IMPACT OF WATER AND SANITATION QUALITY ON CHILD HEALTH: EVIDENCE FROM PAKISTAN

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Introduction

- Relationship between childhood development and later life outcomes (Strauss and Thomas 2008)
  - Low brain development so poor cognition (lower IQ), diminished mental ability and learning capacity resulting poor school performance in childhood
  - Low adult wages, lost productivity, worse socioeconomic outcomes
  - Increased risk of nutrition related chronic diseases such as diabetes, hypertension, obesity in future
- Reduced supply of healthy & productive labor force which affects market development

What affects Child Health?

- Various factors such as
  - acute malnutrition
  - infectious diseases
  - iodine deficiency
  - ionizing radiation
  - stress hormones
  - Pollution

- Exposure to shocks (both in-utero and during childhood)
  - Natural disasters such as floods, famines, earthquakes
  - Man-made shocks, for instance, pollution and violent conflicts

How to measure child Health?

- Indicators for child health
  - Weight-for-height (wasted), Weight-for-age (underweight), Height-for-age (stunted)

- Stunting:
  - Height exhibits the stock of past outcomes
  - Indicator for a child's long tem nutritional status
  - Reference population and Height-for-age z score (HAZ)
  - Stunted if HAZ<-2 SD; Severely stunted if HAZ<-3 SD

Motivation

- What happens to HAZ in the absence of these shocks?
- Can children be still stunted even when they are well-fed?
- The answer is **YES**
- Well fed children in India were also found to be stunted
- Pursuit of other potential causes for stunting
- Lack of access to clean drinking water and improved sanitation facilities

Motivation: Situation in Pakistan

- In Pakistan, 45% children are stunted and 23% are severely stunted (PDHS 2013)
- Moreover, 16 million people in Pakistan have no choice but to use poor quality of water (WaterAid Pakistan 2016)
- According to Geeta Rao Gupta - the deputy executive director at UNICEF
  - *There are 41 million people who do not have access to a toilet in Pakistan and as a result they are defecating in the open. And open defecation has significant health and nutritional consequences*
- However, no study is available for Pakistan that scientifically establishes the link between access to safe drinking water and improved sanitation and stunting

Objectives

- The prime objective of the study is to investigate the causal impact of access to improved drinking water and sanitation facilities on stunting among the Pakistani children aged five and below.

- The second objective is to identify the channels through which safe drinking water and improved sanitation affect, if at all, the incidence of stunting in children.

Prior Evidence

- Mixed Evidences
  - Safe drinking water and development and survival of children (Fogden et al. 2009; Ashwani et al. 2014)
  - Better sanitation and hygiene practices are also essential (Cumming et al. 2016)
  - The combine effect of unimproved water and poor sanitation facilities is more pronounced in increasing stunting (Gauri 2008; Osita et al. 2014; Ngure et al. 2014)

Potential Channels

- Water and Sanitation and Diarrhea
  - Diarrhea →intestinal infections → nutrients losses → stunting
- Water and Sanitation and Environmental Enteropathy
  - Crawling children put objects in their mouth → enteric pathogens → inflammation to the guts → poor absorption of nutrients → stunting
- Water and Sanitation and Soil-Transmitted Helminths
  - Helminths → hookworm infections → malabsorption of nutrients during pregnancy → affects mother and fetus → stunting

Data and Variables

- Pakistan Demographic Health Survey (2012-13)
- The PDHS (2013) successfully interviewed 14,000 households from all districts of Pakistan
- Data also covers information of 3,070 children aged 5 years and below
- These children are the primary analytical unit
- Children's health status was measured using the height-for-age z (HAZ) scores
- Two groups: household with improved water and sanitation facilities are in the **treated group** whereas those with unimproved facilities are in **control group**

Classification and treatment and comparison groups

Variable	Improved Sources	Unimproved Sources
Source of drinking water	Piped into dwelling/yard/plot, Public taps or standpipes, Boreholes or tube wells, Protected dug well, Protected spring and rainwater, Bottle water, Filtration plant	Unprotected dug well. Unprotected spring. Tanker Truck or Cart with drum. Surface water
Sanitation facilities	Pour-flush system to piped sewer system ,Pour –flush to septic tank, Pour –flush to pit latrine, Ventilated improved pit latrine (VIP), Pit latrine with slab	Pour-flush not to sewer/Septic, Pit or tank latrine , Pit latrine without slab or open pit, Bucket hanging toilet or latrine, No facilities, bush or field

Classification based on Quality Type

Variables	Poor quality	Intermediate Quality	High Quality
Water Sources	Surface water i.e. Rivers, lakes and standing water	Below surface water i.e. springs, boreholes standpipes, wells and dug wells (not part of public pipe system).	Direct access to piped water, direct water bought from vendors
Sanitation facilities	No access to toilet facilities	Access to basic or improved toilet i.e. Pour-flush system to piped sewer system, Pour–flush to septic tank, Pour –flush to pit latrine, Ventilated improved pit latrine (VIP), Pit latrine with slab.	Access to flush toilet

Empirical Methodology

- Use of Propensity Score Matching
- We estimate the impact of water sources and sanitation facilities using various variants of the following equation

$$HAZ_{ij} = \beta_0 + \beta_1 Treatment_j + \gamma X + \varepsilon_{ij} \qquad (1)$$

- We also run separate regressions to examine the impact of different quality types on HAZ using the following equation

$$HAZ_{ij} = \alpha + \beta_1 High\ Qaulity_j + \beta_2 Int.Quality_j + \beta_3 Poor\ Quality_j + \gamma X + \varepsilon_{ij} \quad (2)$$

HAZ and Regression Analysis

	Water Sources		Sanitation Facilities	
Variables	Model 1	Model 2	Model 3	Model 4
Treatment_water	0.385*** (0.105)	0.178* (0.103)		
Treatment_sanitation			0.511*** (0.074)	0.239*** (0.077)
Controls	**No**	**Yes**	**No**	**Yes**
Adj R-squared	0.004	0.097	0.014	0.099
Observations	3,070	3,070	3,070	3,070

Test of Means for Treatment and Control Groups (Water Sources)

Variables	Unimproved Waters sources	Improved Water Sources	Difference
HAZ	-2.116 (0.117)	-1.731 (0.0353	-0.385*** (0.1054)
Child Age (Years)	2.073 (0.073)’	2.075 (0.027)	-0.001 (0.078)
Gender of Child	1.513 (0.026)	1.490 (0.009)	0.023 (0.027)
Mother’s Age	30.112 (0.356)	29.303 (0.116)	0.808*** (0.341)
Mother’s Education	0 .177 (0.020)	0.440 (0 .009)	-0.262*** (0.026)
Mother’s Employment	0.180 (0.020)	0.212 (0.007)	-0.031 (0.022)
Fathers Education	0 .494 (0.026)	0.675 (0.009)	-0.180*** (0.026)
Household Size	9.204 (0 .206)	9.302 (0.100)	-0.097 (0.282)
Residence (Urban/Rural)	0.2841 (0.023)	0.453 (0.009)	-0.169*** (0.027)
Observations	366	2,704	

Test of Means for Treatment and Control Groups (Sanitation Facilities)

Variables	Unimproved sanitation facilities	Improved sanitation facilities	Difference
HAZ	-2.136	-1.624	-0.511***
	(0.062)	(0.040)	(0.742)
Child Age (Years)	2.099	2.064	0.034
	(0.046)	(0.030)	(0.055)
Gender of Child	1.489	1.494	-0.005
	(0.016)	(0.010)	(0.019)
Mother's Age	29.415	29.393	0.808**
	(0.356)	(0.116)	(0.341)
Mother's Education	0.203	0.496	-0.290***
	(0.013)	(0.010)	(0.018)
Mother's Employment	0.337	0.153	0.184***
	(0.015)	(0.007)	(0.015)
Fathers Education	0.504	0 .717	-0.213***
	(0.016)	(0.009)	(0.018)
Household Size	9.062	9.388	-0.325
	(0.137)	(0.116)	(0.200)
Residence (Urban/Rural)	0.201	0.532	-0.330***
	(0.013)	(0.010)	(0.018)
Observations	918	2152	

HAZ and Propensity Score Matching

Matching Technique	ATT for Water sources	ATT For Sanitation facilities
Nearest Neighbor	0.297* (0.172)	0.262** (0.126)
Radius matching	0.415** (0.128	0.378*** (0.080)
Kernel Matching	0.347*** (0.135)	0.250** (0.098)
Stratification Matching	0.145 (0.152)	0.265** (0.107)
Observations	3,070	3070

Combined Impact of Water and Sanitation Sources

Matching Technique	ATT for Water and Sanitation
Nearest Neighbor	0.214** (0.100)
Radius matching	0.383*** (0.078)
Kernel Matching	0.244** (0.089)
Stratification Matching	0.213** (0.094)
Observations	3,070

HAZ and Quality Types of Water and Sanitation

	Water Quality		Sanitation Quality	
Variable	Model 1	Model 2	Model 3	Model 4
High	0.702*** (0.155)	0.284* (0.151)	0.796*** (0.084)	0.453*** (0.093)
Intermediate	0.475*** (0.133)	0.227* (0.129)	-0.310** (0.148)	-0.392*** (0.147)
Poor	-2.254*** (0.127)	-2.190*** (0.235)	-2.340*** (0.075)	-2.244*** (0.215)
Controls	**No**	**Yes**	**No**	**Yes**
Adj. R Squared	0.006	0.097	0.042	0.112
Observation	3070	3070	3070	3070

Channel: Diarrhea and Quality Types

	Water Quality		Sanitation Quality	
Variable	Model 1	Model 2	Model 3	Model 4
High	0.020 (0.032)	0.018 (0.032)	-0.016 (0.019)	-0.015 (0.021)
Intermediate	0.027 (0.027)	0.024 (0.028)	-0.091*** (0.029)	-0 .078*** (0.030)
Poor	0.194*** (0.026)	0.471*** (0.054)	0.235*** (0.017)	0.508*** (0.049)
Controls	**No**	**Yes**	**No**	**Yes**
Adj. R Squared	0.0003	0.034	0.002	0.035
Observation	3070	3070	3070	3070

Concluding Remarks

- Using Propensity Score Matching, the paper finds that lack of access to clean drinking water and improved sanitation facilities increase stunting
- The quality types also play important role
- Diarrhea is one of the channels
- Nutrition specific interventions should also take into consideration the environmental factors such as water quality and sanitation facilities for the intervention to be effective in the fight against stunting
- Awareness programs should be introduced among the residents about good hygiene practices

Thank you!

Questions/Comments/suggestions