented more than 2.5 million fatalities per year a decade ago [12]. By examining the integration of immunization and healthcare services, this study addresses a critical gap in our understanding of how to effectively combat malnutrition in vulnerable populations. The findings could inform policy decisions and intervention strategies in Pakistan and other developing countries facing similar challenges. Given the complex interplay between malnutrition, infectious diseases, and natural disasters, this study aims to determine whether combining immunization and healthcare services can improve the nutritional status of children aged 6–59 months in flood-affected areas of South Punjab, Pakistan. The primary objective is to assess the effectiveness of an integrated approach in reducing malnutrition rates among this vulnerable population. Additionally, the research seeks to identify specific factors within the integrated service model that contribute most significantly to positive nutritional outcomes.

It is anticipated that this study will provide valuable insights into the potential synergies between immunization programs and broader healthcare services in addressing childhood malnutrition. We expect to observe improved nutritional indicators, such as mid-upper arm circumference (MUAC) measurements, among children who receive integrated services compared to those who do not. Furthermore, we hope to uncover best practices for implementing such integrated approaches in resource-limited and disaster-prone settings. The findings of this research could potentially inform future public health interventions and policy decisions, not only in Pakistan but also in other developing countries facing similar challenges related to childhood malnutrition and recurring natural disasters.

MATERIALS AND METHODS

Study design and setting

This research employed a mixed-methods approach, combining a cross-sectional observational study with structured interviews [13]. The survey was designed to identify the factors that affect the nutritional status of children in flood-affected areas. The interview and survey questions were based on research questions in which professionals in the content area were reviewed [14,15].

Ethical approval process

A questionnaire was designed to begin the survey, and ethical approval was obtained from the bioethical research committee of the University of Management and Technology, Lahore. Before conducting the study, all participants were assured that the data collected from the questionnaires and interviews would remain confidential and that no personal identification would be revealed by any means other than understanding the current objectives of the research.

Participants and recruitment process

The study was conducted among children aged 6 months to 5 years in different areas of South Punjab. Data collection focused on mothers' feeding practices and factors affecting children's nutritional status in flood-affected regions. The data were collected from August to November 2023.

Sample, inclusion and exclusion criteria

The participants were recruited through convenience sampling by physically visiting areas affected by floods [16]. Our aim was to collect data from children (6-59 months) and their families to determine the factors that affect the nutritional status of children and nutritional practices among parents during or after floods. The sample size was determined using cluster sampling techniques, resulting in a total of 384 participants. The age of the children was the same as needed. The inclusion criteria for this study were: (a) Children aged 6 months to 5 years, (b) Mothers or fathers who completed the survey, and (c) Residents of flood-affected areas in South Punjab. The exclusion criteria for the study were: (a) People who were not residents of flood-affected areas, (b) Children less than 6 months or greater than 5 years of age, (c) Children prone to chronic diseases, (d) Children with any other serious or hereditary disorders. All the participants opted to participate in the study.

Data collection

Structured interviews and surveys were conducted with families to gather comprehensive data on children's nutritional status, feeding practices, and the impact of floods on their health. The interviews were designed to capture nuanced information about the challenges faced by families in maintaining proper nutrition for their children in the aftermath of floods. The questionnaire was scored with a maximum score of 112 and a minimum score of 12. A low score indicates low nutritional status, and a high score indicates good nutritional status. An additional scale was drafted to identify markedly underweight, average, overweight, and obese children using the WHO Weight for Height chart.

Statistical analysis

The data were statistically analyzed using IBM SPSS version 25. Categorical variables (i.e., socioeconomic status) were analyzed using frequency distributions. MUAC was analyzed by descriptive statistics. Pearson correlation was applied to determine the relationships between the MUAC and nutritional status, between the MUAC and weight and between the MUAC and height. The significance set is if the p value <0.05 is considered to have a significant relationship, otherwise if the p value >0.05 then it does not have a meaningful relationship with a level of evidence of 95%.

RESULTS

Demographic data of the participants

The demographic data showed that the mean age and standard deviation of age were 21.83 ± 14.843 months. The mean weight and standard deviation of weight were 7.17 ± 2.530 kg. The mean height and St. deviation of the height were 72.16 ± 8.274 cm. Among the 384 participants, 60.68%, 233 had a mid-upper arm circumference greater than 12.5 cm, and 151 (39.32%) had a circumference less than 12.5 cm in the middle upper arm. The demographic data of the participants are presented in Table 1.

Table 1. Demographic data of the participants

	Age of Participants in Months	Weight of Participants in Kgs	Height of Participants in cm
Number of Participants	384	384	384
Mean	21.83	7.17	72.16
Std. Deviation	14.845	2.530	8.274

Hypothesis confirmation

The Pearson correlation coefficient between the MUAC and nutritional status of the child was $p=0.035$ (Table 2), and that between the MUAC and weight of the child was $p<0.001$ (Table 3). Both correlations were highly significant, as the level of significance (2-tailed) was less than 0.05. The Pearson correlation between the MUAC and height of the children was highly significant ($p<0.001$) (Table 4).

Table 2. Correlation between MUAC and nutritional status

		Mid Upper Arm Circumference in cm	Nutritional Status
Mid Upper Arm Circumference in cm	Pearson Correlation	1	0.032
	Sig. (2-tailed)		0.035*
	N	384	384
Nutritional Status	Pearson Correlation	0.032	1
	Sig. (2-tailed)	0.035*	
	N	384	384

Remarks: * indicates there is a significant difference, with a probability of $P < 0.05$ (2-tailed), and a level of evidence of 95%.

Table 3. Correlation between MUAC and weight

		Mid Upper Arm Circumference in cm	Weight of Participants in Kgs
Mid Upper Arm Circumference in cm	Pearson Correlation	1	0.050
	Sig. (2-tailed)		$<0.001^*$
	N	384	384
Weight of Participants in Kgs	Pearson Correlation	0.050	1
	Sig. (2-tailed)	$<0.001^*$	
	N	384	384

Remarks: * indicates there is a significant difference, with a probability of $P < 0.05$ (2-tailed), and a level of evidence of 95%.

Table 4. Correlation between MUAC and height

		Height of Participants in cm	Mid Upper Arm Circumference in cm
Height of Participants in cm	Pearson Correlation	1	0.513
	Sig. (2-tailed)		<0.001*
	N	384	384
Mid Upper Arm Circumference in cm	Pearson Correlation	0.513	1
	Sig. (2-tailed)	<0.001*	
	N	384	384

Remarks: * indicates there is a significant difference, with a probability of $P < 0.05$ (2-tailed), and a level of evidence of 95%.

DISCUSSIONS

Correlation between MUAC and nutritional status

In this study, the nutritional status of 6–59-month-old children in the flood-affected districts of DG Khan and Muzaffargarh in South Punjab was evaluated after the integration of healthcare and vaccination programs. Because existing susceptibility can be worsened by floods, especially in young children, our research is essential for identifying and addressing nutritional problems in these populations [17–19]. Since it acknowledges the connections between many facets of a child's well-being, the integration of healthcare services and immunization is an important strategy. The conclusions of this study provide important information for developing focused treatments by illuminating the nutritional circumstances of children in these areas. Most likely, the evaluation entailed a thorough investigation of variables, including eating habits, access to medical care, and how vaccinations affect general health [20].

A cross-sectional study was conducted to determine the prevalence and risk factors for child malnutrition based on the MUAC in areas of Khyber Pakhtunkhwa, Pakistan, affected by flooding. A total of 298 infants aged 6–59 months were selected for this study. An independent anthropometric measure, the MUAC, was used to assess children's nutritional health [21,22]. In the current study, different parameters, including height, weight, age, and MUAC, were used to assess the malnutrition status of the children. The current study highlights that neonates and children face heightened vulnerability to floods, leading to increased risks of infectious diseases and malnutrition due to limited access to clean water and compromised hygiene practices, including infant formula preparation and breastfeeding. This is in accordance with a previous study that reported that floods exacerbate challenges in supplemental feeding, exacerbating malnutrition risks, whereas humid postflooding environments contribute to respiratory and skin issues among children [7]. Similarly, studies indicate that unfavorable environmental factors, such as heavy rain or floods in the early stages of life, have a major effect on children's cognitive, behavioral, and physical development when they are between the ages of two and six years [23].

Previously, the nutritional status of children under five years of age and related determinants were evaluated in a cross-sectional study carried out in two Nepal districts (Kavre and Dolakha). A total of 243 children under the age of five were chosen from two village development committees. Most of the children were malnourished based on anthropometric measurements, such as age, height, weight, and MUAC [24]. Children from three rural communities in Sri Lanka participated in this cross-sectional study. A total of 547 children (53% female) between the ages of 1 and 15 years were included in the study [25]. According to one study, having a large family, a low monthly income, small houses, and working mothers were strongly linked to undernutrition in school-age children [26,27]. In Korea, this study was conducted using the growth index and children's age to assess the eating habits and nutritional status of children from community childcare. The study included 152 participants (5–15 years of age), comprising 79 females and 73 males. The study showed significant results according to the body mass index used to calculate the growth index based on weight, height, and age [28].

Correlation between MUAC and weight

Geospatial analysis was conducted in 2023 in India on undernutrition children, which features high-low weight regions as far as neighborhood areas of interest and distinguishes the potential spatial gamble elements of undernutrition across the voting public. Striking varieties in the commonness of undernutrition across the voting public were observed. The majority of this voting public that performed ineffectively, both with regard to younger sustenance and financial pointers, was situated in the northern, western, and eastern parts of India. An enormous relationship of organic, financial, and ecological factors, for example, women's weight records, children's paleness, neediness, family disinfection offices, and institutional births, was identified. The outcomes feature the need to obtain an instrument of political responsibility that straightforwardly interfaces chosen delegates to maternal and younger well-being results. The spatial changeability and examples of undernutritional pointers and their correspondence demonstrate that need-setting in exploration may likewise be extraordinarily affected by local affiliation [29]. In comparison to the present study, the socioeconomic status of parents, their occupation, their education, and the areas where the children were born were significantly related to the nutritional status of those children and the mid-arm circumference area ($p < 0.001$).

A study was conducted in India's four metropolitan cities on status and its correlation with noncommunicable diseases among children and adolescents in slum and nonslum areas in 2023. Children from slums were at a greater risk of diabetes than those from nonslums, and diseases such as hypertension were more prevalent in children living in nonslum areas of India [30]. In contrast, the results of this study indicate that communicable diseases such as diarrhea and cholera are prevalent in areas of low socioeconomic status, such as the slum area of Pakistan. Poverty and poor nutritional status lead to such diseases, which is why the correlation between complaints of symptoms associated with diarrhea and cholera among flood-affected children in Pakistan is highly significant ($p < 0.001$).

Another study to determine the cause and prevalence of stunting among children from flood-affected areas was conducted by Haq et al. [27] out of 656 households surveyed; 40.5% of children were stunted, with higher rates among girls (46.3%) than boys (36.1%). Among under-five children, the prevalence of stunting was 50.7%. Factors associated with stunting included the child's age ($p < 0.05$, 13-24 months), maternal age, family type, and lack of access to improved drinking water and toilet facilities. These findings emphasize the urgent need for targeted interventions and policy measures to address stunting in flood-prone areas. Compared to the current study, the children's nutritional status and the precise mid-arm circumference area were substantially correlated with the parents' socioeconomic position, occupation, education, and the areas where the children were born ($p < 0.001$).

This cross-sectional analysis included data on sociodemographic factors, diarrhea incidence, and anthropometric measurements. Children with diarrhea had a significantly greater prevalence of stunting, wasting, and underweight than did those without diarrhea (75.2%, 76.5%, and 74.1% vs. 24.8%, 23.5%, and 25.9%, respectively). Bivariate regression revealed correlations between the incidence of diarrhea and age (2-4 years), number of family members, poor income, bathing in ponds, consuming untreated water, flooding, living in mudhouses, and using uncovered utensils [31]. A survey data analysis from 2017 to 2019 in Mozambique concluded that low weight-for-height and mid-upper arm circumference (MUAC) generally indicate that the same children are wasted [32]. These findings are consistent with those of the present study, illustrating the importance of interventional strategies and policies for affected regions.

Another study aimed to assess the prevalence of stunting and related factors in children under five years of age in southern Ethiopia using a cross-sectional design with 660 child-mother pairs, employing structured questionnaires and anthropometric measurements [33]. Variables with a P value < 0.25 in the bivariate analysis were included in the multivariable logistic regression, with significance declared at a P value < 0.05 , in line with the present study, with a similar P value. Moreover, studies also point to nutrient deficiency causing stunting among children in flood-hit areas [6,34], along with a lack of food security [34] and a lack of diarrhea [35]. As the present study mentioned, children suffer the most from natural disasters such as floods [36]. An Ethiopian study reported that of 8935 children, 8.1% were severely underweight, 17.1% were moderately

underweight, and 74.8% were normal [37], in contrast to the present study, which reported an association between nutritional status and the MUAC, height, and weight of children.

Correlation between MUAC and height

In 2016, a study investigated the impact of flooding on the prevalence of wasting, stunting, and underweight in rural eastern India, focusing on children who were repeatedly flooded in 2006 and 2008. The results showed a significantly greater prevalence of acute malnutrition among children flooded in 2006 and 2008 (51.6%) and among those flooded only in 2008 (41.4%) than among those in nonflooded communities (21.2%). In repeatedly flooded communities, severe wasting was observed, with a confidence interval of 95% [36]. In contrast to the present study, where the association between nutritional status of affected children and that of MUAC, height and weight were found with a confidence interval >95%. The addition of the MUAC along with the weight-to-height (W-H) variables in the present study improved the accuracy of the prediction and diagnosis of malnutrition according to previous studies [38,39].

In the Maldives, a cross-sectional study surveyed children under 5 years of age and their mothers, assessing infant and child feeding indices and anthropometric measurements. The prevalence rates for underweight, stunting, and wasting were 24.6%, 32.4%, and 16.3%, respectively, with significant associations ($P<0.05$) found between feeding index scores and weight for age [31], in comparison with the current study findings of nutritional status and weight ($P<0.05$). To avoid this stunting, dietary supplementation should be started as early as possible after a disaster strike. Singh [40], additionally, the present study used 12.5 cm as the cutoff value for the MUAC, but other studies have recommended 14 cm or greater to indicate malnutrition [28,41], while others have used a standard low cutoff value for the MUAC to indicate severe malnutrition [42–44].

The current study offers recommendations for healthcare policymakers to address the situation in flood-affected areas of Pakistan, as do other studies to improve feeding practices for children [45]. Supplementation programs should be initiated [28,46], as recommended by the present study, along with the analysis of new nutritional intervention programs [47]. The current study used the MUAC, height, weight, age, and other factors to assess malnutrition. The integration of healthcare services with vaccination campaigns might provide valuable insights into comprehensive treatments aimed at addressing the complex factors influencing child nutrition in regions vulnerable to disasters [48–50].

Limitations and future directions

The limitations of this study, including the reliance on self-reported data or measurements taken at a single time point, may introduce recall bias or measurement error, particularly when assessing nutritional intake or healthcare utilization. The participants who lived in remote and unstable environments were difficult to access for safety reasons. The nutritional status of children in flood-affected areas may be influenced by external factors beyond the scope of this study, such as eating disorders. Factors specific to the flood-affected areas of South Punjab may limit the applicability of these findings beyond this specific setting. Future research topics, including longitudinal studies to determine the persistent effect of integrated immunization and health care services on the nutritional status of children in flood-affected communities and methodologies that determine the communities involved in the research process, should be investigated. Taking into account the one-of-a-kind cultural and social dynamics of South Punjab, as you explore the effect of community-led efforts on maintaining health gains over time and conduct cost-effectiveness evaluations of integrated programs to offer information for policymakers on the economic viability and advantages of ongoing investments in nutrition-focused efforts in flood-prone areas.

CONCLUSIONS

The study concluded that the nutritional status of children in flood-affected areas of Pakistan is poor, and a comprehensive and multipronged strategy is needed to improve their nutritional status. This strategy should include the promotion of breastfeeding, adequate complementary

meals, vitamin A supplementation, and crisis interventions for malnutrition. Additionally, interventions such as immunization, education on clean hygiene practices, postnatal nutrition consultation, and children's services clinics can help prevent malnutrition and its effects.

CONFLICT OF INTEREST

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

AUTHOR CONTRIBUTIONS

Conceptualization, Methodology, Software, Validation, Formal analysis, Investigation, Resources, Data Curation, Writing - Original Draft, Writing - Review & Editing, Visualization, and Supervision: MT.

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