Brazilian Journal of Biology®

ISSN 1519-6984 (Print)
ISSN 1678-4375 (Online)

Original Article

Prevalence and determinants of stunting among preschool and school-going children in the flood-affected areas of Pakistan

Prevalência e determinantes da baixa estatura entre crianças em idade pré-escolar e em idade escolar nas áreas afetadas pelas enchentes do Paquistão

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Abstract

Stunting is a significant public health problem in low- and middle-income countries. This study assessed the prevalence of stunting and associated risk factors of stunting among preschool and school-going children in flood-affected areas of Pakistan. A cross-sectional study was conducted by visiting 656 households through multi-stage sampling. Respondent's anthropometric measurements, socio-demographic information and sanitation facilities were explored. A logistic regression model was used to determine determinants of stunting, controlling for all possible confounders. The overall prevalence of stunting in children was 40.5%, among children 36.1% boys and 46.3% of girls were stunted. The prevalence of stunting in under-five children was 50.7%. Female children (OR=1.35, 95% CI:0.94-2.0), children aged 13-24 months (OR=6.5, 95% CI: 3.0-13.9), mothers aged 15-24 years (OR=4.4, 95% CI: 2.6-7.2), joint family (OR=2.1, 95% CI: 1.4-3.0) did not have access to improved drinking water (OR=3.3, 95% CI: 1.9-5.9), and the toilet facility (OR=2.8, 95% CI, 1.9-4.3), while the children from district Nowshera (OR=1.7, 95% CI: 0.9-3.2) were significantly ($P<0.05$) associated in univariate analysis. The regression model revealed that child age, maternal age, family type, quality of water, and toilet facility, were the significant ($P<0.05$) factors contributing to child stunting in the flood-hit areas. Identification of key factors might be helpful for policymakers in designing comprehensive community-based programs for the reduction of stunting in flood-affected areas. In disasters such as flood, the detrimental consequences of the stunting problem could be even more on children. Evidence-based education and care must be provided to the families in the flood-affected regions to reduce the stunting problem. The determinants of stunting should be targeted by making comprehensive policies regarding proper nutrition, livelihood, clean water, and sanitation facilities in flood-hit regions.

Keywords: malnutrition, stunting, flood, z-score.

Resumo

A baixa estatura é um problema significativo de saúde pública em países de baixa e média renda. Este estudo avaliou a prevalência de nanismo e os fatores de risco associados de nanismo entre crianças em idade pré-escolar e em idade escolar em áreas afetadas por inundações do Paquistão. Foi realizado um estudo transversal visitando 656 domicílios por meio de amostragem em múltiplos estágios. As medidas antropométricas do entrevistado, informações sociodemográficas e instalações de saneamento foram exploradas. Um modelo de regressão logística foi usado para determinar os determinantes do nanismo, controlando todos os possíveis fatores de confusão. A prevalência geral de baixa estatura em crianças foi de 40,5%, entre as crianças 36,1% dos meninos e 46,3% das meninas com baixa estatura. A prevalência de baixa estatura em crianças menores de 5 anos foi de 50,7%. Crianças do sexo feminino (OR = 1,35, IC de 95%: 0,94-2,0), crianças de 13-24 meses (OR = 6,5, IC de 95%: 3,0-13,9), mães

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Received: March 17, 2021 – Accepted: May 13, 2021

de 15-24 anos (OR = 4,4, IC de 95%: 2,6-7,2), família conjunta (OR = 2,1, IC 95%: 1,4-3,0) não tiveram acesso a água potável de qualidade (OR = 3,3, IC 95%: 1,9-5,9) e a banheiro (OR = 2,8, IC de 95%, 1,9-4,3), enquanto as crianças do distrito de Nowshera (OR = 1,7, IC de 95%: 0,9-3,2) foram significativamente (P < 0,05) associadas na análise univariada. O modelo de regressão revelou que a idade da criança, idade materna, tipo de família, qualidade da água e banheiro foram os fatores significativos (P < 0,05) que contribuíram para a baixa estatura infantil nas áreas afetadas pelas enchentes. A identificação de fatores-chave pode ser útil para os formuladores de políticas no planejamento de programas comunitários abrangentes para a redução da baixa estatura em áreas afetadas pelas enchentes. Em desastres como enchentes, as consequências prejudiciais do problema de baixa estatura podem ser ainda maiores para as crianças. Educação baseada em evidências e cuidados deve ser fornecida às famílias nas regiões afetadas pelas enchentes para reduzir o problema de nanismo. Os determinantes do retardo de crescimento devem ser almejados pela formulação de políticas abrangentes sobre nutrição adequada, meios de subsistência, água potável e instalações de saneamento nas regiões afetadas pelas enchentes.

Palavras-chave: desnutrição, nanismo, inundação, pontuação z.

1. Introduction

Malnutrition is a primary cause of mortality and morbidity of children, leading to 45% of under-5 deaths (Gbogbo and Thonneau, 2019). According to an estimate, 159 million under-5 children are stunted globally (Schrijner and Smits, 2018). Malnutrition has become a severe problem in underdeveloped countries and natural disaster affected regions (Jaspars and Young, 1995). Chronic under-nutrition is pervasive in most low-income countries, hit by a natural disaster (Evans and Bassani, 2018), resulting in low levels of human performance. Stunting is an important anthropometric measure used for assessing child undernutrition in developing countries (Stevens et al., 2012). In 2005, approximately 178 million children under five years of age in low- and middle-income countries were stunted (Monteiro et al., 2010).

Child growth and development in early life is critical because it could lead to stunting based child chronic under-nutrition, if not adequately monitored (Wang et al., 2009). Stunting is mainly related to slowing physical and cognitive growth, likely to have dangerous long-term consequences (Saeed et al., 2017). Stunting ultimately affects the developmental prospects of nations and thus serves as a marker for poverty and underdevelopment. The children considered too small for their age when the height for age (HAZ) value be less than minus two standard deviations (-2SD) from the WHO Child Growth Standards median of the reference population (WHO, 2002). Stunting refers to the failure to reach linear growth potential due to inadequate nutrition and poor health (Bhutta et al., 2011).

Inadequate food or nutrients, food insecurity, disease burden and economic inequality leads to stunting in children (Haq et al., 2020; Hong, 2007; Shinsugi et al., 2015). More often, the stunting problem arises at about six months of age when children are shifting from breast milk to complementary poor quality foods (Souganidis, 2012). The consequences of stunting are poor school performance, increasing the chance of morbidity and mortality. Stunting leads to a reduction in children's size, so it is also affected to reduce work capacity (Cheah et al., 2010; Chirwa and Ngalawa, 2008).

Across Pakistan, 43.7% of children under five were stunted in 2011 compared to 41.6% in 2001 (Bhutta et al., 2011). The stunting rates: 70.5% in 1977; 62.5% in 1985-87; 42.7% in 1990-94, 54.5% in 1990-91 and 41.5% in 2001 in Pakistan (Zulfiqar Bhutta, 2012). According to the Pakistan National Nutrition Survey 2018, the prevalence of stunting among children under five years of age was 40.2% (UNICEF, 2018).

Flood severely disrupts the livelihood in low-resource settings. Natural disasters like flood and tsunami cause direct economic losses and physical injuries, and long term psychological impacts, including post-traumatic stress disorder and anxiety in the affected population (Dai et al., 2017; van Griensven et al., 2006). Basic health, social services, and water and sanitation services disrupt and become a challenge for the health care provider during flooding, which might affect the child's nutritional status (Rodriguez-Llanes et al., 2016).

Severe monsoon rains commenced in late July 2010, triggering the worst floods to hit Pakistan since 1929, sweeping through various provinces, Federally Administered Tribal Areas and Azad Jammu Kashmir. The National Disaster Management Authority (NDMA) reported that more than 20 million people out of Pakistan's population of 170 million are affected by the floods. Khyber Pakhtunkhwa (KP), the northwest frontier province, suffered 58% deaths, 41% injuries and 16% damaged houses of the total instances in Pakistan. Massive losses in agriculture and livestock production have seriously affected the food and nutritional security of flood-hit families (NDMA, 2011). This disaster has brought to light the pre-existence of widespread child malnutrition (acute and chronic) across the province and, thus, a direct consequence of their lower social status, less food available to them, and difficulty accessing healthcare facilities.

In this study, stunting was used as the imperative index of nutritional status of preschool going children (5-60 months) and school-going children (>5 to 12 years of age) in flood-hit areas of KP Province, Pakistan. The current study aimed to find the prevalence and determinants of stunting among preschool (0-5 years) and school-going (6-12 years) children in the flood-affected areas in KP, Pakistan.

2. Methods

2.1. Study population, setting and sampling strategy

The current study was a cross-sectional study conducted in flood-affected areas of KP Pakistan, including Charsada, Nowshehra, and Dera Ismail Khan districts from June 2014 to June 2016. The study included 656 preschools and school-going children (Magnani, 1999) aged 1-12 years. Sample size was calculated by the standard formula ($n=1.96^2 \times 0.309\ (1-0.309)/0.05^2= 328$). The calculated sample size was multiplied by the Design Effect (DE), generally assumed 2. The final sample size was n = 656. A total of 540 samples from the targeted areas were collected for the requisite data in the project's first year. The remaining samples were investigated in the second year as per the recommended sample size and enumeration plan.

Multi-stage sampling and simple random sampling technique were used for the selection of sites and samples, respectively. District-wise data and samples detail were divided according to tehsils & union councils (UCS) and sub-divided according to villages. The respondent's household was visited at specific intervals by the trained personnel. Chronically ill and children of nonconsenting parents were excluded from the study.

This research was carried out in accordance with the Declaration of Helsinki's guidelines, and all procedures involving research study participants were approved by the University of Agriculture Peshawar's ethical committee (IRB#002). All the study's respondents signed written informed consent.

2.2. Data collection procedure

A questionnaire in English and local languages (Urdu and Pashto) based on a rapid assessment field survey was developed, pretested on 40 samples, and appropriate modifications were made. Data were collected through a modified questionnaire by trained and experienced personnel.

2.3. Socioeconomic information and anthropometry

Weight was measured through a digital scale up to 0.1 kg. Recumbent length was calculated for under two years' children using a length board, and for the rest, standing height up to 0.1 cm by using a stadiometer was measured. Z-score was calculated to find out the length for age (LFA), and height for age (HFA) according to the WHO criterion (Dang et al., 2014; Haq et al., 2020; WHO, 2007).

Demographic and socioeconomic information consisted of gender, child age, maternal age, the status of household (internally displaced people (IDPs) or host), family type (joint or nuclear family), family size (small=<5 members, medium=5-10 members, large=>10 members), father and mother's occupation (not working, part-time working, full-time working), monthly income in Pakistani rupees, father education (educated refers to people who attended school and could read and write, illiterate), mother education (educated refers to people who attended schools and could read and write, illiterate), water quality (improved=protected water from well, tube well or springs, not improved= unprotected water from river\canal\stream\pound) and household toilet facility (Flush, pit latrine, no facility).

2.4. Statistical analysis

ENA (Emergency Nutrition Assessment) for Smart (www.scribd.com) software calculated z-scores. Children whose LFA/HFA less than −2 SD of the WHO Child Growth Standard median were considered stunted. Descriptive statistics, like frequency and percentage, were used. SPSS F20 (SPSS, Chicago, IL, USA) was used for further analysis. A logistic regression model was used to determine the determinants of child stunting. Odds ratio (OR) and 95% confidence intervals (CIs) were calculated for the strength of association. A proposed data-adaptive stopping criterion was used based on minimum bootstrap cross-validated prediction error and thereafter selecting the best possible model. This strategy has the advantage of conducting variable selection by optimizing the appropriate stopping criterion and evaluating the chosen sub-model's predictive accuracy at the same time. The main idea was to use bootstrap K-fold cross-validation for calculating the prediction error for various cut-off values to enter or remove a predictor variable(s) from the model. The program chooses the cut-off values with the minimum bootstrap cross-validated prediction error fit the final logistic regression model (Mahmoood and Salzman, 2016). We used our R statistical software/language codes for the collected data for the final model (Supplementary File Table 1). $P<0.05$ were considered statistically significant.

3. Results

3.1. Socioeconomic and demographic characteristics of the study population

Among the 656 children, there were 371 (56.6%) boys, 285 (43.4%) girls, and 298 (45.4%) preschool going children, while the remaining 358 (54.6%) were school-going children. The percentage of joint and nuclear families was 282 (43%) and 374 (57%). Regarding parental education level, 372 (56.7%)of mothers and 311 (47.4%) of fathers were illiterate. The monthly income of the majority of the household, 284 (43.3%), was higher than Rs. 15000. About 94.8% of mothers were housewives. The majority, 536 (81.7%), of households were using an improved source of water, and 201 (30.6%) of households have no washroom facility (Table 1).

3.2. Prevalence of stunting

Table 2 reveals the greatest absolute burden of under-five stunted children in the flood-hit areas of KP. The global prevalence of stunting based malnutrition (<-2 z-score) in children under five years was found 151 (50.7%) whereas prevalence of moderate malnutrition (<-2 z-score and >=-3 z-score) was 34 (11.4%) and very high prevalence of severe malnutrition (<-3 z-score) was 117 (39.3%). Stunting affects more girls than boys. It was observed that the global prevalence of stunting under-five years of female children 81 (57.9%) is high as compared to male children 70 (44.3%). Similarly, the prevalence of moderate and severe malnutrition in female children, 20 (14.3%) and 43.6%, respectively, is high as compared to male children 14 (8.9%) and 56 (35.4%). From these figures, the burden of stunting was higher in preschool-going children than in school-going children. The overall prevalence of stunting in preschool and school-going children recorded is 266 (40.5%), out of

Table 1. Socioeconomic and demographic characteristics of the study population.

Factors		Frequency; N=656	Percentage (%)
Gender of the child	Male	371	56.6%
	Female	285	43.4%
Age of the child (months)	1-12	7	1.1%
	12-24	45	6.9%
	25-36	62	9.5%
	>36	542	82.6%
Maternal age (years)	15-24	165	25.2%
	25-34	258	39.3%
	>34	233	35.5%
Status of the household	Host	600	91.5%
	IDP	56	8.5%
Family type	Joint family	282	43.0%
	Individual family	374	57.0%
Family size	Small	166	25.3%
	Medium	278	42.4%
	Large	211	32.2%
Occupation of father	Not working	34	5.2%
	Part-time working	34	5.2%
	Full time working	588	89.6%
Occupation of mother	Not Working	622	94.8%
	Part-time working	14	2.1%
	Full time working	20	3.0%
Income (PKR)*	5000-10000	181	27.6%
	10001-15000	191	29.1%
	>15000	284	43.3%
Father education	Literate	345	52.6%
	Illiterate	311	47.4%
Mother education	Literate	284	43.3%
	Illiterate	372	56.7%
Water quality	Improved	536	81.7%
	Not Improved	120	18.3%
Districts	Charsadda	280	42.7%
	Nowshera	276	42.1%
	Dera Ismail Khan	100	15.2%
The facility of toilet available	Flush/Pit Latrine	455	69.4%

PKR=Pakistani rupees.

which 85 (13.0%) moderately stunted (< -2SD and ≥-3SD) and 181 (27.6%) are severely stunted (< -3SD).

Out of 656 children, 60.4% of boys and 39.6% of girls were normal (non-stunted) (Supplementary Figure 1). It reveals that female children are comparatively more vulnerable to malnutrition. Among the districts, district Nowshera was more exposed (49.03%) than districts Charsadda and Dera Ismail Khan [35.02% and 15.95%, respectively; Supplementary Figure 2). There was a decreasing trend with the age of children because there is a high prevalence of stunting at low age groups compared to the higher age group (>36 months; Supplementary Figure 3). Children with flush/pit latrine facilities in their households were less likely to be under-nutrition than children having no facility (Supplementary Figure 4). There was a clear indication that children living in district Nowshera and Charsadda were most suspicious of malnutrition based on stunting (Supplementary Figure 5). The pyramid shown in Supplementary Figure 6 describes the stunted rates for different child age groups stratified according to the gender of the children. It indicates that female children were slightly more likely to be under-nutrition as compared to male children.

3.3. Determinants of stunting

We calculated odds ratios using logistic regression and explored the fitted statistical model to investigate the effect of various socioeconomic and demographic determinants on stunting (Supplementary Table 2). In univariate analysis, female children (OR=1.35, 95% CI:0.94-2.0), children aged 13-24 months (OR=6.5, 95% CI: 3.0-13.9), mothers aged 15-24 years (OR=4.4, 95% CI: 2.6-7.2), joint family (OR=2.1, 95% CI: 1.4-3.0) did not have access to improved drinking water (OR=3.3, 95% CI: 1.9-5.9), and the toilet facility (OR=2.8, 95% CI, 1.9-4.3), while the children from district Nowshera (OR=1.7, 95% CI: 0.9-3.2) were significantly associated ($P<0.05$) with stunting based chronic undernutrition.

The final model in Table 3 shows that child age, maternal age, family type, quality of water, and toilet facility, were the significant factors ($P<0.05$) contributing to child stunting in the flood-hit areas. The summary statistics for the final model has been shown in Supplementary Table 1.

4. Discussion

We used stunting as an imperative measure of the nutritional status of preschool and school-going children in the flood-hit areas of KP, Pakistan. The prevalence of malnutrition (50.7%) calculated as a measure of stunting in children under five years of age was substantially higher in the flood-hit areas of KP. We also explored the prevalence of stunting in preschool and school-going children's in the target population and its associated socioeconomic and demographic risk factors. 266 (40.5%) were globally stunted, whereas 27.6% (181/656) were severely stunted. In this study, only stunting in children has been documented according to the objective of the study instead of dwarfism. Stunting and dwarfism are different, as stunting is type of chronic malnutrition, while dwarfism can be caused

Table 2. Prevalence of stunting by gender.

	All (n)% (95% CI)	Boys (n)% (95% CI)	Girl s(n)% (95% CI)
Children aged 5-60 months (n=298)		**(n=158)**	**(n=140)**
[a]Global malnutrition	(151)50.7(45.0-56.3)	(70)44.3(36.8-52.1)	(81)57.9(49.6-65.7)
[b]Moderate malnutrition	(34)11.4(8.3-15.5)	(14)8.9(5.4-14.3)	(20)14.3(9.4-21.0)
[c]Severe malnutrition	(117)39.3(33.9-44.9)	(56)35.4(28.4-43.2)	(61)43.6(35.6-51.8)
[d]Whole child population (n=656)		**(n=371)**	**(n=285)**
[a]Global malnutrition	(266)40.5(36.9 - 44.4)	(134)36.1(31.4-41.1)	(132)46.3(40.6-52.1)
[b]Moderate malnutrition	(85)13.0(10.6-15.7)	(38)10.2(7.6 -13.7)	(47)16.5(12.6 - 21.2)
[c]Severe malnutrition	(181)27.6(24.3-31.1)	(96)25.9(21.7-30.6)	(85)29.8(24.8-35.4)

[a]Global malnutrition (<-2 z-score); [b]Moderate malnutrition (<-2 z-score and >=-3 z-score); [c]Severe malnutrition (<-3 z-score); [d]Whole child population includes both preschool and schoold going children; CI=Class interval.

Table 3. Variables in the Equation Using Automated Model Selection Method with α_{in} = 0.16 and α_{out} = 0.21.

	β	P value	Exp (β)	95% CI for Exp (β)	
				Lower	Upper
Gender	0.318	0.101	1.375	0.940	2.010
Age of Child (months)		<0.001			
1-12	1.206	0.214	3.340	0.498	22.383
13-24	1.883	<0.001	6.571	3.097	13.942
25-36	1.716	<0.001	5.561	2.998	10.313
Above 36(r)	-				
Maternal age(years)		<0.001			
15-24	1.474	<0.001	4.368	2.643	7.219
25-34(2)	0.501	0.027	1.650	1.058	2.572
>34(r)					
Family Type	0.727	<0.001	2.070	1.416	3.026
Water Quality	1.207	<0.001	3.345	1.897	5.897
Toilet Facility	1.039	<0.001	2.828	1.872	4.271
Districts		<0.001			
Charsadda	0.223	0.487	1.250	0.666	2.347
Nowshera	0.541	0.089	1.717	0.921	3.202
DI Khan (r)					
Constant	-2.732	<0.001	0.065		

by other systemic diseases, such as hormonal or genetic problems. Flood disrupts the nutritional status of children. A study conducted in flood-affected areas of Pakistan earlier concluded that flood negatively impacts mid-class-based children under five malnutrition (Haq et al., 2021).

The prevalence of stunting is high around the globe. De-Onis et al. (2012) measured the prevalence of stunting in Switzerland using the data from 1990-2010 and concluded that several stunted children under five ages were 171 Million in Switzerland and 167 Million in developing countries. Their study found that the prevalence of stunted children under five decreased from 39.7% in 1990 to 26.7% in 2010. They forecasted that the trend of stunting to be 21.8% or 142 million in 2020.

UNICEF (2013) reported that globally, more than one quarter (26%) of children under five years of age were stunted in 2011 – roughly 165 million children worldwide. But this burden is not evenly distributed around the world. Sub-Saharan Africa and South Asia are home to three-fourths of the world's stunted children. Fourteen countries, including Pakistan, are home to 80 percent of the world's stunted children (UNICEF, 2013).

Comparison between the extent of stunting in flood-hit areas with non-flood hit areas might be helpful. According to the 2018 National nutrition survey of Pakistan, 4 out of 10 under-five years' children were stunted. The prevalence of stunting is 40.2%, with 12 million stunted children in Pakistan (UNICEF, 2018). These figures are lower than our findings, where the prevalence of stunting based under 5 malnutrition is 50.7%. Due to the extent of the flood, the prevalence of stunting is much higher in flood-hit areas as compare to non-flood areas.

Stunting problem has been thoroughly studied in developing countries (Abdi et al., 2017; Aheto et al., 2015; Espo et al., 2002; Mosites et al., 2017). The determinants of stunting vary according to different researchers. According to Rayhan and Khan (2006), birth interval, size at birth, mother's body mass index at birth, and parent's education were the critical determinants for stunting. According to Som et al. (2007) in India, the significant factors were women education and household Condition Index. Moreover, they concluded that months of breastfeeding and birth order show an association with children's health status under five.

Teshome et al. (2009) stated that the significant factors for stunting were the sex of the child, child age, duration of breastfeeding, types of food, age of introduction of complementary feeding, and method of feeding. In Libya, the determinants of stunting according to young age<2 years, having less educated fathers, throwing garbage in the street, being a boy, filtered water, the father never/rarely play with the child, and low birth weight among under-five children (El Taguri et al., 2009). According to Ramos et al., the prevalence of low height was 10.9%. Mother's younger age and low level of education, the mother who had fewer than six prenatal consultations, lower socioeconomic status, and households that had more than one child younger than five years were the inverse factors for low height (Ramos et al., 2015). The reasons for stunting in flood-hit areas of Pakistan is not clear. Flood severely disrupt livelihood in low resource settings. Earlier, a study in India concluded that a long-lasting nutritional response due to floods should be considered to combat the consequences of malnutrition in children (Rodriguez-Llanes et al., 2016). Another study reported that the children who were younger than one year during the flood had a higher prevalence of stunting as compared to the control (Rodriguez-Llanes et al., 2011). Essential health, social services, and water and sanitation services disrupt and might worsen a child nutritional status (Rodriguez-Llanes et al., 2016). People of flood-hit regions are vulnerable to many diseases. As in the long run, these people have no livelihood, issues regarding food security, and high prices of commodities that might lead to stunting. The factors, as mentioned earlier, hinder the passage of adequate nutrition and proper health facility provision to the affected communities by flood in Pakistan.

There were certain limitations in the current study. As a cross-sectional study, the observational context of our research may not appropriately estimate the stunting problem. This study was only conducted in one region, which may not be generalized to other flood-hit areas. Our research applies to rural settings, as mostly flood occurs in rural areas. Follow-up studies might confirm the determinants of stunting in flood-hit areas. Nevertheless, the current study is the first study that gave in-depth information regarding the stunting problems in flood-hit areas of Pakistan.

4.1. Implications for practice

Reducing stunting could improve cognitive growth, decrease susceptibility to infection, minimise morbidity and mortality levels, and further reduce poverty (Vonaesch et al., 2017). In disasters such as flood, the detrimental consequences of the stunting problem could be even more on the population of children. Evidence-based education and care must be provided to the families in the flood-affected regions to reduce the stunting problem. The determinants of stunting should be targeted by making comprehensive policies regarding proper nutrition, livelihood, clean water, and sanitation facilities in flood-hit regions.

5. Conclusion

In summary, age of the child, age of mother, family type, type quality of water, and toilet facility, are the significant factors contributing to stunting-based child malnutrition in the flood-affected areas of Pakistan. Our study also reveals that the prevalence of stunting is high in flood-affected areas as compared to the national data in a normal situation. Identification of key factors might be helpful for policymakers in designing comprehensive community-based programs for the reduction of stunting in flood-affected regions. These include community management of malnutrition, infant and young child feeding practices and micronutrients deficiency management programs in the targeted areas. Moreover, proper planning and preparedness for disasters might be the key elements to combat child stunting in flood-hit areas.

Acknowledgements

The authors pay special thanks to the Director Nutrition Nuclear Institute for Food and Agriculture *(NIFA) Peshawar*, Pakistan, and the whole laboratory staff for their technical support.

This research project was financially supported by the Higher education commission (HEC) of Pakistan. The funder has no role in designing, writing and publishing of this manuscript.

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Supplementary Material

Supplementary material accompanies this paper.

Supplementary Figure 1 Gender-wise prevalence of Stunting Among Pre-School and School Going Children in Flood Hit Areas of KP

Supplementary Figure 2 District-wise Prevalence of Stunting among Pre-school and School Going Children in Flood-Hit Areas of KP

Supplementary Figure 3(a & b): Age-wise Prevalence of Stunting Among Pre-school and School Going Children in Flood-Hit Areas of KP

Supplementary Figure 4 Pyramid for under-nutrition based on stunting for child age nested in toilet facility in the flood hit areas of KP

Supplementary Figure 5: Pyramid for malnutrition based on stunting for child age nested in three districts of flood-hit areas of KP

Supplementary Figure 6 Pyramid for malnutrition based on stunting for child age nested in gender of the pre-school and school going children

Supplementary Table 1 Summary statistics for the final model of collected data

Supplementary Table 2 Association of stunting with determinants among pre-school and school-going children in the affected area of Khyber Pakhtunkhwa (univariate analysis)

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