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ORIGINAL CONTRIBUTION

Analyzing the Mediating Role of Food Insecurity between Economic Factors and Child Health in Pakistan: An Application of Haye's Logistic Model

Abdul Mansoor[1*], Dr. Sabahat Subhan [2]

[1]Ph.D. Scholar, Department of Economics, National University of Modern Languages, Islamabad, Pakistan

[2]Assistant Professor, Department of Economics, National University of Modern Languages, Islamabad, Pakistan

Abstract— This study tends to assess the critical selected economic factors intervening the child health problems in Pakistan. Child health problem is of great concern and became even more important after the United Nation's Sustainable Development Goals vision of Global Social, Economics, and Environmental sustainability. This study analyses the data of the Pakistan Household Integrated Economic Survey (HIES) 2018-19, which is the latest available data in the current year, 2022. A total frequency of 24809 households are included in the study sample and are inquired about their economic proceeding of life and their child's health problems. Child health is a derived factor that is not obviously directly affected by its socio-economic determinants. Unlike the previous studies, this study follows an indirect analysis while explaining child health determinants. Hayes' process of mediation is applied to see the role of global food insecurity in the households in the country and its implication on the child health ratio in Pakistan. This study implies a significant negative role in asset poverty. Food insecurity on the child health in Pakistan, meaning that if a household is food insecure, that will lead to a high risk of child adverse health problems and vice-versa. Moreover, there are some direct effects of asset poverty on the child's health as they assess the fiat source of finance for the household after a liquid form of monetary assets.

Index Terms— Child health, Asset poverty, Food insecurity, Pakistan

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Introduction

The welfare of a country is associated with a healthy environment and good individual health. Alma Ata's declaration (1978) documented the importance of health in public policy as well as reforms in the health sector that affects the well-being of a country. However, an improvement in the socio-economic profile resulting from an effective public policy is likely to be helpful in the status of improved health (Shiell, 1991). The issue of health is a universal issue among the various countries of the world. A healthy child grows up to play a significant role in the effective labour force. 'Human' is now considered a 'capital' in the sense that if handled with care and equipped with proper knowledge and skills, it will play a significant role in the development of a country. In line with this policy back in September 2000,

*Email: iiui.mansoor@gmail.com

the 189-member countries of the United Nations (UN) consistently adopt the Millennium Declaration that indicates some key development challenges and targets along with progress measurements followed by the sustainable development goals.

Pakistan faces a double burden of disease coupled with parental conditions. The situation of the public health services shows an uneven spreading of health incentives between the rural-urban regions (Ali, 2002). The rural dwellers specific with lack of education are at a greater disadvantage in terms of primary health provisions i.e., the major dwellers of remote rural areas of Pakistan partially failed to get benefit from the public program of immunization of infants and children under 5 years of age. Although life expectancy, the standard of living, and other health statistics show an improvement but not steady. There exist clear disparities in health outcomes across the country. There is a significant amount of under nutrition in children across South Asian countries, the ratio of which is recorded as 1 out of 5 children. According to the Poverty Alleviation survey, about 1% of the country's GDP is lost due to health deficiency in the country (Pakistan Alleviation Fund, 2010). Pakistan, being a signatory of the United Nation's MDGs, should seriously strive towards the achievement of the targets set.

This study emphasizes child health because 'health' is a conditional requirement for bringing a boost in productivity, while adequate health relies on adequate food intake, which ultimately depends upon the availability of enough income. Thus, both social and economic indicators can be seen as important components of growth and development. Child health is evaluated as the outcome of diverse socio-economic factors. Income plays a key role in almost all health-associated problems as it directly contributes to food insecurity, which in turn results in poor education performance, and low productivity, and thus leaves economic progress at a low pace.

Compared to adults, children are more vulnerable to the household's poor economic status. Poor child health leads to serious morbidity and sometimes can cause ultimate death. Since the turn of the twentieth century, the infant and child mortality rate in developed countries has steadily declined, but it is still high in developing countries. However, the situation in Pakistan in this regard is not promising. The infant mortality rate of around 74 per 1000 live births is far short of the desired target set for the Sustainable Development Goals (SDGs), which is 25 per 1000 live births. Research shows the existence of a high disparity in child mortality in regional differentials. It is likely that this disparity mainly reflects the differences in the existing living environment of the people, including the low income of a household, provision of social series, public utilities like availability of safe drinking water, sanitation, and education level of the population (Scott et al., 2014).

To see the extent of child health, there is an immense need to showcase the critical factors causing child health problems and devise a suitable policy to overcome this issue. Empirical evidence shows that among the major factors of infant mortality under five years is the unavailability of proper medical care, which is endorsed by the insufficient income of a household (Chakrabarti, 2003). Poor economic conditions and food insecurity do not allow a household to allocate sufficient funds to health expenditures, that counter affects the household's health and family. Food insecurity classifies three parameters of food security i.e., adequacy, accessibility, and equity of food distribution across the masses.

Given the recent information gathered by the Household Integrated Economic Survey of Pakistan (2018-19), this paper aims to examine the child's health status by exploring some new ways. Unlike the direct effects, which is the common practice to explore the outcome variable via a list of economic factors, this study set the goal of analyzing the indirect effects of selected economic determinants by exploring the role of a new factor i.e., global food insecurity among the household of Pakistan. There is sufficient work done in this regard, but little emphasis is being given to indirect channels of the factors affecting child health.

The rest of the paper is organized as follows; section II documents the review of previous literature; section III encircles the methodology, which is also a novelty of this study. Data and variables are discussed in sector IV. section V includes the empirical estimation and discussion, followed by the conclusion and policy recommendations.

Literature Review

Previous studies showed that children growing up in families with a lower SES have a higher body mass index (BMI), as reported by Howe et al. (2011), report more behavioral problems (Reiss, 2013), more psychosomatic symptoms (Piko & Fitzpatrick 2007), lower quality of life (Rajmil et al., 2014), less healthy nutrition (Raffensperger et al., 2010), less physical activity (Piko & Fitzpatrick 2007), a higher media consumption (Piko & Fitzpatrick, 2007), and experience more critical life events than children growing up in families with a higher SES (Evans & Kim, 2010).

Arif and Ibrahim (1998), using the Pakistan Integrated Household Survey (1995-96), determine the social, economic, and demographic covariates of the prevalence of diseases among children under five years in Pakistan. The study shows that the age of the child is a strong determinant of child morbidity. However, household income also appears to be a strong factor in child morbidity. Children living in a house equipped with piped water or a motor pump inside the house were likely to be sick less than the case otherwise. Bartick et al. (2017) analyze the outcomes of breastfeeding on child health and the effect of health expenditures on demand for medical care. Although the main focus was on the impact of breastfeeding, the analysis was multivariate. The study explores that breastfeeding is significant and

beneficial for reducing illness and improving growth among infants and young children. Arif (2004) explores child health in Pakistan children employing two important indicators i.e., morbidity and malnutrition. The results documented that immunized children are less likely to be sick compared to those who did not get the vaccination. Lin (2007) explains the role of earnings, health facilities, and demographic variables in determining the outcome of a child's health and mortality rates in Taiwan, revealing the mortality rate is countercyclical to that of the unemployment rate in the country. Singh and Kogan (2009) have established that poor children have worse health situations than non-poor and the mortality rate of infants is shown to be inversely related to their social and economic status. Similarly, a study by Kawachi and Subramanian (2014) has shown that poverty alone does not completely explain this relationship. Wilkinson (2006) explains that once a society goes beyond the point of absolute deprivation and people can meet their basic requirements of life, then it is the equal distribution of income that positively affects health outcomes.

Objectives of the study

This study is limited to inquire;

- The impact of selected economic factors on child health.
- The role of asset poverty on child health.
- The footprints of food insecurity and its repercussions on child health.

Conceptual framework

The Mosley and Chen (1955) conceptual framework for the study of child mortality in developing countries figure 1 is adapted. This study is based on the most recently available information of HIES 2018–2019 datasets. Table I provides the classification of variables employed in this study, given the conceptual framework. Although the framework is made focused on selecting some relevant factors keeping in view the current challenges. This study follows Haye's process to showcase the factors affecting child mortality in Pakistan.

Fig. 1. Framework (Source: Author own development considering Mosely and Chen (1884))

Methodology

This study considers a recent survey of HIES (2018-19) to explore the critical factors affecting child health in Pakistan by employing a new dimension of assessment i.e., global food insecurity among the households. Haye's process of mediation is employed to assess the relationship among the selected variables. Haye's (2017) propose an indirect way of assessing the causal relationships that provide a new horizon to the empirical assessment of social and economic factors. This study novel the role of food insecurity on child health in Pakistan.

The study also investigates the problem of child mortality from the angle of food insecurity among households, which is a new addition to the existing literature on child mortality in Pakistan.

The empirical analysis is carried out in two steps. In the first step of the analysis, the factors are regressed by applying the binary logistic model since the dependent variable is dichotomous. The results are derived without the involvement of the mediator. In the second step, the indirect effects are calculated by applying Haye's process of conditional mediation. For this purpose, the methodology Haye's is applied and uses macro for the empirical works in the SPSS software package. After that, in the third step, the validity of the indirect effects is shown to authenticate the results.

Data and variables

This study includes some critical factors of child health in Pakistan by grouping the explanatory factors into mediators and control variables. This study includes the child's health i.e., is by definition less than 5 years of age. Explanatory variables are Income Per Capita of Household (PI), Health Expenditure of a Household (HE), Total Expenditures of a Household (TE), Expenditures Per Capita (ECAP), Food Insecurity (FI), and Child Health (CH). Data is taken from the Household Integrated Economic Survey (2018-19) published by the Pakistan Bureau of Statistics.

Haye's process of conditional modelling

Statistical mediation and moderation-based analysis are prevalent in behavioral sciences. Increasingly, these methods of analysis are being combined in the form of the analysis of mediated-moderation or moderated-mediation. It is also known as conditional process modeling, MacKinnon, Fairchild, and Fritz (2007a). This section provides a primer on some of the important concepts and methods in the conditional analysis process. Unlike the traditional regression analysis, conditional data processing answers' the questions of 'how' which results in a deeper understanding of the moderation analysis under study, Jaccard and Turrisi (2003). Furthermore, it provides insight into how that understanding can be applied. As a research area develops and matures, the focus ultimately shifts away from demonstrating the existence of an effect; it rather focuses on the understanding of a mechanism by which an effect operates and establishing its frontier conditions or contingencies. The goal of mediation analysis is to establish the extent to which some assumed causal variable X influences some outcome variable Y through one or more mediator (M) variables (Baron & Kenny, 1986).

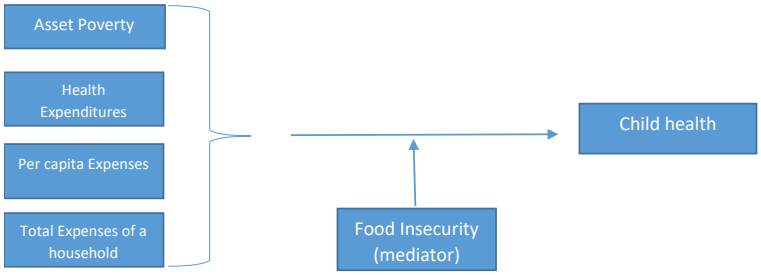

Fig. 2. Conceptual model following Haye's process for mediation

Figure 2 explains the conceptual model of this study. The mediating factor is food insecurity. This study looks into the role of food insecure households in explaining the changes in the outcome variable i.e., child health in Pakistan, by using the HIES latest round issued by the Bureau of Statistics Pakistan. Health expenditures are vital in explaining the extent of child health, while this phenomenon is made clearer by including a per capita expenditure of a household to see the individual cost of health. Total expenditure covers all other expenses other than the health of a household upon the children under 5 years of age. Asset poverty is another benchmark in explaining child health because poverty is one of the critical elements of developing nations. This study uses this variable as a group of people having more or no assets. These groups are nominated as asset-poor and asset-rich people of the country. There is a detailed discussion about the asset holdings of the households in the HIES questionnaire.

Empirical model for data analysis

Logit regression is applied to identify the influence of the explanatory variables on mortality under-five child health among the households. Logistic regression is best for assessing the dichotomous dependent variable. The logistic regression model expresses a qualitative dependent variable as a function of some explanatory variables. In this study, child mortality (Z) is considered as a dependent variable which takes a value of 1 if a child is sick and 0 otherwise.

Z = 1, If a child dies before reaching the age of 5 years. = 0, otherwise.
where, the logit model assumes the probability (P_i) that child health is a function of an index (Z_i).
Where:
(Z_i) is a standard-logistic cumulative function of P_i i.e. P_i (Y) = f (Z_i). The probability of a child health is given as;

$$P_i(Y=1) = \left(\frac{1}{1+e}\right)^{-z_i}$$

While that of no child health is Q1 (y = 0) = 1- P_i (y = 1)
Since;

$$1 - P_i(y=1) = 1 - \left(\frac{1}{1+e^{-Zi}}\right)$$

$$1 - P_i(y=1) = \left(\frac{1++e^{-Zi}-1}{1+e^{-Zi}}\right)$$

$$1 - P_i(y=1) = \left(\frac{e^{-Zi}}{1+e^{-Zi}}\right)$$

But,

$$\left(\frac{1}{p_i(y=1)}\right) = 1 + e^{-zi}$$

Thus,

$$\left(\frac{p_i(y=1)}{1-p_i(y=1)}\right) = \frac{1}{e^{-Zi}} and this implies; \left(\frac{p_i(y=1)}{1-p_i(y=1)}\right) = e^{Zi}$$

A probability of child health is calculated by Z_i equation i.e.

$$Z_i = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_n X_n \cdots\cdots \quad (1)$$

X's are the explanatory variables, and Z_i is a dichotomous dependent variable of child health under 5 years of age (1 = yes, and 0 otherwise).

Key explanatory variables

The outcome variable is infant mortality, which is the death of a live-born child in the first five years of life. In this study, it is re-coded as a dichotomous variable. The explanatory variables included in the study are community-based socio-economic, the household determinants of child mortality, covering per-capital earning of a household, transfer earning proxied by receiving Zakat or Usher, pre-natal and post-natal maternal health, and child vaccination factors in line with the conceptual framework of the study.

The intermediate or proximate determinants

It is not obvious that an explanatory variable directly causes a change in the dependent variable. There is, sometimes, a channel by which the cause and effect showcase itself. Unlike the other studies, this analysis takes care of the indirect channels of causality while assessing the health ratio of children under five in Pakistan by following Haye's process of conditional regression. Since this study focuses only on the selected economic factors like total expenditures, health expenses, food insecurity, and asset poverty, where the food insecurity channelizes the determinant of child health. Similarly, community these economic factors play a role in determining the outcome variable in this regard.

Table I
Binary logistic regression explaining child health in Pakistan (Author's own calculations)

	Log Odds	S.D	d.o.f	*p*-value
Per Capita Health Expenditures	0.123	.036	1	.001
Total Expenses	0.324	.029	1	.000
Asset Poverty	-0.127	.015	1	.004
Expenditure Group	0.156	.033	1	.000
Constant	-6.027	.338	1	.000

The binary logistic regressions provide the values in log odds. The outcome of Table I provides the empirical analysis for the assessment of selected economic variables and their impact on the health of children under five years of age. According to the table per capita, health expenses are positively related to a child's health. This outcome is in line with Byaro and Musonda (2007), who explains that the household spends more on health-related products and other health objectives that improve the health of the child.

Similarly, total expenses also show a significant change in the child's health. It brings about 32 percent change in the child's health as it includes the realization of all the other benefits that may not come under the circle of health expenses as there are a lot many indirect factors that also affect the health of a child-like healthy food, medication, healthy environment, etc. These outcomes endorse the statement of Terrelonge (2014), Pokhrel and Sauerborn (2004), and Yardim (2010).

Asset poverty is the novel inclusion of this study. This variable is comprised of asset-rich and asset-poor people. Assets are the immovable monetary factors of households that might to rigid compared to the cash in hand. Assets comprise property, land, livestock, and monetary objects like prize bonds and shares, etc. the coefficient of asset poverty (-0.127) is negative and statistically significant, meaning that as a person moves towards the asset-rich category, the child's health improves to its best by 12 percent and vice versa. Assets are different from the cash in hand but help secure the health outcome as it is independent of the income of a household.

This study focuses on the expenditure side of the household to explain the changes in the outcome variable. It is because of this reason that income cannot be calculated primarily by just assessing the wages of an individual (Terrelonge, 2014). Each person earns from different sources, like a seller having their shop. There is a detailed discussion regarding the income of a household, but even then, it is a tough job to calculate precise values. On the other hand, expenditures are the real monetary phenomenon. It explains clearly that hoe much is provided to meet the cost of health by each household.

Table II
Correlation matrix of the economic factors affecting child health

	Constant	Per Capita Health Expenditures	Total Expenditures	Food Insecurity	Asset Poverty	Expenditure Group
Constant	1.000	-0.605	-0.650	-0.243	0.285	0.662
Per Capita Health Expenditures	-0.605	1.000	-0.182	-0.060	0.028	-0.877
Total Expenditures	-0.650	-0.182	1.000	0.195	-0.526	-0.047
Food Insecurity	-0.243	-0.060	0.195	1.000	0.257	-0.021
Asset Poverty	0.285	0.028	-0.526	0.257	1.000	0.000
Expenditure Group	0.662	-0.877	-0.047	-0.021	0.000	1.000

Table II shows the correlation matrix of the economic factors and their correlates to explain the child health issue across Pakistan. According to the new round of HIES (2018-19), per capita expenditures (0.06) are negatively associated with the food insecurity of households across the country. Expenditure groups are based on the low expenditure and high expenditure groups. As the expenditure groups rise from low levels to high groups, the per capita expenditures decline as more resources are allocated to health facilities. Asset poverty (0.028) is positively associated with per capita expenses. More is the asset-rich person; high would be the per capital fund allocation to the health. Food insecurity and health expenditures (-0.06) are negatively correlated as a person is a food insecure; less would be the income spent on health activities as a household considers food as a basic need that must be fulfilled first. Food secure people and expenditure groups are negatively correlated (-0.021), as the high expenditure groups are less food insecure and vice versa. Health is the most important factor for any household and especially for children under 5 years of age, after the three basic needs of food, shelter, and clothing. Most of the studies highlight the direct effects, but this study tends to showcase the indirect effects of economic factors on child health. Global food insecurity is for the first time introduced in the HIES survey in Pakistan.

Haye's indirect effect model for mediation

Haye's process for mediation is complex. Certain rules are followed by this process. There must be a single explanatory variable to judge at a particular time, while multiple mediators can be used by specifying the model number from Haye's process models. The following table provides the results for mediation of the food insecurity between the economic factors affecting the child's health.

Table III
Correlation matrix of the economic factors affecting child health (values are calculated on a 95% confidence interval)

Panel (a) Model Summary					
R^2	MSE	F	Df1	Df2	p-value
0.3999	0.5851	4722.34	1.000	24807.00	0.0000

Table 3. Continue.....

Panel (b) Relationship Running from Asset Poverty to Food Insecurity						
	Coefficient	S.E	*t*-value	*p*- Value	LLCI	ULCI
Constant	2.316	0.114	202.907	0.000	2.293	2.338
Asset Poverty	-0.237	0.003	-68.719	0.000	-0.244	-0.230
Panel (c) Relationship Running from Independent and Mediator variables to Child health						
	Coefficient	S.E	*Z*	*p*-value	LLCI	ULCI
Constant	-1.677	0.059	-28.370	0.00	-1.401	-1.561
Asset Poverty	0.032	0.011	2.746	0.006	0.009	0.055
Food Insecurity	0.213	0.019	11.020	0.000	0.175	0.251
Panel (d) Direct effect of X on Y						
Effect	S.E	*Z*	*p*-value	LLCI	ULCI	
Food Insecurity	0.032	0.0117	2.746	0.006	0.009	0.055
Panel (e) Indirect effect of X on Y						
Effect	Boot	Boot	LLCI	Boot	ULCI	
Food Insecurity	-0.050	0.004	-0.060	-0.041		

In Table III, the process of mediation is expressed. In this model, the dependent variable is child health, which is the dichotomous variable (child is sick = 1, 0 otherwise) which is regressed upon the economic factor of asset poverty that, is a categoric variable of asset rich to asset poor status of the household. The mediating factor is food insecurity. Food insecurity is an index that is formulated by this study by including eight different queries answered by the household during the survey. After the formation of the index, the households are categorized into food secure, mild food insecure, and high food insecure among the total population of 24809 households. Part (a) of the table shows the model summary, which shows that the coefficient of determination is 0.39, which is an effective model.

Part (b) of the table shows the results for the relationship between asset poverty leading to food insecurity. The coefficient (-0.237) is negative and highly significant, showing a noteworthy effect of 0.23 percent caused by a 1 percent change in the asset poverty status of the household verifying the result of Thomas (2019), who found that food insecurity is especially harmful to health during early childhood. This issue is also highlighted by Pai and Bahadur (2020) for developing countries.

Part (c) of the table incircles the coefficients of paths between asset poverty and child health outcomes and between food insecurity and child health outcomes. Wood (2003) highlighted the impact of poverty on the child health outcome in the USA. In line with his result, this study concludes that both of the variables are highly significant and have a critical positive impact on child health of 0.032 and 0.213 percent impacts respectively.

Part (d) of the table shows the direct effect between the explanatory and dependent variables, which is -0.032. The direct and indirect effects are tested using the bootstrap standard errors and confidence intervals. This process run in the null hypothesis of population effect is zero against the alternative hypothesis of a non-zero effect of a mediator. Since the zero value does not lie between the bootstrap lower and upper limit confidence intervals, therefore, the null hypothesis is rejected, and we proceed to the indirect effect of the mediator.

The last segment (e) of the table shows indirect evidence of the mediator factor. The mediator shows a significant impact of mediating role between child health and asset poverty by providing a negative association between the variables. Again following the guidelines, as the zero is not lying in between the upper and lower critical values of the bootstrap confidence intervals, we reject the null hypothesis, and hence it is clear that the indirect effect is non-zero. The coefficient after the mediation process increases, showing a vital role of a mediating factor in explaining the changes in the dependent variable by the explanatory variable. More precisely, the results in the table conclude that if a household is food insecure, the chances of adverse child health in the family will be obvious and vice versa. In other words, it is concluded that to reduce the chance of child sickness; people must take care of their daily food intake and make sure that a person's employment is intact.

Results and Conclusion

Considering a theoretical point of view, financial acts like, for example, government spending can play an important role in public health to achieve meaningful population health improvements. However, studying causal relationships between health expenditure and health outcomes of children is complex since other socio-demographic and clinical factors contribute a lot. Previous studies like Burnside and Dollar (1998), and McGuire (2006), among others, have been attributed to mis-allocations of overall public health expenditure due to corruption, poor economic policies, and poor incentives for the poor.

Child health is a composite reflector of economic, social, and healthcare services and their distribution situation in Pakistan. Across the globe, Pakistan is bearing the third highest burden of fatalities, mortality, and child morbidity. Factors affecting child health in Pakistan

are investigated by using Binary Logistic Regression Analysis with a new dimension of the indirect process of mediation. With special reference to economic factors like household expenditures, per capita, health expenditures, assets, poverty, and global food insecurity are found to be significantly important to child health in Pakistan. Child health effects decrease as the level of household expenditures increases on health, reduction in asset poverty is observed. Child health is found to be significantly improved with a mediating role of food insecurity in the country compared to other direct effects. Child health is significantly higher for children who were born to poor dwellers of the country. Haye's process explains the more robust outcome of the explanatory variables and their impact on the dependent variables.

Policy Implications

This study investigates the impact of economic determinants on child health in Pakistan by highlighting the mediating role of the asset poverty index of households. This study is unique as it follows the indirect effects of the economic factors while explaining the child health severity in the country. This study employs the HIES latest data comprising 24809 households across Pakistan. In light of the empirical findings of the study, child health is a derived factor of not only the direct economic factors but also some hidden factors that are more likely to be acting as an indirect factors like food insecurity. It is important to sort out the problem rather than find a solution to the problem. It is advised by the think tanks of the various decision-making organizations to overcome the problem of food insecurity of the people of the country. A major portion of the poor's payroll is spent on food-related items. For this, a government can devise some micro-financing schemes for the poor's, ration cards, which are still in progress in many developing countries like India. Once this problem is reduced to a certain level, people will divert their second priority to child health expenditures at their best.

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