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Is there any Threshold in the Causal Association of Mother's Education with Child's Health? A Case study of Pakistan

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ABSTRACT

Past studies failed to solve the problem of nonlinearity and threshold in the association of mother education with infants' health. This research diagnoses and investigates the existence of threshold. Successive eight educational plans during 1955-1998 in Pakistan record a large variation in the educational policies and investment and a great focus on primary schooling. It motivates us to select Pakistan and construct the instrument for purging the coefficients of mother education from endogeneity bias along with the threshold impact. IV regression outcomes disclose that only 11-16 years of mother education has significant impact on infants' health outcomes, implying a threshold level at 6-10 years schooling. Thus, it is argued that low cognitive capability via lower level of education, poor educational quality, ineffective education for health even in the text books of 6-10 years of education leads to a threshold in the relationship of mother education with child nutrition.

Keywords
HAZ; Threshold; IV regression; Pakistan

JEL Classification
H51; H75; I18

1. Introduction

If deserved nourishment is not provided to the kid during his or hers initial 2 years this could lead to some grotesque effects on the overall health, mental health and physical growth of a child. This in return give goading to bad grades in school and could well result in feeble output from the student and give halt to his growth which in result stop the churning wheel of the economy as well (Glewwe & Miguel, 2007). Malnutrition is a bane for the economy as it causes parents to be

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spendthrift on the health of the kid. It results in the physical damages of the nerves tissues and if not dealt properly and on time causes pecuniary loss to the parents. Where many countries have been at cursing end as their children are underweight and to our dismay Pakistan is not far behind. Pakistan is well in the race to be in the top echelons of being the world's most malnutrition country. As per the study children under age 5 are suffering malnutrition and the numbers are 44 percent and the number of children underweight is 31 percent which makes the situation worth mooting over (National Institute of Population Studies, 2013). Though these issues that has been discussed above make us lose sleep children's being underweight and unhealthy. This study aims to bring about some solutions to this scorching task at hand. To get into the nitty-gritty of this study it was imperative for us to look into the behavior of the mothers. Because it goes without saying the behavior of the mother will rub off of the child as well. This study is pioneering in this aspect in which we check the educational level and the awareness of the mother which is directly related to the health of the child. To pull through this study we made certain groups in which we divided the mothers in different groups based on their educational background such as (1-5, 6-10 and 11-16 years schooling) to check how does this effect of child's health.

Infants look out to their parents in every dire need. Father is responsible to bring home the bacon and to keep the roof over heads. Mothers are all together are different ball games. In countries like Pakistan mothers are revered as does God. They look out for every minute demands of their child. It is incumbent upon mothers to make the child nourished with all the nutrition's one could have had asked for. The happiness and mental growth of the child depends upon this aspect of the study. In Pakistan which is known to be a third world country mother's education makes a lot of difference as it does in developed economies. If a mother is not educated which makes her less knowledgeable about certain issues? How does a mother who herself has no idea what health issues are supposed to make the demands of the child meet? Education has always had an importance. Developed economies have got there where they are through education and innovations. Women's do need to get educated. They are the ones who are going to keep our next generation to the next levels. In Pakistan there is an adage that goes by mothers are the first teachers to their kids (Novak, 2016). When on takes into account the health of a child his mother's health also takes the precedence. As the famous maxim goes by healthy mind makes for the healthy body. If God forbid there is some issue with the mother the health of the child will be affected as well. They are the cog of the same machine (Nafiu & Hamidu, 2017). As per the study in America which showed that 54 percent of the deaths can be curbed by educating the mothers (Polakow, Butler, Deprez, & Kahn, 2012). This makes it indispensible tool to curb this menace of child death. Ergo it is important to assume the link which has been developed here that education makes for a healthy nation. A healthy nation will turn

around the fate of the economy with adept mind and nimble bodies in place. Dexterous mind is all today's world ask for (Cutler & Lleras-Muney, 2006). Erstwhile studies have showed that there is a positive relation between mother's education and a child health. This also has a strong impact on the income of the household. If a child is not adept the big chunk of the income of the household will go into the kitty of doctors and teachers which will cash in on this. This issue inadvertently makes up for a larger chunk in the country. Economic growth of any country depends on how nimble and agile their children's are as they are the ones who are going to reign in the workings of the country (Borhan, Ahmed, & Hitam, 2018). How does this issue play out in the economy of any country regardless of it being developed our under developed? It is known to all and sundry that an education is an indispensible ingredient in the dish of the economy. Taking a further plunge into the studies it is being noted mother's education takes precedence over anything else in here. In Pakistan mothers are known to take the bull by the horns inasmuch as going to any length to save their kid (Ramos, Dumith, & César, 2015). Hence, the quality education foremothers has a great share in every part of economy (Wang & Wong, 2011).

1.1 Theoretical Framework about the Association between Education and Health

The related theories used in this paper have been introduced by Becker (Becker & Becker, 2009) and discussed by (Chou, Liu, Grossman, & Joyce, 2010). Becker's theory was associated with the allocation of time for both non-market and market activities by households. The foremost assumption is that they produce non-market commodities (e.g. health) consuming market commodities and time. Becker & Becker (2009) empirically examined the households' choices about the number of babies and their health. According to his model, households get utility from formal commodities, as well as from the number of babies and their health quality (informal commodities), calculated by expenses per baby and babies' health. This study follows Becker's model, with child health as an argument in the utility function for household.

Chou, Liu, Grossman, & Joyce (2010)and Grossman (1972)have estimated the impacts of education on non-market goods, i.e., the causal impacts of education and the mechanisms through which it impacts non-market goods. He has introduced a background in which education creates allocate efficiency impacts and productive efficiency impacts. Productive efficiency impacts indicate that more education results in more efficiency in production process of non-market-sector; for a given number of inputs, more educated persons obtain better health outcomes than less educated ones. Theoretical models mostly show that the economists are agreed upon the positive and significant parents' education child health connection (Grantham-McGregor et al., 2007; Behrman & Rosenzweig, 2004; Kovsted, Pörtner, & Tarp, 2002; Strauss & Thomas, 1995). Some studies have marked little or no causal relationship (Desai & Alva, 1998; Glewwe & Miguel, 2007)

while few studies have observed negative association (Alderman & Lavy, 1996). The related literature detects some nonlinearities in this association (Iltaf, Shahid, & Khan, 2017; Pal, Pari, Sinha, & Dhara, 2017). Desai & Alva (1998) also concludes the presence of non-linearity in this association; arise from the greater magnitude of the estimate of higher education relative to the primary education's estimate. Barnet (1995) has reported that health based education is also more effective and comprehensive in secondary grade than the primary grade in Pakistan. Although this nonlinearity has substantial implications on policy measures, no serious effort to highlight this issue has been made in the literature.

Now the important question is how a threshold or non-convexity may arise in this relationship. It is argued that low cognitive capability via poor education, lower educational quality, ineffective education for health in prospects leads to a permanent cost, and hence to the threshold in the relationship of mother education with child nutrition. Technically speaking, cognitive talent comprises a large range of characteristics, such as memory, perception, attention, action, mental imagery and problem solving. It is proven that mother's cognitive talent should approach to a threshold so as to be effective in the production of child health. Some past studies evidence that early child birth, and the corresponding diseases of mother and babies are an outcome of low cognitive talent. The mothers with low cognitive talent have three times higher chances to have two births before age 20 than those with the higher cognitive talent in USA. Moreover, early child birth is also associated with LBW and miserable child health (Shearer et al., 2002). Thus, education quality has great importance in this association because it is essential in the development of health knowledge and numeracy skill, and its utilization. It is quite imaginable that a student with 5 years schooling may not have ability to write and read at all in developing nations. In this scenario, non-linearity or a threshold in this association is not surprising. We can find the chances of threshold in the descriptive analysis of mother literacy and her education in Table 8 given in appendix, using the filtered data set. This table 8 shows that 87.5%, 49%, 31.2%,18.7% and 10.7% mothers cannot read a single word at 1-5 years of schooling, respectively while 18.4%, 32.5%,38.7%, 16.9%, 16.7%, and 9.3% mothers can read a sentence but by parts. Thus, this lower quality of 1-5 years of schooling may suggest a threshold in this relationship.

This study contributes to the current literature by searching out the threshold level in mother's education child nutrition gradient for Pakistan. This work is essential for two reasons. Firstly, the existence of a threshold may result in a poverty trap. Inappropriate public expenditure on education may produce worsening health of the succeeding generations which results in low level of efficiency and income. This may deteriorate the income inequality condition in a country. Secondly, it has imperative implications on policy problems. Mostly, the governments of

developing nations offer subsidy to primary education for females due to the fact that the non-market benefits, like, children's health, fertility, etc. are reasonably important, while its effect on female contribution into labor force is very little. The institutions' statistics show a successive rise in the construction of primary institutions in Pakistan along with a poor health status of children among primary passed mothers (National Institute of Population Studies, Islamabad, 2013).

Therefore, if the education for mother has no or negative effect on child health for a particular lower (primary) level of schooling (in other words, if a threshold level is present), policy makers need to call for steps to erase the possible reasons of threshold or reconsider about the size of the subsidy program. Firstly, non-parametric methods are employed to explore the bivariate relationship of mother education with child health in order to determine the presence of threshold effects. If this association is nonlinear, dummies of different level of mother schooling along with zero schooling as reference category are added in the regression of child health to explore the effective level of education of mothers to impact child health. Thus, this study will extends the literature on mother education child health gradient to search out any nonlinearity or threshold using PDHS, 2012-13) data.

Where threshold level implies the difference in the cognitive talent among mothers having different level of formal education, it also refers to the unseen able factors which may impact both mother education and child health, simultaneously. Now an important question is how to deal with mother education in the econometric regression. In a different channel, given that school enrollment for female is lower; mothers who attain education are inherently more talented and motivated. Their motivation and talent are unseen able factors for the researcher and missing from the regression. Therefore, estimates of education endogeneity bias. Mostly, past studies regarding the relationship of mother education with child health have tried to employ instrumental factors (factors which are correlated with mother education but are uncorrelated with unseen able factors that directly impact child health) to get rid of the biasness arisen from the endogeneity problem. Since it is very difficult to find the instruments that obviously satisfy this condition, they do not promise to solve the endogeneity issue**.**

The instruments may consist of such different variables that may explain mothers' access to different kind of institutions over the periods when she was schooling going age (6-10 years) like some studies have used a dummy of mother born place as an instrument, showing that whether educational institutions were easily available in her living place over the years of her school age (6-10) or not and some studies have assumed mother's birth cohort as instrumental factor indicating the higher intensity of institutions' construction followed by the policies on education

over the periods of her birth cohort(Currie & Almond, 2011). The logic behind this instrument is to reveal mother's accessibility to the institutions in her resident place and her birth cluster.

This study also makes a contribution in term of introducing instrumental factors for mother education. We find a great variation in health policies, reforms and higher public expenditures on education over 1955-1998 in Pakistan. The mothers born over the period of 1963-1996 are highly affected by these reforms and plans because there is a wide difference in the intensity of institutions' construction in this period. Furthermore, we also see a clear difference in the average education within different birth cohorts. Thus, mother education is instrumented with her birth cohort because where it reflects a differential intensity of institutions' construction; it also captures a great variation of the relevant institutions' supply in the period of enrollment (6-10 years), which presents her differential access to them. This factor is correlated with the education of mothers and uncorrelated with the unseen able factors that could affect child health. Due to missing the data on her birth place, only birth cohort is focused. Our study also takes mother nutritional level as instrument for mother education because it impacts her education and child health, simultaneously (Ahmed & Iqbal, 2007). Secondly**,** a large variation in the educational reforms and plans, and the public expenditure in the education sector during 1955-1998 provoke the selection of this country and the construction of this instrument for mother education. Up to my knowledge, none study has used a variation in education policies to get information about her education and child health associations in Pakistan. However, some past studies have done this kind of work for Nigeria, Taiwan, Indonesia, and the U.S.

A list of health inputs included to produce informal goods (infants' health) may also be endogenous (e.g. food intake, mother decision to vaccinate babies, her health practices and sanitary). The household economic theory states that both child health and his nutrition inputs (e.g. calorie intake, duration of breastfeeding) are jointly determined by households (Becker &Becker, 2009). However, the latest data-set PDHS 2012-13 on these inputs are missing. The number of living children and their health quality are also simultaneously determined as in the Becker and Lewis' model (1973). Likewise, mothers' participation decision in the economic activities and their infants' health are expected to be jointly determined. Hence, family income level may be endogenous factor because infants' illness may negatively influence parents' working hours (labor supply) and earning(Chen & Li, 2009). In our analysis, mother education, her knowledge about health, wealth index and access to health services are assumed endogenous health inputs due to any of these possible biases. Given the possible biases, 2SLS-IV regression is employed to estimate the reduced form demand function for child health and the endogenous health inputs to get rid of the endogeneity issue.

2. Data and Methods

Successive 8 educational plans in Pakistan over the period 1955-1998 record large variations in the educational policies and investment in education sector, just showing a great focus on primary schooling. It motivates us to select Pakistan and construct the policy instrument for purging the coefficients of mother education from endogeneity bias along with finding the threshold in the relationship of mother education with child health. Thus, this case study for Pakistan is primarily chosen due to the choice of instrument**.** Mother education in the production function for child health is endogenous as mother's unobserved characteristics for instance, her ability, determination and motivation etc. impact her educational achievement and ultimately, affects her children's health. In this study, instrument for mother education is constructed on the basis of a large variation in educational policies, programs and the government investment in this sector(Central Bureau of Education and Federal Bureau of Statistics, 1998). Relevant data are filtered from the PDHS 2012-13 data-set. A sample of 3404 women aged 15-49 who could produce birth cards containing child birth height and weight, were selected from the data set. These children were under 5.

Height-for-age Z score (HAZ) and Weight-for-age Z score are taken as the indicators of long (stunting) and short run (underweight) health outcomes for under 5 children. Since one of key objective of this research is to see the existence of a threshold that may produce a poverty trap, long term child health indicator is much closer to our analysis in the scenario of achieving 4^{th} MDG (reducing under 5 infants' mortality rate by 2/3 during 1990-2015). Three dummies for mother education are created: 1-5=1, 6-10=2 and 11-16=3, with zeros schooling as the reference category. we could not produce dummies for each category of education because the observations for the grades of 1, 2, 3, 6, 7 and 9 are not enough to accurately estimate the marginal impact.

Mother knowledge about health is also a part of key determinants of child health. Mother knowledge about hepatitis disease is taken as the proxy for it. It is in the binary form (if she doesn't know about hepatitis =0, otherwise=1)**.** It is also assumed an endogenous factor because maternal knowledge about health is mostly judged via her ability to understand, evaluate, and apply health knowledge with the usage of health promotion resources. Therefore, this endogenous variable is instrumented by the information containing watching TV, reading newspapers, and listening radio(Strauss & Thomas, 1995) to get rid of possible omitted factor bias. All instruments are also in the binary form (No=0 and Yes=1).

Lifetime permanent household income is a significant predictor of the long term child health status, thus it should be a part of the health regression controlling for the income impact. As the data on permanent household wealth are hardly available for the research work, present income or present expenditures are mostly taken as a proxy. When current income obviously leads to measurement error problem, it is likely to be endogenous to the decisions of household health. To keep away from this kind of bias, wealth statistics of the household and non-labor income are commonly taken as a proxy of permanent income. Unfortunately, PDHS 2012-13 misses the data

collection on expenditure or any income. However, but it successfully collected the information about various kind of household holdings for instance, ownership of a radio, a television, a scooter, a bicycle etc. as well as residence characteristics like drinking water, sanitation facilities and the types of floor and roof material. A wealth index is built by PDHS using the information about all possible assets, and principle component analysis**.** Different weights are assigned to the households' holdings for instance, television, radio, etc. and to the living circumstances (for example, type of roof materials, etc.). The wealth index is also used to minimize the endogeneity issue, because included assets in this index are accumulated by a household over time and are less likely to be jointly determined through child health (Linnemayr, Alderman, & Ka, 2008). Thus, wealth index is accepted as a proxy of permanent level of income and the households' living standard. Thus, WI scores are categorized into poor=0, middle class=1 and rich=2. However, due to lack of guarantee that WI is exogenous, Durbin chi-square and Wu-Hausman F-statistics for endogeneity test are conducted in the following sections.

Unluckily, PDHS 2012-13 also failed to collect information about health facilities, the availability of health workers, or any factor of community living environment. However, the survey contained the questions like whether the prenatal care is received by the mother or not, whether family planning employee visited her in the last 12 months, and whether the piped water facility was available for the household. All of these variables are binary. This research used medical assistance from nurses as a proxy for the community health services in the binary form. Some studies have also assumed it as endogenous(Becker & Becker, 2009).Residence factor captures urban-rural variation in infants' health outcomes.

2.1 Methods

Mukabutera et al. (2016) and Strauss & Thomas (1995) have introduced a theoretical framework of households' decision making for the derivation of the reduced form demand function for children's health. Their specification is followed to estimate the regression equation as given below:

$$\boldsymbol{H_i = \alpha + \beta_1 Medu_i + \beta_2 X_i + e_i} \quad (1)$$

Where, Hi is health status of the child i in a household, X is the vector of controlled factors such as child's age, its square, parents' age, region, access to health services dummy, mother knowledge dummy and scores of wealth index, Med is a vector of mother education dummies, and e is the residual**.**

2.2 Causal Association of Mother Education with Children's Health

The modeling scheme will incorporate netting out the influence of the unobserved elements in the estimation procedure, which may impact both mother education and child health association, simultaneously. To consider this possible endogeneity, we use two-stage least squares instrumental variables methods (2SLSIV).Partially**,** Duflo (2001)has helped to erase the issue of possible

endogeneity by utilizing mothers 'birth cohort as instrument variable and has reported that Indonesian Government made a huge investment in schooling construction programs between 1973-78 and introduced the interaction between the total schools built in the mothers' birth region and her birth cohort as instrument for her education. Beginning with the national conference on education held in 1947, seven national policies and eight 5 year plans on education, and more than six other schemes were announced and launched over the period 1955-1998 in Pakistan. Under the national educational policy of 1992, numerous projects under nation and worldwide organizations were launched to enhance women participation in education.

Table 1: Numbers of Different Type of Institutions over different time Spans

Institutions	1964-65	1974-75	1984-85	1994-95	1996-97
Mother education between 1-5	821	15673	21551	39987	46691
Middle Schools	589	1266	1817	5582	6425
Higher Secondary vocational institutions	425	218	1434	3410	3736
Arts and Science Colleges	62	96	153	251	296
Professional Colleges	5	8	8	9	9
Universities (Male and Female)	6	10	21	24	25

Where a wide variation in the record of newly established female institutions was a response of earlier educational plans and policies, it also implied different accessibility for females born in the corresponding time spans. A previous study assessed a stark difference of public investment in schools' construction in rural-urban regions of Nigerian order to suggest birth place of mother as instrument (Moja, 2000). Mothers 'birth years are divided into four cohorts, 1963-72, 1973-79, 1980-88 and 1989-96 in the light of Table 1. This will help us to investigate the impacts of different educational institutions' construction on the average education for mothers in each cohort. Table 2 depicts the average education for mothers in different birth cohorts.

Table 2: Average Education in Years by Mothers' Birth Cohort

Mother Birth Cohorts	Mean	N	Std. Deviation	Std. Error of Mean
1963-72	1.67	226	3.732	0.248
1973-79	3.43	741	5.022	0.184
1980-88	4.36	1636	5.037	0.125
1989-96	3.69	801	4.548	0.161
Total	3.82	3404	4.893	0.084

We find a significant variation in the average education of mothers across cohorts. The younger mothers have higher average education relative to the elder mothers regardless of their residence place in childhood because overall institutions for female education have increased over the periods of 1974-75 and 1984-85. However, the mothers in the last cohort show little decline in the average education from their elders. This may be attributed to less construction of formal

educational institutions in this period. Table 3 revels a large variation in the average education among mothers born in different cohorts.

Table 3: Variation in Average Level of Education Across Cohorts

Birth Cohorts	Difference	S.E	Unadjusted C.I at 95%	
(1973-79)-(1963-72)	1.757	0.368	1.035	2.479
(1980-88)-(1963-72)	2.683	0.344	2.009	3.357
(1989-96)-(1963-72)	2.020	0.365	1.305	2.736
(1980-88)-(1973-79)	0.927	0.215	0.506	1.347
(1989-96)-(1973-79)	0.264	0.247	-0.221	0.748
(1989-96)-(1979-80)	-0.663	0.209	-1.073	-0.253

A significant variation in the average education for mothers between cohorts is observed. It implies that mothers related to different cohorts have differential access to institutions as highlighted in table 2. Consequently, the variation in the public investment for education over time is resulted in differential average education for mothers. This demands to employ her birth cohort as instrument variable for mother education. Moreover, mother education is also instrumented by her BMI because healthy mothers have more likelihood of attaining more education (Ahmed, 2007). Thus, to measure the influence of instruments on endogenous factors, the following equation will be estimated:

$$\boldsymbol{E_i = \alpha + \beta_1 Z_i + \beta_2 X_i + \varepsilon_i} \quad (2)$$

Where E is the vector of endogenous factors, α is a constant, Z is a vector of instruments, X is a vector of controlled factors, β_1 and β_2 are parameters, and $\boldsymbol{\varepsilon}$ is an error term. The estimation of Equation (2) will give us predicted values which are not directly linked with child health. This is the first stage of a 2SLS estimation to find out the existence of causal connection between maternal education and child health (hypothesis 1). The 2nd stage of 2SLS equation is:

$$\boldsymbol{H_i = \gamma + \theta_1 E_i + \theta_2 X_i + \mu_i} \quad (3)$$

Where Hi is the health outcomes for child i, γ is a constant, Ei is a vector of endogenous factors, X is a vector of controlled factors and μi is an error term. The predicted values from 1st stage are replaced with endogenous factors (E_i) in Equation (3) and later on, this equation is estimated to get unbiased estimators confirming that the predicted values are not correlated with the $\mu_i$in Equation (3).

3. Regression Results

This study demonstrates the association of mother education with health outcomes of under 5's infants. As mother education and her health knowledge are endogenous regressors, this study employs 2SLS-IV regression. These two endogenous regressors are incorporated in the model after verification of over-identification and endogeneity tests. Results from the Sargan chi-square test

for over-identification and Durbin chi-square, and Wu-Hausman F statistics for endogeneity are added in the bottom of table 4 and 5. The p-values of Sargan statistics are 0.48 and 0.59 in HAZ regressions and 0.3 and 0.3 in WAZ regressions, indicating that "the joint H_0 = the instruments are valid" cannot be rejected. Thus, the instruments qualify the over-identification criteria and thus, they are jointly valid instruments and are correctly omitted from the second stage estimations. It infers that instruments are not correlated with the residual term. This statistics also implies that although some instruments may be weak, overall they are valid. The Durbin chi-square and Wu-Hausman F-statistics confirm that the regressors assumed endogenous are really endogenous. The null hypothesis of these statistics is that the regressors are exogenous. The p-values <0.05 in both specifications show that these two regressors are endogenous. However, WI and access to health services factors incorporated in the following specifications are exogenous factors due to insignificant endogeneity statistics. Given that these possible endogenous factors are indeed endogenous, 2SLS-IV regression method is preferred over OLS for estimation as shown in Table 4 and 5.

Table 4: Impact of Mother's Education on Child's Height for Age: Specification (1)

Regressors	OLS (1)	IV (2)	OLS (3)	IV (4)
Mother Education between 1-5	0.3 (0)***	1.18 (0.55)	0.173 (0.12)	-0.38 (0.89)
6-10	0.67 (0)***	1.8 (0.36)	0.51 (0)***	0.82 (0.67)
11-16	0.77 (0)***	3.61 (0.05)**	0.6 (0)***	3.37 (0.042)**
Mother Health Knowledge	0.15 (0.1)*	3.02 (0)***	0.23 (0.02)**	2.99 (0)***
Mother Age	-0.012 (0.07)*	0.02 (0.18)	-0.015 (0.03)**	.015 (0.36)
Father Age	-0.015 (0)***	0.001 (0.8)	-0.016 (0)***	-0.001 (0.94)
Child Age	0.08 (0)***	-.05 (0)***	-0.08 (0)***	-0.055 (0)***
Age Squared	0.001 (0)***	0.001 (0)***	0.001 (0)***	0.001 (0)***
Residence (1)	-0.17 (0.02)**	-0.5 (0)***	-0.074 (0.36)	-0.58 (0)***
Access to Health Services			-0.01 (0.9)	-.103 (0.44)
Wealth Index (1)			0.18 (0.07)*	0.88 (0)***
Wealth Index (2)			0.41 (0)***	1.01 (0.04)**
Over Identification Test (d.f)		3.50 (4) (0.48)		2.83 (4)(0.59)
Wu-Hausman Test (d.f)		15.4 (6) (0)		17.72 (6)(0)
Durbin Chi-Squared Test (d.f)		90.35 (6) (0)		103.6 (6)(0)
Observations	3404	3404	3404	3404
R-Squared	0.47		o.48	

Instruments=Mother birth cohort, her BMI, listening radio, and reading newspaper, P-values are in parentheses, *** significant at 1%; ** significant at 5%; * significant at 10%.

Firstly, we discuss columns (1) and (2) in Table 4, which present OLS and 2SLS-IV estimates for HAZ specification, respectively. This specification contains mother education dummies, mother and father age, child age, child age squared and residence dummy as key regressors. As statistics rejects H_0, IV will be preferred over OLS, we will only focus on the IV results and will take OLS results to throw light on the magnitude and direction of the biased coefficients.OLS

estimates for all grades of mother education are highly significant and interestingly, the coefficients of 6-10 and 11-16 years education get double and more than double than that of1-5.It implies that HFZ improves at different rate as education level of mothers increases. This concludes that this impact may not be linear in education. Although OLS outcomes verify a highly significant influence of 1-5 and 6-10 years education on HAZ, this significance impact goes away with IV. However, IV regression indorses that only 11-16 years of education is significantly ($p<0.05$) impacting HAZ and this impact is positive because mothers with higher education are more likely to avail more economic opportunities and are more empowered in household decision making and utilizing resources that definitely has positive influence on HAZ. It is also confirmed that well educated mother's truly increase the hygienic conditions for their babies, which finally keep them healthier. This outcome is also aligned with (Ahmed, 2007; Currie & Moretti, 2003). The magnitude of its coefficient much bigger (3.61) than that of the OLS estimate for two reasons implying biased OLS estimates. Firstly, this much bigger estimate of the higher education in IV regression explains the omitted variable baseness in the corresponding OLS estimate as well as broadly shows that the measurement error in education, which may result in downward biasness in the OLS coefficient, partly offsets any upward ability bias (Angrist & Newey, 1991; Card, 1993; Psacharopoulos & Patrinos*, 2004; Staiger & Stock, 1994)**.** Furthermore, this measurement error impact is compounded if talent bias in OLS coefficients is relatively small. However, this measurement error in education alone may not elucidate such big differences (Card, 1993). Thus, the bigger IV estimates highlights that smaller OLS estimates are highly biased and show the causal association between mother education and WAZ, and HAZ in Table 4 and 5. Furthermore, inconsistent association of 1-5 and 6-10 years of schooling on WAZ and HAZ may be due to the fact that 1-10 years of schooling fail to equip them with necessary health knowledge to promote child health despite of the successive 8 education plans to boost up females' primary schooling in their birth cohorts. Thus, it refers to the existence of threshold at 6-10 years of schooling in this specification. This outcome is contradicted to (Ahmed, 2007; Maïga, 2013)who empirically find the threshold level at 5 years of schooling.

The empirical outcomes underline the same scenario in the comparison of OLS and IV estimates of mother knowledge. The coefficient of mother knowledge about health is highly positive and significant ($P<0.01$) showing that mothers with rising trend in health knowledge have higher HAZ by 3.02 S.D of the height for the similar sex and age group of children, holding other factors constant due the fact that health knowledge produces common awareness within society and ultimately, they can get more benefits from health oriented programs launched by public sector. According to Abuya, Ciera, & Kimani-Murage (2012), the risk of contagious diseases can be curtailed via health knowledge and easy approach to latest medicines. The columns 3 and 4 approximately presents the same outcomes for the estimates of mother education and her

knowledge in term of comparison between OLS and IV regressions except the coefficient of primary education in OLS estimation becomes insignificant.

A convex connection between age and HAZ is measured in all columns of this specification. The estimates of both child age and its squared are significantly (P<0.01) negative and positive, respectively, demonstrating that HAZ decreases with age but with diminishing slope. It means that elder infants are worse in HAZ than younger ones. This outcomes is also supported by (Ahmed, 2007; Krueger & Malečková, 2003).However, the estimates of mother and father's age are inconsistent in IV regression while they are highly significant in OLS estimation with a very small magnitude. Rural mothers have a disadvantage of 0.50and 0.58 S.D (P<0.01) in terms of height comparing with the urban ones in columns 2 & 4 because they mostly lack basic health services and hold poor infrastructure and environmental settings. This result is also favored by(Fakir & Khan, 2015; Khattak, Iqbal, & Ghazanfar, 2017). The estimates of residence are also improved in IV regression, implying the better choice of educated mother in residence for better health their babies.

Wealth index and access to health services are added in the 3 and 4 columns to understand how the magnitude of mother education's estimates is altered with the inclusion of these variables. By doing so, the coefficient of mother education stays on significant (P<0.05), but it reduces marginally, indicating that the key impact of higher education on HAZ is not via income. This results is supported by (Maiga, 2015).This outcome shows that the rising wealth status of middle and rich class families gives a rise to HAZ by 0.88 and 1.01 S.D respectively, holding all else constant because rich parents can meet the expense of more nutritious food and better medication, and can afford a healthy environment setting for their children so that they remain healthier (Chai et al., 2016; Farooq, 2012).However, an access to health services has inconsistent connection with HAZ in columns 2 and 4.

Summary statistics of variables of interest presented in Table 7 (in appendix) show that About 54% of mothers have zero education, 15% have 1-5 years of schooling, 19% have 6-10 years of schooling and only 11% have 11-16 years of education. The mean of HAZ at -1.97 is very closed to the WHO declared moderate stunting (-3 < HAZ < -2) criteria while average WAZ (-1.34) is far from moderate underweight condition (-3 < HAZ < -2)(Wolde, Berhan, & Chala, 2015). 42% mothers grew up in urban areas while 58% are resided in rural regions. The average MBMI shows that overall; mothers are healthy in the sample. On average, 39% households belong to rich and middle class.

Table 5: Impact of Mother's Education on Child's Weight for Age : Specification (2)

Regressors	OLS (1)	IV (2)	OLS (3)	IV (4)
Mother Education between 1-5	0.05 (0.52)	1.1 (0.53)	0.04 (0.6)	-1.42 (0.55)
6-10	0.34 (0)***	-1.66 (0.4)	0.3 (0)***	-1.7 (0.34)
11-16	0.51 (0)***	4.39 (0)***	0.48 (0)***	3.8 (0)***
Mother Health Knowledge	0.34 (0)***	1.95 (0)***	0.34 (0)***	1.9 (0)***
Mother Age	-0.003 (0)***	-0.003 (0.84)	-0.014 (0)***	-0.008 (0.62)
Father Age	-0.002 (0.48)	0.009 (0.12)	-0.002 (0.5)	0.008 (0.13)
Child Age	-0.03 (0)***	-.007 (0.44)	-0.03 (0)***	-0.008 (0.38)
Age Squared	0.0001 (0)***	0.00001 (0.9)	0.0003 (0)***	0.00001(0.9)
Residence (1)	0.28 (0)***	-0.12 (0.25)	-0.25 (0)***	-0.4 (0)***
Access to Health Services			-0.062 (0.33)	-0.15 (0.15)
Wealth Index (1)			-0.038 (0.6)	0.72 (0.02)**
Wealth Index (2)			0.075 (0.4)	1.1 (0)***
Over Identification Test (d.f)		2.4 (2) (0.3)		2.35 (2)(0.3)
Wu-Hausman Test (d.f)		20.55 (6) (0)		21 (6)(0)
Durbin chi-square Test (d.f)		119.5 (6) (0)		122 (6)(0)
Observations	3404	3404	3404	3404
R-Squared	0.4		0.4	

Instruments=Mother birth cohort,listening radio, and reading newspaper, P-values are in parentheses, *** significant at 1%; ** significant at 5%; * significant at 10%.

Approximately, the similar kind of outcomes for mother education and her knowledge in term of comparison between OLS and IV regressions in all columns of Table 5 are measured except the primary education in OLS columns becomes insignificant. Similarly, the bigger coefficients of 11-16 years of education in IV columns validate that the corresponding OLS coefficients are highly biased, showing the causal connection between mother education and WAZ. IV columns reveal that mothers with an increasing rate of higher education raises WAZ by 4.39 S.D and 3.8 S.D respectively, controlling other factors. The signs of the other controlled factors are reasonable in OLS columns. The negative estimate of child age and positive estimate of its square in OLS point out that child's WAZ firstly reduces with age and improves at the later time. However, these age variables are inconsistent in IV regression. The magnitude of residence factor in IV gets little better, implying that that rural child also suffers a disadvantage of WAZ by 0.874 S.D due to lack of basic health facilities.

In this specification, wealth index and access to health services are also added in columns 3 and 4 because we want to see how the magnitude of estimates is changed with the inclusion of these variables. By doing so, access to health services remains inconsistent, but the estimate of the higher education is significantly reduced while controlling for other factors, indicating that the influence of the higher education on WAZ is partially through the channel of wealth status. This outcome is aligned with (Chen & Li, 2009; Chou et al., 2010). However, it is still significantly

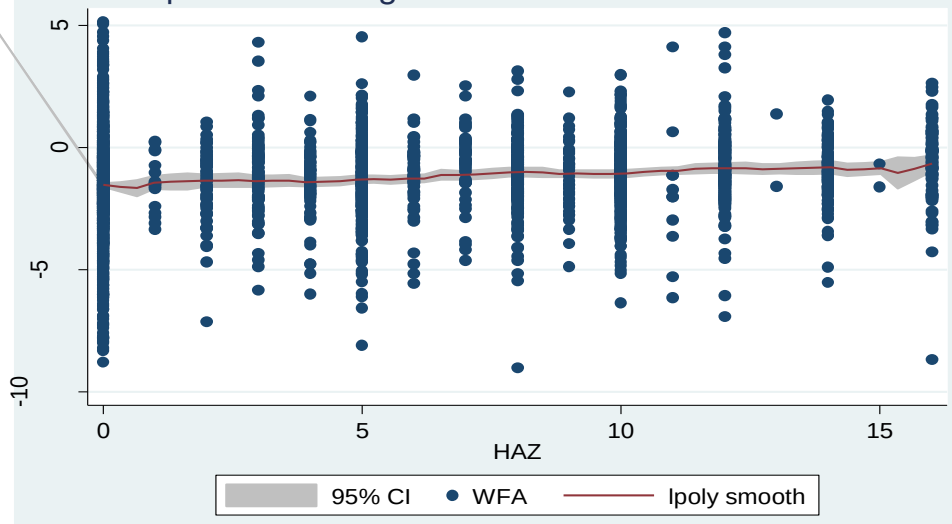
much bigger than that of OLS. IV estimates show that an increasing trend of middle and rich families' wealth significantly scales up WAZ by 0.72 and 1.1 S.D (P<0.05 and P<0.01) respectively.

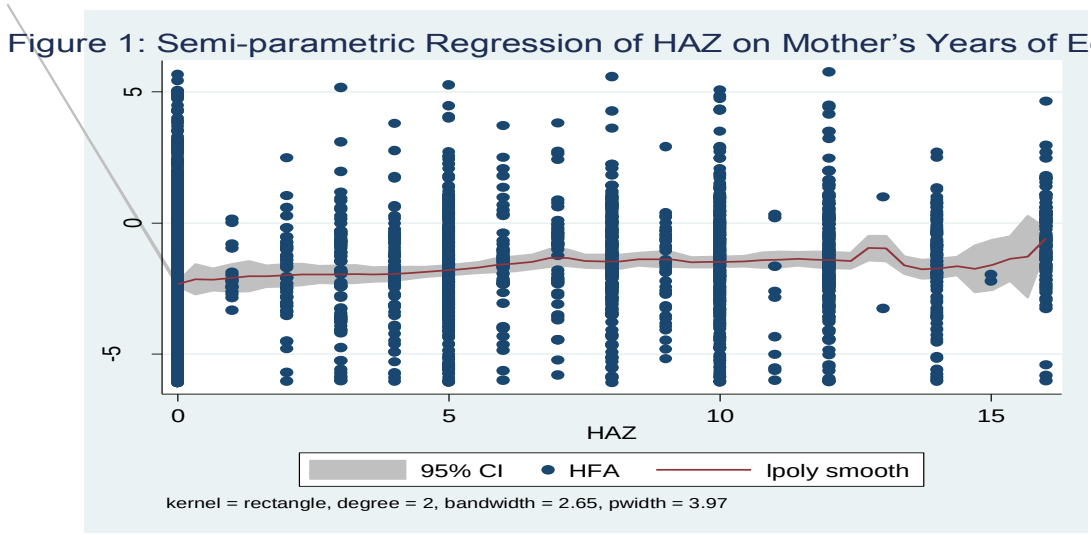
To sum up, it is reliably found that the 11-16 years of education has highly significant and positive influence on WAZ and HAZ while OLS estimates of mother education are also highly significant, but they are seriously a victim of biasness as shown from their magnitudes. This outcomes is also aligned with (Ahmed, 2007; Currie & Moretti, 2003). IV estimations for both cases indicate threshold at 6-10 years of mother education. Thus, mother education impactsWAZ and HAZ only at 11-16 years of education.

3.1 Semi-Parametric Regressions Results

To examine the threshold effects, the bivariate maternal education infants' health outcomes' connections are measured. A local polynomial smoothing of the semi-parametric relationships between HAZ, WAZ and mother education at 95% confidence interval curves, are shown in Figure 1 and 2. A 2ndorder polynomial degree is taken. The graph predicts the non-linear relationship. Given that overall mother education in Pakistan is very low, the confidence intervals are appeared much wider after 14 and 15 years education for HAZ and WAZ, respectively because few mothers are highly educated. Therefore, the coefficients for those grades of education are fewer precise.

Figure 2: Semi-parametric Regression of WAZ on Mother's Years of Education





3.2. Threshold Effects

In the preceding section, the bivariate associations between mother education, WAZ, and HAZ are non-linear. Therefore, HAZ and WAZ are regressed on the dummies for all grades of mother education in the health production function, along with zero education as reference category to verify the threshold impacts. The Table 6 shows that the estimates of 16 years are 1.73 (P<0.01) and 0.88 (P<0.01) for HAZ and WAZ specifications, respectively. These are the biggest and positive estimates, implying that 16 years education will raise HAZ by 1.73 S.D relative to 0.51 S.D for 5 years of schooling and 16 years education will also scale up WAZ by 0.9 S.D relative to 0.52 S.D for 10 years of education. Where the pattern of coefficients at different education dummies provides justification for non-linear relationship between mother education, WAZ, and HAZ, it also confirms that the influence of mother education on WAZ and HAZ is much strong only at 16 years education, implying the presence of threshold at secondary education. The negative estimates may reveal that students are very bad at that level of education.

Table 6: Threshold Effects Regression Results

Education Dummies	HAZ(OLS)	WAZ (OLS)
1	0.39 (0.53)	0.061(0.41)
2	0.31 (0.30)	-0.08 (0.24)
3	0.38 (0.24) **	0.419 (0.19)
4	0.42 (0.25) *	0.122 (0.19)
5	0.510 (0.13) ***	0.16(0.1)
6	0.82 (0.31) ***	0.34 (0.24)
7	1.117 (0.32) ***	0.8 (0.25) ***
8	0.85 (0.164) ***	0.43 (0.13) ***

9	0.57 (0.34) *	0.33 (0.26)
10	0.9 (0.12) ***	0.52 (0.09) ***
11	-0.83 (.64)	-0.41 (0.5)
12	1.003 (0.17) ***	0.735 (0.13) ***
13	1.187 (1.48)	1.42(1.15)
14	0.59 (0.2) ***	0.59(0.16) ***
15	0.24 (1.48)	0.38 (1.15)
16	1.73 (0.237) ***	0.88(0.18) ***
Constant	-2.32 (0.048) ***	-1.54(0.04)***

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p

4. Conclusion and Recommendations

This paper elaborates the mother education child health gradient in Pakistan for under 5's children. The summary statistics declare that the mean value of HAZ at -1.97 and WAZ at -1.34.Though the past studies point out the presence of nonlinearity and threshold in this association, no effort has been made to investigate this issue, despite its substantial implications on public health programs. A change in the educational policies captured by mother birth cluster is taken to struggle for purging the coefficients of mother education from endogeneity bias. As Hausman statistics discards H_0, IV is preferred over OLS, only IV results are focused and OLS results are taken to highlight the magnitude of the biased coefficients. Though OLS estimates corroborate a highly significant and positive influence of 1-5 and 6-10 years education on HAZ and similar effect of 6-10 years of schooling on WAZ, these significance impacts go away with IV in both specifications. However, IV regressions indorse that only 11-16 years education of mother is significantly impacting HAZ and WAZ and the bigger IV estimates of 11-16 years education in both specifications highlight that smaller OLS estimates are highly biased and show the causal association between mother education and child health due to endogeneity bias. Thus, IV estimations in both cases indicate threshold at 6-10 years of mother education, signifying that mother education impacts WAZ and HAZ only at 11-16 years of education. Similarly, where the pattern of coefficients at different education dummies provides justification for non-linear relationship between mothers' education and WAZ, and HAZ, it also validates that the influence of mothers' education on WAZ and HAZ is much strong only at 16 years education implying the existence of threshold at secondary education. Where an inconsistent association of 1-5 and 6-10 years of schooling with WAZ and HAZ in IV regressions defines the limit of threshold, it also highlight that 1-10 years of schooling fail to equip them with necessary health knowledge to give arise child nutrition in Pakistan. The empirical outcomes underline the same scenario of endogeneity biasing the comparison of OLS and IV estimates of mother knowledge for health. As

wealth index and access to health services are added in both specifications, the coefficients of mother 11-16 years education stays on significant, but it reduces marginally in HAZ specification, indicating that the key impact of higher education on HAZ is not via wealth status while this estimate in WAZ specification is significantly reduced, signifying that the influence of the higher education on WAZ partially works through the channel of wealth status. However, access to health services remains inconsistent in both specifications. A local polynomial smoothing graph also predicts the non-linear relationship between mother education, HAZ, and WAZ.

It is being vehemently argued here that the nutrition initial 2 years of a child is pivotal for both mental and physical growth. It has been proven both rationally and by putting past data sets together that the deficiency of nutrients can have long lasting and gruesome effects not on the child alone but on the whole nine yards of the society as well. Investment in female education can bring about a change for good in labor productivity. The threshold impact identifies that the biggest impact of education on HAZ and WAZ is occurred at 11-16 years of education. Therefore, educational policies designed for girls should emphasize on trying to attach them with schools and colleges after 10 year of schooling to equip them with necessary health knowledge to give rise to child nutrition in Pakistan, instead of plans to promote only primary schooling. This will only be possible at higher short term financial cost on the behalf of other productive sectors, but it will raise long term future labor productivity and economic growth in Pakistan. Health knowledge effect suggests that health care information programs designed for girls can be helpful to reduce HAZ and WAZ in Pakistan. The wealth index influence in WFA and HAZ specifications direct that educated women should be facilitated to join income-generating activities in order to share household expenditures and finance their infants' nutrition.

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Table 7: Summary Statistics

Variables	Mean	Standard Deviation
Child Age	29.9	17.26
HFA	-1.97	2.14
WFA	-1.34	1.64
MBMI	23.64	4.86
Mother Age	29.37	6.15
Husband Age	35	9
Mother Education		
0	0.54	17.26
1-5	0.15	2.14
6-10	0.19	1.64
11-16	0.1	4.86
Urban	0.42	0.49
Rural	0.57	0.49
Health Knowledge		
She did not heard about Hepatitis	0.16	0.36
She heard about Hepatitis	0.84	0.36
Wealth Index scores		
Poor Household	0.22	0.41
Middle Household	0.38	0.48
Rich Household	0.39	0.48
Mother Birth cohort		
1963-72	0.07	0.25
1973-79	0.22	0.41
1980-88	0.48	0.5
1989-96	0.23	0.42

Table 8: Fraction of Mothers Who Cannot Read and Can Read a Sentence by parts at Different Levels of Schooling

Years of Schooling	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Mothers who cannot read	87.5%	49%	31.2%	18.7%	10.7%	0%	2.3%	1.1%
Mothers who can read a sentence by parts	6.3%	18.4%	32.5%	38.7%	16.9%	16.7%	9.3%	3.9%