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A dynamics appraisal of association among food Insecurity, women and child health: Evidence from developing countries

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ABSTRCT: Food insecurity has adverse consequences on women and child health in developing country. This study aims to fill the existing research gap by examining the dynamic impacts of food insecurity on women and child health outcomes, this study adds fresh large scale panel data; and unlike the existing studies this study estimates the short run dynamics on food insecurity on women as child health of developing countries. We found that there was a positive association between health expenditure, women fertility rate, women and child health outcome. There was a negative and statistically significant impact of food insecurity on women anemia in developing countries of Asia. Overall, the empirical analysis found that there was strong strength to be negative correlation between food insecurity and women and child health outcome, particularly in relation to women's participation as a productive labour force. The study suggests that there is need to multidimensional approach such as women and child health outcome, is needed to advance this type of research areas and should be followed broad spectrum policy interventions to improve the women and child health status as part of sustainable development goals.

Keywords: Food Availability, Food Access, Food Utilization, Food Stability, Asia

JEL code: J13, I18, I19, I11, Q18

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1. Introduction

Globally, debates on food security have involved women and child health as a key indicator to stimulate sustainable development (FAO,2018). Interesting, many researchers have explored a strong linked between women and child health and food insecurity, particularly in case of marginalized and deprived regions who have limited access of socioeconomic resources (Quisumbing and Pandolfelli, 2010) . Food security is meant to a state when all the people have economic and physical access to safe, healthy and adequate to fulfil their dietary requirements for healthy and energetic life (FAO, 2006). Measuring the dynamics of food security has been inadequate in developing countries as women and child health status and other socioeconomic and political factors, have not been examined into account (Aziz et al, 2020; Palmeira, 2020). Nevertheless, of the fact that almost half of global population and about 42% of the total labour force consists on women in under develop economies (FAO,2015), poor women and child health status remains a global issue, particularly in developing countries (UNDP, 2016). Women and children in low and middle income countries are more vulnerable to experience food insecurity (Alarcao, 2020; Sinclair et al, 2019). There is need to improve women and child health status to rise not only their education status but also nutritional status (Galiè et al., 2019). Worldwide, about 450 million adults have been facing alarming food insecurity since 2014. From them, 6% are adult women and 14% are children. Women and Children in less developed countries are more likely to become food insecure than males as they take less calories and food intake compared to males (Broussard, 2019; Brown et al., 2018). In some countries, more food is preferably served to male as compare to female members in the household (Torheim and Arimond, 2013), which causes food insecurity (Von Grebmer et al., 2014). Moreover, food insecurity not only leads to low immunity, but also worsen the health status of women (Johnston et al., 2014). Similarly, the extent of food insecurity has inauspicious costs for children health status (Von Grebmer et al., 2014). There may be many factors behind extent of food insecurity, but the most important reason is their low income and disparity in intra- food intake (Laar and Aryeetey, 2015). The remaining factors involve limited household employment opportunities and education (Chimhowu, 2019; Po and Hickey, 2018; Bayissa et al., 2018). Food insecurity has had negative implications not only for health status but also economic development (Ariti et al., 2018). Globally, various studies on the topic of women health and empowerment and its impacts for food security as well as other development ends are

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being done in recent past (Farrukh et al, 2020; Tsiboe et al., 2018; Lentz, 2018; Suraningsih et al., 2016; Tibesigwa and Visser, 2016; Wiesmann, 2006).

However, so for so developing countries are concerned, no such research has been done previously, although impact of different factors on food (in)security have been examined by plethora of studies (Akram, 2018; Abrar ul haqet al., 2018; Naz et al., 2014; Bashir et al., 2013; Anila and Kiani, 2011; Ahmad and Farooq, 2010). The impact of food insecurity as potential factor on women and child health remains an unexplored area in developing countries. To be the best of our knowledge, no study has been estimated the short and long run impact of food insecurity on women and child health status, especially in developing countries. Therefore, present study fills the existing research gap in following ways; first, by examining the long run impact of food insecurity on women and child health, this study adds fresh large scale panel data; and second unlike the existing studies this study estimates the short run dynamics on food insecurity on women as child health of developing countries.

2. Conceptual Framework

There are multidimensional levels of concern when delving into consequences of food insecurity from national to household to household to individual and among individuals (Farrukh et al, 2020). At individual level, anyone food intake habit is influenced by expectations, self-motivation, personal efficacy and socioeconomic capability. At household level where resources for food is scared, choice of food depends on availability and access rather than nutritional value and content, whereas the intra-household food distribution will further affect food consumption through the surrounding culture and norms. The unfavourable health impacts of food insecurity in developing countries are wide-ranging affecting women and child's mental, physical, cognitive and nutritional well-being (Wiesmann, 2006). Food insecurity can have long term opposing effects on brain and cognitive development that is influenced by nutritional inadequacy pathways (Ariti et al., 2018). A pregnant woman with low quality of food, limited food intake, yet more nutrient requirements increases her own and her growing infant's risk of inadequate micronutrient and caloric intake. Food insecure children have a 150% more likely of anemia and iron deficiency, which leads to impairments in psychomotor, mental and cognitive development (Tsiboe et al., 2018). They have been found to have deficiency in magnesium, vitamin A and protein (Chimhowu, 2019).

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According to Laar and Aryeetey (2015) that under 3 year children in food insecure households had upraised odds ratios for respiratory infections as compare to food secure households. Similarly, another study of Johnston et al., (2014) found that food insecure household kids are 32% more likely to be got ill and poor health.

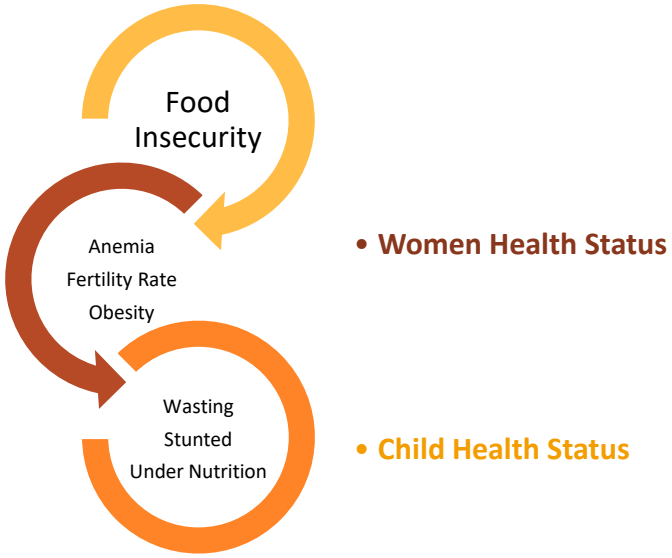

Figure 1 Conceptual linkages of food insecurity with women and child health (Source: Author's Estimation)

Mental health status is also affected by food insecurity (Broussard, 2019; Brown et al., 2018). Similarly, the children who are food insecure will themselves face physical and mental health problems. Therefore, this study fills the existing research gap by examining the long and short run effects of food insecurity on women and child health in the case of developing countries.

3. Material and Methods

To estimate the impact of Food security on women and child health status in the developing countries of Asia, study used the Panel GMM estimation Method presented by the Arellano and Bover, 1995; Blundell and Bond, 1998). To estimate the impact of Food security on women and child health status in the developing countries of Asia through the GMM estimation technique, we need to estimate the moment conditions for health status function $f(Health\_Status, \theta)$ which is the proxy of six health variables related to women and child health.

$$m(\theta_0) \cong E[f(Health\_Status, \theta_0)] = 0 \quad (1)$$

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Where $Health\_Status$ is the proxy of of six health variables related to women and child health with the following moment condition $\theta \neq \theta_0$.

The estimation of the moment condition nothing except the simple average

$$\hat{m}(\theta) \cong \frac{1}{n}\sum f(Health\_Status, \theta) \tag{2}$$

Minimize health status function $f(Health\_status, \theta)$ with respect to the θ, using the equation 2. The resulted estimator will depend on choice of the norm function,

$$\left\| \hat{m}(\theta) \right\|_W^2 = m(\theta)^n W \hat{m}(\theta) \tag{3}$$

Where W in equation 3 is the weight norm function bases of given data set.

$$\hat{\theta} = \arg\min_{\theta \in \Theta} \left(\frac{1}{n}\sum_{n=1}^{n} f(Health\_status, \theta) \right)^n \hat{W} \left(\frac{1}{n}\sum_{n=1}^{n} f(Health\_status, \theta) \right) \tag{4}$$

The equation 4 is the final equation of the GMM which fulfil the following properties of GMM consistent, efficient, and asymptotically normal.

3.1. Econometric Modeling

3.1.1. Women Heath Equations

$$\ln Anemia\_Women_{ij} = \beta_{ij,1} Fnemia\_Women_{t-1} + \beta_{ij,2} Food\_Supply + \beta_{ij,3} Health\_Exp. + \beta_{ij,4} \Pr otein\_Supply + \beta_{ij,5} Dietary\_Energy + \beta_{ij,6} PCGDP + \beta_{ij,7} Food\_\Im port + \beta_{ij,8} Pop\_water\_avil + \varepsilon_{ij} \tag{5}$$

$$\ln Women\_Fertility_{ij} = \beta_{ij,1} Women\_Fertility_{t-1} + \beta_{ij,2} Food\_Supply + \beta_{ij,3} Health\_Exp. + \beta_{ij,4} \Pr otein\_Supply + \beta_{ij,5} Dietary\_Energy + \beta_{ij,6} PCGDP + \beta_{ij,7} Food\_\Im port + \beta_{ij,8} Pop\_water\_avil + \varepsilon_{ij} \tag{6}$$

$$\ln Obesity_{ij} = \beta_{ij,1} Obesity_{t-1} + \beta_{ij,2} Food\_Supply + \beta_{ij,3} Health\_Exp. + \beta_{ij,4} \Pr otein\_Supply + \beta_{ij,5} Dietary\_Energy + \beta_{ij,6} PCGDP + \beta_{ij,7} Food\_\Im port + \beta_{ij,8} Pop\_water\_avil + \varepsilon_{ij} \tag{7}$$

3.1.2. Child Health Equations

$$\ln Child\_Wasting_{ij} = \beta_{ij,1} Child\_Wasting_{t-1} + \beta_{ij,2} Food\_Supply + \beta_{ij,3} Health\_Exp. + \beta_{ij,4} \Pr otein\_Supply + \beta_{ij,5} Dietary\_Energy + \beta_{ij,6} PCGDP + \beta_{ij,7} Food\_\Im port + \beta_{ij,8} Pop\_water\_avil + \varepsilon_{ij} \tag{8}$$

$$\ln Child\_Stunded_{ij} = \beta_{ij,1} Child\_Stunded\mathbf{t}_{t-1} + \beta_{ij,2} Food\_Supply + \beta_{ij,3} Health\_Exp. + \beta_{ij,4} \Pr otein\_Supply + \beta_{ij,5} Dietary\_Energy + \beta_{ij,6} PCGDP + \beta_{ij,7} Food\_\Im port + \beta_{ij,8} Pop\_water\_avil + \varepsilon_{ij} \tag{9}$$

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$$\ln Child\_under\_Nutrition_{ij} = \beta_{ij,1} Child\_under\_Nutrition_{t-1} + \beta_{ij,2} Food\_Supply + \beta_{ij,3} Health\_Exp. + \beta_{ij,4} \Pr otein\_Supply + \beta_{ij,5} Dietary\_Energy + \beta_{ij,6} PCGDP + \beta_{ij,7} Food\_\mathrm{Im}port + \beta_{ij,8} Pop\_water\_avil + \varepsilon_{ij} \quad (10)$$

Where i represent cross section (number of countries) and j represent data spam (1992-2019).

3.2.Data Description and Sources

To empirically analyze the impact of Food security on women and child health status in the developing countries of Asia (Pakistan, China, Bangladesh, India, Bhutan, Indonesia, Malaysia, Nepal, Sri Lanka, Korea, and Philippines), following study used the annul data taken from the Food and Agriculture Organization (FAO) for the period 2001 to 2018. Table 1 depicted the detail description and with description of all variables with the unit of variables used in the study to estimate the impact of Food security on women and child health status in the developing countries of Asia.

Table 1 List of Dependent and Independent Variables

Sr.	Variables	Description	Unit
1	Prevalence of anemia among women of reproductive age	(Anemia_Women)	(15-49 years)
2	Women Fertility Rate	(women fertility)	(percent)
3	Prevalence of obesity in the adult population	(Obesity)	(18 years and older)
4	Percentage of children under 5 years affected by wasting	(Child wasting)	(percent)
5	Percentage of children under 5 years of age who are stunted	(Child stunded)	(percent)
6	Prevalence of undernourishment	(Child under nutrition)	(percent) (3-year average)
7	Per capita food supply variability	(Food_Supply)	(kcal/cap/day)
8	Per Capita Health Expenditure	(Health_Exp.)	(US $)
9	Average protein supply	(Protein_supply)	(g/cap/day) (3-year average)
10	Average dietary energy supply adequacy	(dietary_energy)	(percent) (3-year average)
11	Gross domestic product per capita, PPP, dissemination	(PCGDP)	(constant 2011 international $)
12	Value of food imports in total merchandise exports	(Food_import)	(percent) (3-year average)
13	Percentage of population using at least basic drinking water services	(Pop_Water_avil)	(percent)

Table 2 presented the estimated results of correlation matrix that explained the association of Food security (food supply, Protein supply and dietary energy intake as the proxies of the food security),

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women and child health status with other control variables (health expenditures, per capita income, availability of drinking water, and food imports) in the selected developing countries of Asia. The main diagonal of the table 2 correlation matrix shows the self-association of each. The reported result shows food security (food supply, Protein supply and dietary energy intake) negatively associated with the women health (anemia in women and women fertility rate).

Table 2 Results of Correlation Matrix

	ANEMIA_WOMEN	Women_fertility	OBESITY	FOOD_Supply	Health_Exp	PROTEIN_SUPPLY	DIETARY_ENERGY	PCGDP	FOOD_IMPORT	POP_WATER_AVIL
ANEMIA_WOMEN	1.00									
Women_fertility	0.74	1.00								
OBESITY	0.92	-0.98	1.00							
FOOD_Supply	-0.97	-0.95	0.96	1.00						
Health_Exp	-0.93	-0.90	0.95	0.95	1.00					
PROTEIN_SUPPLY	-0.97	-0.98	-0.95	0.92	0.86	1.00				
DIETARY_ENERGY	-0.79	-0.83	-0.73	0.67	0.58	0.86	1.00			
PCGDP	-0.99	-0.98	1.00	0.98	-0.96	0.94	0.72	1.00		
FOOD_IMPORT	0.49	-0.54	0.43	-0.45	0.35	0.43	0.59	0.45	1.00	
POP_WATER_AVIL	-0.87	-0.96	0.64	0.93	-0.88	0.98	0.85	0.96	-0.58	1.00

4. Empirical Results

The table 3 presented the estimated empirical results of the impact of the food security on women health in selected developing countries of Asia. This study uses three proxies for estimating the women health: (1) prevalence of anemia in women, (2) women fertility rate, (3) obesity. Food supply, protein supply and dietary energy intake used as the proxies of the food security with other control variables (health expenditures, per capita income, availability of drinking water, and food imports).

The Asia is the largest and most populous continent of the world that facing great challenges of health and widespread hunger due to food insecurity which leads to various deficiency disorders

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like anemia, iodine, zine, vitamins A and D Akhtar (2016). Health expenditures is the opportunity cost to reduce the prevalence of anemia in women. The empirical result of table 3, model 1 shows the negative electricity prevalence of anemia in women due to the health expenditure. One percent increase in the health expenditure can reduce the 0.71 percent anemia prevalence of anemia in women in selected developing countries of Asia. Subsequently model 2 and model 3 also suggested the positive association of health expenditure women fertility rate and obesity.

Deficiency of iron (Anemia) in women is the basic root due to the food insecurity and major public health concern in developing countries of Asia. Study used food supply, Protein supply and dietary energy intake as the proxies of the food security. The empirical result of table 3, model 1 shows that Anemia in women significantly linked with the food security. There exist negative and statistically significant association of women anemia with food supply, Protein supply and dietary energy intake. The reported results of table presented the elasticities of women anemia due to change in the food supply, Protein supply and dietary energy intake. One percent increase in the food supply reduce 0.02 percent prevalence of anemia in women in selected developing countries of Asia. While one percent protein supply reduces the 0.17 percent prevalence of anemia in women. One percent increase in dietary energy intake reduces 0.07 percent prevalence of anemia in women in selected developing countries of Asia. The empirical results are consistent with Ghose *et. al.* (2016) reported the relationship of food insecurity and women in anemia and (Skalicky *et. al.*, 2006) estimated high likelihood ratio of suffering from anemia in women who face the problem of food insecurity in U.S. Subsequently empirical results show that per capita income, availability of drinking water services, and food imports which increase the domestic food supply of can reduce prevalence of anemia in women the in selected developing countries of Asia.

The food insecurity increases the birth defect risk among pregnant women, due to the compromised nutrition, depression, anxiety and stress. The empirical result of table 3, model 2 shows that women fertility rate positively associated with the food security. Food supply, Protein supply and dietary energy intake statistically significant affect the Women fertility rate in the selected developing countries of Asia. The empirical results of table 3, model 2 presented the elasticities of women fertility rate due to change in the food supply, Protein supply and dietary energy intake. One percent increase in the food supply increases 0.03 percent women fertility rate in selected developing countries of Asia. While one percent protein supply increases the 0.35 percent women

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fertility rate. One percent increase in dietary energy intake reduces 0.24 percent women fertility rate in selected developing countries of Asia. The empirical results are consistent with (Carmichael, *et. al.*, 2007) suggsted the posstive association of food insurity and birth defect risk among pregnant women in U.S. and (Carmichael, *et. al.*, 2007) estimated high maternal stress increases the birth defect risk among pregnant women in U.S. Subsequently estimated result shows that per capita income, availability of drinking water services, and food imports which increase the domestic food supply of can increase the fertility rate in women the in selected developing countries of Asia.

The food insecurity increases the associated risk of obesity (weight change) may be due to the lack of resources (poverty) that negatively affect the ability to maintain consistent access to nutritious foods. The empirical result of table 3, model 3 shows that Obesity positively associated with the food supply food security, while negatively associated with Protein supply and dietary energy intake in the selected developing countries of Asia. The empirical results of table 3, model 3 presented the elasticities of Obesity due to change in the food supply, Protein supply and dietary energy intake. One percent increase in the food supply increases 0.06 percent prevalence of obesity in adult population in selected developing countries of Asia. While one percent protein supply reduces the 0.08 percent prevalence of obesity in adult population. One percent increase in dietary energy intake reduces 0.04 percent prevalence of obesity in adult population in selected developing countries of Asia.

Table 3 Impact of Food insecurity on Women Health

Countries	**Developing Countries**		
Variables	**Model 1**	**Model 2**	**Model 3**
LnAnemia_Women$_{t-1}$	**0.75** (0.16)	----	----
Lnwomen fertility rate$_{t-1}$	----	**0.82** 0.31	----
LnObesity$_{t-1}$	----	----	**0.60** 0.30
LnFood_ Supply	**-0.02** 0.00	**0.03** 0.01	**0.06** 0.01
LnHealth_Exp.	**-0.71** 0.31	**0.45** 0.21	**0.65** 0.17
LnProtein_supply	**-0.17** 0.08	**0.35** 0.09	**-0.08** 0.08
Lndietary_energy	**-0.07** 0.03	**0.24** 0.09	**-0.04** 0.04
LnPCGDP	**-0.23**	**0.06**	**0.27**

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	0.07	0.06	0.13
LnFood_import	**-0.03**	**0.07**	**-0.01**
	0.01	0.02	0.02
LnPop_Water_avil	**0.69**	**0.84**	**-0.25**
	0.25	1.22	0.46
Constant	**14.06**	**-26.12**	**4.50**
	1.20	1.28	0.86
N	167	171	164

legend: * p<0.10; ** p<0.05; *** p<0.01

The table 4 reported the estimated empirical results of the impact of the food security on child health in selected developing countries of Asia. Study used three proxies for the child health, Percentage of children under 5 years affected by wasting, Percentage of children under 5 years of age who are stunted and Prevalence of undernourishment. While food supply, Protein supply and dietary energy intake as the proxies of the food security with other control variables (health expenditures, per capita income, availability of drinking water, and food imports). Child wasting, child Stunting and under nutrition is the key indicators of child health caused by the malnutrition. The children who are suffer wasted and stunted were the most at risk (Briend, *et. al.*, 2015).

Table 4 Impact of Food Insecurity on Child Health

Countries	**Developing Countries**		
Variables	**Model 4**	**Model 5**	**Model 6**
LnChild wastingt-1	**-0.58**	----	----
	0.22		
LnChild stundedt-1	----	**-0.79**	----
		0.31	
LnChild under nutritiont-1	----	----	**0.72**
			0.20
LnFood_ Supply)	**-0.77**	**-0.46**	**0.07**
	0.33	0.27	0.01
LnHealth_Exp.	**-0.63**	**-0.94**	**-0.79**
	0.12	0.35	0.38
LnProtein_supply	**-0.50**	**-0.53**	**-0.59**
	0.72	0.63	0.18
Lndietary_energy	**-0.70**	**-0.16**	**-0.35**
	0.85	0.26	0.13
LnPCGDP	**-0.08**	**-0.04**	**-0.51**
	0.04	0.01	0.09
LnFood_import	**-0.08**	**-0.47**	**-0.06**
	1.36	0.74	0.03
LnPop_Water_avil	**-0.09**	**0.70**	**0.32**

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	0.30	0.54	0.56
Constant	**-24.52**	**5.61**	**2.82**
	3.36	1.59	0.32
N	211	198	207
legend: * p<0.10; ** p<0.05; *** p<0.01			

The empirical result of the table 3, model 4 shows that one percent increase in the food supply reduces 0.77 percent children under 5 years affected by wasting. One percent increase in the Protein supply reduces 0.5 percent children under 5 years affected by wasting. Subsequently other control variables (health expenditures, per capita income, availability of drinking water, and food imports) also negatively associated with the children under 5 years affected by wasting.

Table 5 Results of Robustness Test

Sargan test of over identifying restrictions					
H0: over identifying restrictions are valid					
Model 1		**Model 2**		**Model 3**	
chi2(193)	71.06	chi2(188)	32.24	chi2(191)	23.40
Prob > chi2	0.01	Prob > chi2	0.03	Prob > chi2	0.00
legend: * p<0.10; ** p<0.05; *** p<0.01					

Sargan test of over identifying restrictions					
H0: over identifying restrictions are valid					
Model 4		**Model 5**		**Model 6**	
chi2(211)	63.31	chi2(198)	57.62	chi2(207)	71.15
Prob > chi2	0.00	Prob > chi2	0.01	Prob > chi2	0.00
legend: * p<0.10; ** p<0.05; *** p<0.01					

Table 5 reports the Sargan test for the verification of over identification problem and white noise error terms in the GMM model 1, model 2, and model 3. Table 6 reported the Sargan test for the verification of over identification problem and white noise error terms in the GMM model 4, model 5, and model 6. The empirical results of both tables reported that estimated value of the chi square greater than the critical value. So, GMM model 1 to model 6 correctly specified and error terms are uncorrelated in each model.

5. Conclusion and Way forward

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Food insecurity has adverse consequences on women and child health in developing country. The implications of these socioeconomic insecurities lead to chronic diseases. Those women and children with chronic disease will not only tent to increase health expenditures, but are more likely to become burden on household and ultimately, to have decrease the household welfare. This study aims to fill the existing research gap in following ways; first, by examining the long run impact of food insecurity on women and child health, this study adds fresh large scale panel data; and second unlike the existing studies this study estimates the short run dynamics on food insecurity on women as child health of developing countries. We found that there was a positive association between health expenditure, women fertility rate and obesity. There was a negative and statistically significant impact of food insecurity on women anemia in developing countries of Asia.Overall there was strong strength to be negative correlation between food insecurity and women and child health outcome, particularly in relation to women's participation as a productive labour force. The study suggests that there is need to multidimensional approach such as women and child health outcome, is needed to advance this type of research areas and should be followed broad spectrum policy interventions to improve the women and child health status as part of sustainable development goals.

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