Impact of Family size on Child Health in Pakistan

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Abstract

This study aims to estimate the impact of fertility on child health outcomes in Pakistan. Fertility can affect family size and hence the resources available for the welfare of each family member: a larger family size may result in fewer resources for children and adversely affect child health. The existing literature provides suggestive evidence on the likely impact of family size on child health but causal evidence is rare: while fertility decision can affect child health, health of existing children can also influence the decision to have another child. This study uses the incidence of 'twin birth' as an instrument for family size and is the first study for Pakistan that attempts to provide causal evidence on the impact of family size on child health. I use household - level data and child health data (height and weight-for-age, child mortality) from a sample of children under the age of 5 years from the Punjab (Pakistan) MICS rounds. Results show that each additional member of the family reduces height- and weight-for-age z scores by 0.2 – 0.3 standard deviations and increases the likelihood of child death by 8 – 9 percentage points. The results of this study can help policy makers in establishing policies that address the large family size issues and its importance for better child health outcomes.

1. Introduction:

Microeconomic theory suggests that a large family size (or the number of children in a household), may lower the quality of child health. This is attributable to limited resources in the household that are distributed among the children (Maitra &Pal, 2008).A larger household size implies a higher number of individuals compete to consume the given household resources. Each additional child in the family hence reduces the per capita resources in the households, possibly increasing poverty as family size gets larger (Anyanwu 2014).

Child health outcomes can have a long-term impact, not just on the child, but on the overall well-being of the household and ultimately on the economy as well. Children from large families may not receive the required nutrition, adversely affecting health and eventually, short- and long-term educational outcomes (Jackson et al., 2011, Shariff et al., 2000). This then impacts earning capacity and outcomes later in life. Smith(2009) in his study shows that poor health in childhood has a negative impact not just on income earned in adulthood, but family income and labor supply as well.

In their seminal paper, Becker et al. (1990) hypothesize that when the overall level of human capital accumulation is low, there are low returns from human capital investment and high returns instead from having more children. Returns from having additional children are lower when human capital accumulation is high i.e. families with high parental education end up having few (lower quantity) but educated (higher quality) children, whereas, families with low parental education tend to have large family size (higher quantity) but less educated children (lower quality). While the Becker et al. (1990) study focused on the education component of human capital, the theory holds for health as a measure of quality as well.

In this study, I estimate the impact of family size on child health outcomes in Pakistan. Fertility decisions can be impacted by a number of unobserved (for instance, underlying preference for more children or a certain desired ratio of boys and girls in the family) and observed factors, such as health of existing children and education in the household, leading to issues of endogeneity and reverse causality in empirical estimation. I attempt to deal with these issues by making use of an indicator for the woman having ever given birth to twins as an instrument for family size. Having twins increases the family size exogenously and having two instead of one child, may be considered a random event.

I use two rounds of Punjab Multiple Indicator Cluster Surveys (MICS) for Pakistan collected in 2013-2014 and 2017-18 with data on approximately 60,000 children under the age of 5 years for this analysis. Results indicate that an increase in family size by one unit decreases height and weight-for-age z scores by nearly 0.3 standard deviations, and increases the likelihood of child mortality by 8 percentage points. The results are in line with studies conducted in Cameroon (Baye &Sitan, 2016) and Ethiopia (Teferi 2019) which find similar effects of increased fertility on child health. Sub-sample analysis suggests the effects of family size on child health are for children of younger mothers. My results are robust to the inclusion of the gender of twins and proxies for twin type (identical or non-identical) as instruments for family size.

Child health is believed to have long lasting effects on later life outcomes. This makes among other factors, the role of family size in influencing child health important area to study, especially for countries with high fertility rates and family size. Poor child health has long lasting impacts on subsequent life outcomes. Glewwe et al., (2001), Glewwe& Miguel (2007) and

Wisniewski (2010) suggests that there exists a strong relationship between the health of a child and their educational outcomes: malnourishment in early childhood leads to poor performance in school and fewer years of education. Child health also affects the school enrollment rate, children with poor health if enrolled in school, are more likely to drop out (Alderman et al. ,2001). Similarly, according to Shariff, et al. (2000), children with poorer nutritional status have lower educational achievements. Further, their analysis also shows a strong correlation between a higher number of siblings and poor academic performance.

This question is specifically important for the context of Punjab, Pakistan where the average education levels are low – adults in my sample have an average of 5 years of education. Overall early childhood health outcomes are poor in Pakistan - the child mortality rate, at 62 per 1000 live births in rural areas and 45 per 1000 live births in urban areas, are worse than the regional average for South Asia (28 per 1000 births).[1]It is likely that poor child health may negatively impact educational achievement of the child(Shariff, et al. 2000) –. At77%, Pakistan has one of the lowest net adjusted school enrollment rates in the region and as many as 22% of rural and 14.8% of urban school-going children dropout at the primary level (Unicef Annual Report 2018). Findings from this study on child health outcomes may have important implications for policy and programs targeting both early childhood and later life outcomes. This study follows the following structure: Section 2 is based on the review of literature, Section 3 provides the empirical strategy, Section 4 provides empirical results and Section 5 concludes.

[1]Unicef Annual Report 2018: https://www.unicef.org/pakistan/reports/unicef-pakistan-annual-report-2018

2. Literature Review:

Literature shows mixed evidence on the link between the size of a family and child health outcomes. While some studies show no empirical relationship between family size and child health, other show evidence of reverse causation. There are multiple factors which determine family size and child health among which, parent's education or mother's education is considered most important and is most often studied in literature. I summarize the main factors in the literature below.

2.1. Determinants of Child Health:

Literature shows that multiple factors determine child health and development. Law et al. (2003) explores a host of factors that may affect the health of children under the age of five years. They suggest parenting, social and cultural practices, parent's behavior, early childhood nutrition and environment as the main factors affecting child health and development. Moreover, Webair& Bin-Gouth (2013) suggest that caretakers' education and the knowledge about the severity of illness affect health-seeking behavior and health outcomes.

Substantial evidence suggests that the education of parents has a strong impact on child's health outcomes. Parents' education reduces family size as they give more time to human capital activities than child rearing activities due to which families with higher human capital end up having a smaller family size (Becker et al. 1990). Mother's education in particular has been shown to be correlated with child health in multiple ways. For instance, mothers' education can reduce fertility, as they delay marriage, and may also improve child health as more educated women may have greater knowledge about nutrition, immunization, health and sanitation from school(Keats,2018;Monstad et al., 2008; Breierova & Duflo, Abuya et al.(2011) use the Kenyan demographic health survey to show the impact of mother's education (i.e. categorized into three, no education, primary education and secondary education of mothers) on child's immunization and show that females who received primary education compared to those who had no education were likely to get their child immunized by 2.17 times than women with no education.

Beyond health knowledge and practices, many studies focus on socioeconomic background in relation to the child's health. Households' resources can have a substantial influence on child's health, as households with better resources are able to fulfill the basic nutritional requirements of kids better(Currie et al., 2007; Castillo et al.; 2011).

Child outcomes may be expected to vary by child gender. This may be a product of differential endowments of resources and caregivers' time allocated to girls vs. boys. On the other hand, medical literature suggests male and female children may be genetically predisposed to growing differently (Wamaniet al. 2007). A descriptive study of Indian children suggests that female children have slightly better HAZ and WAZ compared to male children, irrespective of their birth order (Dhingra&Pingali, 2021).

2.2. Family Size and Child Health

Small family size implies that family resources being divided among fewer children, increasing the resources available to each child, potentially improving child outcomes. Blake (1981) suggested that the number of siblings, or 'quantity' of children is negatively related to the 'quality' of child and showed that family size has a negative impact on child quality irrespective of how developed the economy is. Becker & Barro (1988) further hypothesize that there are costs to reproduction that translate over generations. For example, if there is a tax on children, this will lower the fertility in the generation that is facing this tax and will permanently lower the number of offspring in all subsequent generations. This means the costs of bearing and taking care of children can gave long-term impacts on future family sizes as well.

Following the quality - quantity relationship, many papers provided evidence on the effect of recourse allocation on child outcomes. Price (2008) with the help of American Time use Survey" shows that the first born of a family receives more quality time by 20-30 more minutes in comparison to the second born child of the same age and same family. More quality time may lead to differences in child outcomes in later life.

In addition to the birth order of child, the effects of size of the family on the child health outcomes may also vary with the child's gender. A family's preference for a son can lead to a higher family size if the earlier births are girls, and at the same time reduce the resources available to older children, particularly girls. Studies from India confirm this bias, and show poor health of daughters for families that don't have an older son and also for the families that have higher fertility preferences (Jayachandran &Kuziemko, 2011).

Pitt(1997) measures the factors affecting child's health using DHS data for African countries, and established a significant and positive relationship between family size and child mortality. Joshi& Schultz (2013) evaluate a family planning program in Bangladesh and find that program villages observed 17% reduction in family size with other benefits such as lower child mortality rates.

As family size increases, there is less time and/or fewer financial resources available for household members. On the other hand, the health of a child may also influence the decision to have another child. In addition, mother-specific unobserved differences in health or genetic reproductive endowments of mothers may affect both family size and child health. Issues of reverse causality and endogeneity means that while literature can largely suggests a negative relationship between family size and child health, with an exception of few studies, it cannot comment on whether family size *causes* poor child health.

Using twin birth as an exogenous variable to instrument for family size was first proposed in a seminal study by Rosenzweig &Wolpin (1980). It has subsequently been used in several studies since largely focusing on understanding the role of family size in impacting child's educational outcomes (e.g. Li et al., 2008; Glick et al., 2007).

A small group of studies use similar IV techniques to understand the impact of fertility decisions on child's health outcomes. Baye & Sitan (2016) explored the impact of fertility decisions (or size of the family on child health) using DHS data for Cameroon. They examined the impact of mother's education on family size with the help of twin birth as an IV for family size. The findings of their study suggest that mother's education is negatively related to family size which in turn can negatively affect child's health. That is, educated mothers have fewer children and their children on average have better health outcomes. Using the Ethiopian Demographic Health Survey,Teferi(2019) constructs two variables to instrument for family size: incidence of twin birth and the gender of first two children, since both factors affect the family size but do not affect the child health directly and finds that an additional birth will adversely affects the early child health which is measured by height for age z scores.

This study aims to contribute to the growing literature on determinants on child health in developing countries. While extensive literature documents that correlation between family size with child health, evidence on causal impacts of fertility decisions on child health is relatively sparse rare. I replicate the twin-birth instrumental variable strategy for Pakistan and add to the literature on the causal impact of family size on early child health. With child health being an important determinant of educational achievement, and with existing low levels of child health outcomes in Pakistan (UNICEF, 2018), the results of this study are potentially highly relevant to policy making in both Pakistan and in other similar developing country contexts.

3. Empirical strategy

3.1. Methodology

A larger family may decrease time/resources for children – i.e. family size affects child health. Unobserved mother-specific health or genetic reproductive endowments can influence both family size and child health leading to concerns of endogeneity. Also, health of existing children can also affect the decision to have more children (and hence family size) i.e. raising the concern of reverse causality.

I employ an instrumental variable (IV) to deal with potential issues of endogeneity and reverse causality. This needs to be (i) *relevant*i.e.it can affect family size in the context of this study. It also needs to be (ii)*exogenous* i.e. does not correlate with other determinants of child health that also affect family size (e.g. parental behavior or resources) and affects child health through its effect on family size. As suggested by Rosenzweig &Wolpin (1980), and used by several studies since their seminar paper, twin birth can be considered to influence family size making it *relevant*. For instance, parents may make the decision to produce or not to produce more children based on resulting family size or the gender of twins. For instance, if a mother gives birth to twin girls, they may decide to have another child to have a son. Secondly, twin birth can be considered to be a random occurrence. Importantly, in so far as it can be considered to be an event that is not likely to be influenced by the mother or other household or individual level considerations, so it is *exogenous*.

I instrument for family size using occurrence of twin births and estimate the following first stage and second stage regressions, respectively:

$$F_{m,h}= \alpha_{o+} \alpha_1 \text{Twin Birth}_{m,h} + \alpha_2\mathbf{X}_{c,m,h}+\alpha_3\mathbf{X}_{m,h}+\alpha_4\mathbf{X}_h + \delta_1 D_{c,m,h} + \delta_2 Y_t+\varepsilon_{1\ m,h} \quad (1)$$

$$CH_{c,m,h} = \beta_o+ \beta_1 F_{m,h} + \beta_2\mathbf{X}_{c,m,h}+\beta_3\mathbf{X}_{m,h}+ \beta_4\mathbf{X}_h + \delta'_1 D_{c,m,h} + \delta'_2 Y_t + \varepsilon_{2\ c,m,h} \quad (2)$$

Where CH is child health, which is measured by weight and height measurements for child c, born to mother m in household h; F is family size, proxied by the number of children ever born to the mother m in the household h; TwinBirth is a dummy variable that measures if the mother has ever given birth to twins; $\mathbf{X}_m$ is a vector of mother characteristics (age, education, age of marriage, mother health),$\mathbf{X}_h$is a vector of household characteristics (education of household head, whether the household is rural, assets) and $\mathbf{X}_{c,m,h}$ is a vector of child characteristics (gender, child's birth order, birth spacing), $\varepsilon_{1m,h}$ $\varepsilon_{2c,m,h}$ are the error terms in equation 1 and 2 respectively. F (family size) in the second stage is instrumented by whether the mother has ever given birth to twins. Furthermore, district and year fixed effects are included in all regressions, denoted by the vector **D** and **Y** in both equations, and standard errors clustered at the level of the mother.[2]

In addition to anthropomorphic measures, I also test the impact of family size on a more extreme outcome of child health – i.e. child mortality. Child mortality is considered to be one of the leading indicators of under 5 child's health. If health outcomes deteriorate, or do so dramatically, we may see an increase in child mortality rates. In order to test for this effect, I use survey measures on whether the mother reports on ever having had a child who later died. I estimate equations 1 and 2 for the sample of mothers, with all controls included as mentioned earlier except for the child level controls (gender, birth order, birth spacing).

The coefficient of interest, $\boldsymbol{\beta_1}$, provides an estimate of effect of family size on child health, and in extreme cases, child death. An insignificant result will indicate family size has no effect on child health.

I include as controls in vector $\mathbf{X}_{cmh}$, characteristics that can affect the resources allocated to a child e.g. the gender of the child, childs' birth order in the family(which due to data limitations is the order of child in family among children aged 0-17 years)and an indicator of

[2] District is the third tier of government administration in Pakistan

short birth spacing[3]; care or time given by caretakers, e.g. mothers age, education, education of the household head; proxies of socio-economic wellbeing, such as household assets; and measures of access to health care and health knowledge (lives in an urban area, mother has ever used contraceptives). My samples exclude children for whom the recorded HAZ and WAZ in MICS are considered by WHO to be outliers. That is, I exclude children for whom the HAZ values lie below -6 or above + 6and WAZ lies below -6 or above + 5 as recommended by the WHO.[4]

3.2. Data:

This study uses data collected in two rounds of MICS data for Punjab, Pakistan, i.e. the 2013-2014 and 2017-18 rounds. In the rest of the paper, I will refer to these as Rounds 1 and 2, respectively. Table 1 provides a summary of relevant sample characteristics from these data sets. The MICS data collects anthropomorphic data on children below the age of 5 years and collects data on their mothers and households. In total, I have data on nearly 26,173 children under 5 years in round 1 and 37,423 children under 5 in 2018. On average the children I have in my sample from these two rounds are 2 years old, 51% are males. The average height-for-age and weight-for-age z scores are approximately -1.4 and -1.3, respectively, indicating general prevalence of stunting and malnourishment. The birth order of children in my sample among with reference to siblings under17 year old children in the family is between 1 and 2. Almost one out of every 10 children in the sample have 'short' birth spacing of an of average of less than 1 year.

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[3] For birth spacing, I follow the method used by Chaudhry, et al. (2019), who include a binary variable for short birth spacing if the average duration between births in a family is less than a year. All results I present in Section 4 are also robust to a slightly different definition of less than two years, as recommended by WHO.

[4] WHO (2006):https://www.who.int/bulletin/volumes/85/6/06-034421/en/

I have data on nearly 42,000 women from the two rounds. On average, women in my sample are 30 years old, have 5 years of education and have given birth to 3 children. 19% of the women report they have experienced death of a child. Approximately 2% report ever having given birth to twins. The household head have, on average, 5 years of education. A third of my sample resides in urban areas. The average household in my sample has approximately 7-8 individuals (children and adult). The MICS also asks if households own certain assets: radio, television, refrigerator, computer, air conditioner and Bicycle. Households in my sample own, on average, 2 out of these 6 assets.

Table 1 – Summary of sample characteristics

Variables	MICS 2013-2014		MICS 2017-2018		Total	
Child characteristics	*No. of obs:*	*Mean:*	*No. of obs:*	*Mean:*	*No. of obs:*	*Mean:*
Weight-for-age z score	26,173	-1.55	37,423	-1.10	63,596	-1.28
Height-for-age z score	26,173	-1.45	37,423	-1.36	63,596	-1.39
Age (years)	26,173	2.01	37,423	1.98	63,596	1.99
Male	26,173	0.51	37,423	0.51	63,596	0.51
If birth spacing < 1 year	25,870	0.09	37,266	0.08	63,136	0.09
Child birth order	26,173	1.40	37,423	1.29	63,596	1.33
Mother Characteristics						
Children ever given birth to	17,502	3.49	24,955	3.31	42,457	3.38
Years of education	17,502	4.42	24,955	4.82	42,457	4.65
Age (years)	17,502	30.30	24,955	30.33	42,457	30.32
Has ever used contraceptives	17,197	0.44	24,520	0.39	41,717	0.42
Has given birth to twins	17,502	.013	24,955	.026	42,457	.020
Has given birth to twin girls	17,502	.004	24,955	.005	42,457	.004
Has given birth to fraternal twins	17,502	.005	24,955	.016	42,457	.011
Child died	17,502	.21	24,955	.17	42,457	.19
Household Characteristics:						
Number of household members	16,126	7.48	22,636	7.56	38,762	7.53
Live in urban area	16,126	.35	22,636	.27	38,762	.30
Number of household assets(0-6)	16,093	1.72	21,610	2.63	37,703	2.24
Head's years of education	16,126	5.17	22,636	5.19	38,762	5.18

Notes: This table provides a summary of data used. Columns 1-2 show average values from MICS 2013-2014, columns 3-4 do the same for MICS 2017-18 and columns 5-6 give a summary of both rounds of data. The sample of children includes all children for whom we have HAZ and WAZ details. We then summarize characteristics of their mothers and the households they belong to. 'Male', 'Has short birth spacing (<=1 year)', 'Child died', 'Has ever used contraceptives', 'Has ever given birth to twins', 'Has ever given birth to twin girls', 'Has ever given birth to fraternal twins', 'Live in urban area' are binary variables equal to 1 if these conditions are true and 0 otherwise. Household asset is a count out of 6 assets household heads are asked if the household owns.

4 Results

I now discuss the results of my estimation. All regressions discussed here include district and year fixed effects, with robust standard errors clustered at the level of the mother. In Table 2, I estimate a fully saturated model with controls for other child, mother and household level characteristics.[5]A twin birth by the mother increases the family size by 0.57 (Table 2, column 1). This effect is significant at the 1% level. In addition, Table 2 shows both the F-statistics from a test of excluded instruments and Montiel Olea and Pflueger (2013) Effective F-stat – the latter allows errors to be correlated and heteroscedastic. Both tests reveal a strong first stage. In columns 2 – 3 of Table 2 and column 2 of Table 3, we see that a larger family size translates to poorer health outcomes for children. Specifically, a larger family size (instrumented by the mother having had given birth to twins) reduces height-for-age scores and weight-for-age scores by 0.29 standard deviations (Table 2). It also increases the likelihood of the mother having experienced the death of a child by 8 percent (Table 3).

These results are in line with findings from similar studies. Teferi (2019) use twin births as an instrument for women's fertility in Ethiopia and finds children from larger families are 0.4 -0.5 standard deviations shorter than children from smaller families. Bayeet al. (2016), also use twin births as an instrument for women's fertility and find that in Cameroon, children of women with higher fertility weigh 0.16 S.D. lower than woman with low fertility.

[5] Table A1 in the appendix provides a similar estimate but of a simple model where I do not control for child, mother or household level characteristics. Results are similar to the results shown in Table 2, although the first shows a stronger relationship between family size and mother having given birth to twin in the first stage (column 1) and small, though statistically significant effects on child height, weight and mortality outcomes. However, my preferred estimation (shown in Table 2) includes controls for other characteristics that may affect child health outcomes, such as mothers' education, birth order or average birth spacing.

The results lend support to the quantity vs. quality argument – an increase in quantity potentially compromises the quality of children. It adversely impacts the health of children, with potentially longer-term impact on human capital development in later life. With constrained resources being shared between more dependents, there may also be related implication on other adults in the household and on decisions about subsequent fertility.

Table2. The impact of family size on child health

Dependent variable:	*First. Stage* *Family size* (1)	*HAZ* (2)	*WAZ* (3)
Twin birth	0.571***		
	(0.053)		
Family size		-0.290***	-0.293***
		(0.085)	(0.070)
Male child	-0.057***	0.006	-0.0001
	(0.015)	(0.014)	(0.012)
Child birth order in family	0.431***	0.146***	0.122***
	(0.009)	(0.039)	(0.032)
Mother education (years)	-0.085***	0.026***	0.015**
	(0.002)	(0.007)	(0.006)
Mother's age (years)	0.175***	0.060***	0.057***
	(0.002)	(0.015)	(0.012)
Household in urban area	0.025	0.029*	-0.001
	(0.017)	(0.016)	(0.014)
Household head education (years)	0.005***	0.024***	0.019***
	(0.002)	(0.002)	(0.001)
Constant	-3.698***	-2.838***	-3.342***
	(0.104)	(0.345)	(0.284)
F-stat on excluded instruments	114.15***		
Montiel Olea and Pflueger (2013) F-stat	114.15**		
No. of obs:	60425	60425	60425
R^2		0.045	0.028

Notes: This table presents results from an IV regression of family size on child health indicators, with mothers fertility instrumented by a dummy variable for if the mother has ever given birth to twins. Column (1) presents the first stage. Columns (2) - (3) present the second stage for height-for-age z scores and weight-for-age zscores respectively, with family size instrumented by twin birth. 'Male child' is a binary variable equal to 1 if the child is a male, 0 otherwise; 'Child birth order in family' is the child's birth rank in the household; 'Mothers age' is as reported in years; years of education of the mother and household head are the full years of education reported; and 'Household in urban area' is a binary variable equal to 1 if the household resides in an urban area. All regressions also include controls for child birth spacing in the family (birth spacing < 1 is a dummy variable for when the birth spacing for the child under consideration is less than 1 year; 0 otherwise (Chaudhry et al. 2019), whether the mother has ever used contraceptives and a count of household assets. All regressions control for district and year fixed effects. All errors are clustered at the mother level and reported in parentheses. *** Significant at 1%, ** Significant at 5%, * Significant at 10%.

Table 3. The impact of family size on child mortality

Dependent variable:	*First. Stage* *Family size* **(1)**	*Child died* **(2)**
Twin birth	0.669***	
	(0.056)	
Family size		0.081***
		(0.020)
Mother education (years)	-0.093***	-0.002
	(0.002)	(0.002)
Mother's age (years)	0.187***	-0.004
	(0.001)	(0.004)
Household in urban area	0.035*	-0.017***
	(0.017)	(0.004)
Household head education (years)	0.007***	-0.003***
	(0.002)	(0.000)
Constant	-2.682***	0.171***
	(0.062)	(0.056)
F-test on excluded instruments	141.82***	
Montiel Olea and Pflueger (2013) F-stat	141.82**	
No. of obs:	40613	40613
R^2:		0.206

Notes: This table presents results from an IV regression of family size on child mortality, with mothers fertility instrumented by a dummy variable for if the mother has ever given birth to twins. Column (1) presents the first stage. Column (2) presents the second stage for child mortality, indicated by a dummy variable for if the mother has ever had a child who later died, respectively. 'Mothers age' is as reported in years; years of education of the mother and household head are the full years of education reported; and 'Household in urban area' is a binary variable equal to 1 if the household resides in an urban area. All regressions also include controls whether the mother has ever used contraceptives and a count of household assets. All regressions control for district and year fixed effects. All errors are clustered at the mother level and reported in parentheses. *** Significant at 1%, ** Significant at 5%, * Significant at 10%.

4.1 Heterogeneity in results

I explore heterogeneity in an attempt to uncover what may be driving these results. First, literature suggests that the results for male and female children may be different. HAZ and WAZ can be worse for girls under age 5 compared to boys due to a combination of social, cultural, and caregiving disparities. In many low- and middle-income countries, gender bias leads to girls receiving less nutritious food, inadequate healthcare, and lower priority in household resources. Additionally, girls may have less access to timely medical care and immunizations, increasing their vulnerability to infections that impair growth. These systemic disadvantages can result in poorer growth outcomes for girls, reflected in lower HAZ and WAZ scores.

Similarly, we may expect children of younger mothers to have worse health outcomes due to increased family size – younger mothers may have less experience at child-rearing and/or greater household responsibilities that do not allow them to provide greater or an equal level of attention to all children. Different considerations may come into play for women who are considering having more children and those who may have completed their fertility. I explore whether results differ for children of mothers who are young and may not have completed their fertility (less than 35 years of age) and those of mothers who may have likely to have completed fertility.

I re-estimate equations 1 and 2 for sub-sample of male and female children, and children of mothers who are younger than 35 years or 35 and older. Results are provided in tables A2 – A4 in the appendix. I find that the effects of family size on HAZ are negative for both male and female children. I see similar results for child mortality. Both male and female children have lower HAZ and WAZ in larger families, the effect is slightly larger in size for girls[6]. I also find evidence that suggests the adverse effect of family size on HAZ and WAZ are driven by children of mothers younger than 35, indicating the role of mother's age, responsibility and fertility considerations on child health. I do not find substantially different, by the mother's age, impact of family size on the likelihood of the mother having experienced the death of a child. This implies that while mothers age may impact the family size that family size may have on the health of a child, it does not lead to substantially worse outcomes i.e. child death. Though not shown here, I find no heterogeneity in effects by the literacy of the mother, with the exception of child mortality, where I find child mortality may be higher among children of illiterate mothers.

4.2 Robustness checks

I carry out a number of checks to test the robustness of these results. First, I test if the effect of having twins on subsequent decisions about having additional children, and hence family size, may be a product of the gender of twins. For instance, having twin girls may mean that the parents may want to have further children in order to have a son. Having twins of opposite-gender may reduce the desire to have further children. Further, it is possible that the gender of the child determines the resources made available to the child, and having twins of the same gender, e.g. girls, may exacerbate such effects. To test if my results may have been driven by such twin-pairs, I include in the first stage, an indicator for whether the twin-pair is of girls. Table 4a provides us the results. Column 1 provides the first stage results and shows that while

[6] Results are obtained from manual 2sls and seemingly unrelated regression (SUEST) estimations in Stata.

having twin children increases the family size, having twins who are girls is less likely to do so. This suggests that parents of twin girls may be less likely to have additional children. The second stage results (columns 2 – 4, Table 4a), remain qualitatively similar to before – larger family size results in 0.2 – 0.3 standard deviation decrease in child HAZ and WAZ, and an approximately 9 percentage point increase in likelihood of child death (Table 4b).

Second, the MICS data only allows us to use record of live twin births. Recent literature has suggested that the ability to carry twins to live birth may be a function of socio-economic factors. Bhalotra& Clarke (2020) suggest one way of controlling for such factors may be to control for mother's health and health knowledge. Data limitation does not allow us to include explicit measures of mothers' health and knowledge but I proxy for such factors by including a control measuring whether the mother has ever used contraceptive. Secondly, live twin births may be function of socio-economic factors. Though we can control for such factors using a host of different variables discussed in Section 3.1, we cannot control for all factors or related unobserved aspects. Farbmacher et al. (2018) contend that while socio-economic factors may impact whether twins are carried to term and successfully delivered, having identical twins – which is an even rarer having twins in the first place – is unrelated to a host of socio-economic factors and just as likely to result in a live birth as birth of non-identical twins (for any given level of socio-economic factors). MICS does not ask if the twins were identical, though it does provide data on the gender of the twins. Since same-gender twins are more likely to be identical than twins of different gender, I use this as a proxy for identical twins and include an indicator of such an event in the first stage. Table 5a provides us the results. Column 1 (Table 5a) shows that while having twins increases the size of the family, the effects do not differ by whether the gender of the twins is the same or different. Second stage results are similar to before and hence robust to the inclusion of this indicator. Results remain qualitatively similar for the child mortality measure (Table 5b).

Finally, I consider the fact that it is possible for each household in the study sample to have more than one mother. In this case, it is possible that the birth of a twin to one mother may affect the fertility decision's of the other mother(s) in the family and/or the health of their children via its affect on the size of the family. I consider the household as an economic unit and construct another IV that is equal to 1 if there is a twin in the household (not just born to one mother) and re-run my main regression. I also cluster all errors at the household level for these estimations. Results are provided in Tables 6a and 6b. I see the results of this estimation and qualitatively and quantitatively similar – an increase in family size by unit is associated with a 0.29 SD decrease in height and a 0.29 SD decrease in weight of children under 5 in sample households; and an increase in the likelihood of child death of 8.1 percentage points.

Table 4a. Robustness checks: Including the gender of twins in instrumental variable.

Dependent variable:	*First. Stage* *Family size* (1)	*HAZ* (2)	*WAZ* (3)
Twin birth	0.627***	-0.258***	-0.268***
	(0.061)	(0.081)	(0.07)
Twins are girls	-0.243*		
	(0.117)		
Mother's age (years)	0.175***	0.055***	0.052***
	(0.002)	(0.014)	(0.013)
Male child	-0.056**	-0.008*	-0.001
	(0.015)	(0.014)	(0.012)
Mother education (years)	-0.085***	0.028***	0.017***
	(0.002)	(0.007)	(0.006)
Child birth order in family	0.431***	0.132***	0.111***
	(0.009)	(0.037)	(0.030)
Household in urban area	0.026	0.028*	-0.001
	(0.017)	(0.016)	(0.014)
Household head education (years)	0.005***	0.024***	0.019***
	(0.002)	(0.002)	(0.001)
Constant	-3.697***	-2.721***	-3.248***
	(0.104)	(0.329)	(0.272)
F-test on excluded instruments	58.57***		
Montiel Olea and Pflueger (2013) F-stat	58.57**		
No. of obs:	60425	60425	60425
R^2		0.058	0.044

Notes: This table presents results from an IV regression of family size on child health indicators, with mothers fertility instrumented by a dummy variable for if the mother has ever given birth to twins and if the twins were both girls. Column (1) presents the first stage. Columns (2) - (3) present the second stage for height-for-age z scores and weight-for-age zscores, respectively, with family size instrumented by twin birth. 'Male child' is a binary variable equal to 1 if the child is a male, 0 otherwise; 'Child birth order in family' is the child's birth rank in the household; 'Mothers age' is as reported in years; years of education of the mother and household head are the full years of education reported; and 'Household in urban area' is a binary variable equal to 1 if the household resides in an urban area. All regressions also include controls for birth spacing in the family (birth spacing < 1 is a dummy variable for when the birth spacing is less than 1 year; 0 otherwise (Chaudhry et al. 2019)., whether the mother has ever used contraceptives and a count of household assets. All regressions control for district and year fixed effects. All errors are clustered at the mother level and reported in parentheses. *** Significant at 1%, ** Significant at 5%, * Significant at 10%.

Table 4b. Robustness checks: Including the gender of twins in instrumental variable.

Dependent variable:	*First. Stage* *Family size* **(1)**	*Child died* **(2)**
Twin birth	0.708***	0.0864***
	(0.064)	(0.020)
Twins are girls	-0.183	
	(0.127)	
Mother's age (years)	0.187***	-0.005
	(0.001)	(0.004)
Mother education (years)	-0.092***	-0.002
	(0.002)	(0.002)
Household in urban area	0.035**	-0.017***
	(0.017)	(0.004)
Household head education (years)	0.007***	-0.003***
	(0.002)	(0.000)
Constant	-2.681***	0.185***
	(0.062)	(0.056)
F-test on excluded instruments	71.20***	
Montiel Olea and Pflueger (2013)F-stat	75.91**	
No. of obs:	40613	40613
R-sq:		0.208

Notes: This table presents results from an IV regression of family size on child mortality, with mothers fertility instrumented by a dummy variable for if the mother has ever given birth to twins and if the twins were both girls. Column (1) presents the first stage. Columns (2) presents the second stage for a dummy variable, if the mother has ever had a child who later died. 'Mothers age' is as reported in years; years of education of the mother and household head are the full years of education reported; and 'Household in urban area' is a binary variable equal to 1 if the household resides in an urban area. All regressions also include controls for, whether the mother has ever used contraceptives and a count of household assets. All regressions control for district and year fixed effects. All errors are clustered at the mother level and reported in parentheses. *** Significant at 1%, ** Significant at 5%, * Significant at 10%.

Table 5a. Robustness checks: Including the different gender of twins in instrumental variable.

Dependent variable:	First. Stage Family size (1)	HAZ (2)	WAZ (3)
Twin birth	0.512***	-0.279***	-0.281***
	(0.075)	(0.084)	(0.069)
Twins are of opposite gender	0.112		
	(0.101)		
Mother's age (years)	0.175***	0.058***	0.055***
	(0.002)	(0.015)	(0.012)
Male child	-0.058**	0.007	0.001
	(0.015)	(0.014)	(0.012)
Mother education (years)	-0.085***	0.027***	0.016***
	(0.002)	(0.008)	(0.006)
Child birth order in family	0.431***	0.141***	0.117***
	(0.009)	(0.038)	(0.032)
Household in urban area	0.025	0.028*	-0.001
	(0.017)	(0.016)	(0.014)
Household head education (years)	0.005***	0.024***	0.019***
	(0.002)	(0.002)	(0.001)
Constant	-3.698***	-2.797***	-3.297***
	(0.104)	(0.339)	(0.279)
F-test on excluded instruments	57.37***		
Montiel Olea and Pflueger (2013) F-stat	59.86**		
No. of obs:	60425	60425	60425
R^2		0.050	0.036

Notes: This table presents results from an IV regression of family size on child health indicators, with mothers fertility instrumented by a dummy variable for if the mother has ever given birth to twins and if the twins were of different gender. Column (1) presents the first stage. Columns (2) - (3) present the second stage for height-for-age z scores and weight-for-age zscores respectively, with family size instrumented by twin birth. 'Male child' is a binary variable equal to 1 if the child is a male, 0 otherwise; 'Child birth order in family' is the child's birth rank in the household; 'Mothers age' is as reported in years; years of education of the mother and household head are the full years of education reported; and 'Household in urban area' is a binary variable equal to 1 if the household resides in an urban area. All regressions also include controls for birth spacing in the family (birth spacing < 1 is a dummy variable for when the birth spacing is less than 1 year; 0 otherwise (Chaudhry et al. 2019)., whether the mother has ever used contraceptives and a count of household assets. All regressions control for district and year fixed effects. All errors are clustered at the mother level and reported in parentheses. *** Significant at 1%, ** Significant at 5%, * Significant at 1%.

Table 5b. Robustness checks: Including the different gender of twins in instrumental variable.

Dependent variable:	*First. Stage* *Family size* (1)	*Child died* (2)
Twin birth	0.642***	0.084***
	(0.081)	(0.020)
Twins are of opposite gender	0.047	
	(0.111)	
Mother's age (years)	0.187***	-0.005
	(0.001)	(0.004)
Mother education (years)	-0.092***	-0.002
	(0.002)	(0.002)
Household in urban area	0.035**	-0.017***
	(0.017)	(0.004)
Household head education (years)	0.007***	-0.003***
	(0.002)	(0.000)
Constant	-2.682***	0.180***
	(0.062)	(0.056)
F-test on excluded instruments	71.14***	
Montiel Olea and Pflueger (2013) F-stat	71.78**	
No. of obs:	40613	40613
R-sq:		0.207

Notes: This table presents results from an IV regression of family size on child mortality, withmothers fertility instrumented by a dummy variable for if the mother has ever given birth to twins and if the twins were of different gender. Column (1) presents the first stage. Columns (2) presents the second stage for a dummy variable, if the mother has ever had a child who later died. 'Mothers age' is as reported in years; years of education of the mother and household head are the full years of education reported; and 'Household in urban area' is a binary variable equal to 1 if the household resides in an urban area. All regressions also include controls forwhether the mother has ever used contraceptives and a count of household assets. All regressions control for district and year fixed effects. All errors are clustered at the mother level and reported in parentheses. *** Significant at 1%, ** Significant at 5%, * Significant at 1%.

In addition to the non-randomness of live birth, another concern stems from evidence from medical literature that twins are born with inferior height and weight at birth (Rosenzweig & Zhang 2009). These differences could lead us to overestimate the apparent negative effects of twin birth on child health. It is also possible that the health of twins impacts parents' decision to have more children and the decision on how many resources (including time and attention) to allocate across their children. Rosenzweig & Zhang (2009) suggest a bounding procedure to determine likely range of effects. Such an estimation is beyond the scope of this thesis and is an avenue of future research. However, it is worth mentioning that given only 2% of my sample have ever given birth to twins, it may be unlikely that the results are driven largely by children who are twins. I also find no evidence that suggests that the current HAZ and WAZ of children in twin and non-twin families in my sample are statistically different (p =0.42 and p = 0.46 respectively).[7] Finally, other studies, notably Angrist et al. (2010) using data from multiple quasi-experimental techniques, find no evidence that such concerns invalidate the instrumental variable exclusion restriction.

I run another regression to see the effect of birth order on family size. The results presented in appendix in table A.5 indicate a clear negative relationship between birth order and child health, particularly in larger families. While second-born children generally do not experience significant health disadvantages across all family sizes, the third-born child in all families shows a statistically significant decline in health, with a HAZ coefficient of -0.029 (p<0.01). In three-child families, this negative effect is even more pronounced, with HAZ and WAZ scores declining by -0.054 (p<0.01) and -0.038 (p<0.05), respectively. The most striking result is observed for

[7] Average HAZ of children in twin vs non-twin families=-1.42and -1.39, respectively; p-value of difference = 0.42. Average WAZ of children in twin vs non-twin families = -1.26 and -1.28, respectively; p-value of difference = 0.46

fifth-born children across all families, who exhibit a substantial and highly significant reduction in both height-for-age (-0.526, $p<0.01$) and weight-for-age (-0.360, $p<0.01$) scores.

Table 6a. The impact of family size on child health

Dependent variable:	*First. Stage* *Family size* (1)	*HAZ* (2)	*WAZ* (3)
Twin birth	0.572***		
	(0.057)		
Family size		-0.290***	-0.293***
		(0.089)	(0.072)
Male child	-0.058***	0.006	-0.000
	(0.015)	(0.014)	(0.012)
Child birth order in family	0.431***	0.146***	0.122***
	(0.009)	(0.040)	(0.033)
Mother education (years)	-0.085***	0.026***	0.015**
	(0.002)	(0.008)	(0.006)
Mother's age (years)	0.175***	0.060***	0.057***
	(0.002)	(0.088)	(0.072)
Household in urban area	0.025	0.286*	-0.001
	(0.017)	(0.016)	(0.014)
Household head education (years)	0.005**	0.024***	0.019***
	(0.002)	(0.002)	(0.001)
Constant	-3.699***	-2.838***	-3.342***
	(0.107)	(0.354)	(0.288)
F-test on excluded instruments	101.58***		
Montiel Olea and Pflueger (2013) F-stat	101.58**		
No. of obs:	60425	60425	60425
R^2		0.045	0.028

Notes: This table presents results from an IV regression of family size on child health indicators, with family's fertility instrumented by a dummy variable for if any mother(s)has ever given birth to twins. Column (1) presents the first stage. Columns (2) - (3) present the second stage for height-for-age z scores and weight-for-age zscores respectively, with family size instrumented by twin birth. 'Male child' is a binary variable equal to 1 if the child is a male, 0 otherwise; 'Child birth order in family' is the child's birth rank in the household; 'Mothers age' is as reported in years; years of education of the mother and household head are the full years of education reported; and 'Household in urban area' is a binary variable equal to 1 if the household resides in an urban area. All regressions also include controls for child birth spacing in the family (birth spacing < 1 is a dummy variable for when the birth spacing for the child under consideration is less than 1 year; 0 otherwise (Chaudhry et al. 2019), whether the mother has ever used contraceptives and a count of household assets. All regressions control for district and year fixed effects. All errors are clustered at the household level and reported in parentheses. *** Significant at 1%, ** Significant at 5%, * Significant at 10%.

Table 6b. The impact of family size on child mortality

Dependent variable:	*First. Stage* *Family size* **(1)**	*Child died* **(2)**
Twin birth	0.669***	
	(0.061)	
Family size		0.081***
		(0.020)
Mother education (years)	-0.092***	-0.003
	(0.002)	(0.002)
Mother's age (years)	0.187***	-0.004
	(0.001)	(0.004)
Household in urban area	0.035**	-0.017***
	(0.017)	(0.004)
Household head education (years)	0.007***	-0.003***
	(0.002)	(0.000)
Constant	-2.682***	0.171***
	(0.065)	(0.057)
F-test on excluded instruments	121.01***	
Montiel Olea and Pflueger (2013) F-stat	121.01**	
No. of obs:	40613	40613
R^2:		0.206

Notes: This table presents results from an IV regression of family size on child mortality, with family's fertility instrumented by a dummy variable for if any mother(s) in the family has ever given birth to twins. Column (1) presents the first stage. Column (2) presents the second stage for child mortality, indicated by a dummy variable for if the mother has ever had a child who later died, respectively. 'Mothers age' is as reported in years; years of education of the mother and household head are the full years of education reported; and 'Household in urban area' is a binary variable equal to 1 if the household resides in an urban area. All regressions also include controls whether the mother has ever used contraceptives and a count of household assets. All regressions control for district and year fixed effects. All errors are clustered at the household level and reported in parentheses. *** Significant at 1%, ** Significant at 5%, * Significant at 10%.

5. Conclusion:

This study investigates the causal impact of larger family sizes on early childhood health outcomes. I explore the impact on height- and weigh-for-age scores, and the incidence of child mortality using data on approximately 60,000 children surveyed in the 2014 and 2018 rounds of MICS for Punjab, Pakistan. I use the incidence of twin birth as an IV for family size and find significant negative effects of larger families on child health – an increase in family size of one unit reduces HAZ and WAZ by nearly a third of a standard deviation and increases child mortality by 8-9 percentage points. Sub-sample analysis reveals that the family size may be an important factor in determining early childhood health of boys and girls. Mother's age also matters – health of children of older mothers, with fertility nearly completed is not impacted by the number of siblings or family size.

The data does not allow us to explore longer term outcomes of children, e.g. whether family size also affects later life academic outcomes of the children. I also acknowledge that it is possible that the results may be biased if the early-life health of twin-pairs effects caretaker time and resource investment in the children. A bounding technique to explore potential range of effects as proposed by Rosenzweig & Zhang (2009) is beyond the scope of this study. However, both limitations present areas of future study. However, the results highlight the role that family size can have on child outcomes and can provide valuable insights for using family planning and other social policies to improve child welfare.

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Appendix:

Table A.1AThe impact of family size on child health

Dependent variable:	*First. Stage Family size* (1)	*HAZ* (2)	*WAZ* (3)
Twin birth	0.841***		
	(0.069)		
Family size		-0.113*	-0.120**
		(0.059)	(0.047)
Constant	3.362***	-0.955***	-1.172***
	(0.061)	(0.208)	(0.167)
F-test on excluded instruments	149.28***		
Montiel Olea and Pflueger (2013) F-stat	149.28**		
No. of obs	63596	63596	63596
R^2		0.038	0.05

Notes: This table presents results from an IV regression of family size on child health indicators, withmothers fertility instrumented by a dummy variable for if the mother has ever given birth to twins. Column (1) presents the first stage. Columns (2) - (3) present the second stage for height-for-age z scores and weight-for-age zscores, respectively. All regressions control for district and year fixed effects. All errors are clustered at the mother level and reported in parentheses. *** Significant at 1%, ** Significant at 5%, * Significant at 10%.

Table A.1B. The impact of family size on child health

Dependent variable:	*First. Stage* *Family size* **(1)**	*Child died* **(2)**
Twin birth	0.857***	
	(0.071)	
Family size		0.054***
		(0.016)
Constant	3.250***	0.008
	(0.059)	(0.052)
F-test on excluded instruments	146.51***	
Montiel Olea and Pflueger (2013) F-stat	146.51**	
No. of obs:	42457	42457
R-sq:		0.170

Notes: This table presents results from an IV regression of family size on child mortality, with mothers fertility instrumented by a dummy variable for if the mother has ever given birth to twins. Column (1) presents the first stage. Columns (2) presents the second stage for a dummy variable, if the mother has ever had a child who later died, respectively. All regressions control for district and year fixed effects. All errors are clustered at the mother level and reported in parentheses. *** Significant at 1%, ** Significant at 5%, * Significant at 10%.

Table A.2 Sub-sample analysis: the impact of family size on child Height-for-age z-scores

Subsample:	*Male child*	*Female child*	*Mother is 35+ (years)*	*Mother is < 35 (years)*
	(1)	(2)	(3)	(4)
Family Size	-0.240**	- 0.318***	0.0998	-0.334***
	(0.122)	(0.119)	(0.221)	(0.083)
Mother's age (years)	0.053**	0.063***		
	(0.021)	(0.021)		
Male child			0.078**	-0.007**
			(0.032)	(0.016)
Mother years of education	0.030***	0.023**	0.063*	0.025***
	(0.011)	(0.011)	(0.033)	(0.007)
Child birth order in family	0.115**	0.166***	-0.044	0.84***
	(0.056)	(0.053)	(0.072)	(0.041)
Household in urban area	0.014	0.044*	0.042	0.033*
	(0.022)	(0.023)	(0.036)	(0.019)
Household head education (years)	0.025***	0.023***	0.024***	0.029***
	(0.002)	(0.002)	(0.004)	(0.002)
Constant	-2.787***	-2.793***	-1.561**	-1.488***
	(0.488)	(0.491)	(0.697)	(0.149)
No. of obs	30544	29881	13558	46867
R^2	0.058	0.042	0.073	0.018

Notes: This table presents results from an IV regression of family size on child health indicator (Height for age zscores) with mothers fertility instrumented by a dummy variable for if the mother has ever given birth to twins. F-stat on excluded instruments from the first stage is 47.39, 69.93, 11.96 and 148.30 for columns 1-4 respectively and are significant at the 1% level. Montiel Olea and Pflueger (2013) F-stat is 47.39, 69.93, 11.96 and 148.30 for columns 1-4 respectively and are significant at the 5% level. Columns (1) and (2) presents the second stage results for sub-sample of male and female children, respectively. Columns (3) - (4) present the second stage results for a sub-sample of children whose mothers are 35 years or older, and younger than 35 years, respectively, with family size instrumented by twin birth. 'Male child' is a binary variable equal to 1 if the child is a male, 0 otherwise; 'Child birth order in family' is the child's birth rank in the household; 'Mothers age' is as reported in years; years of education of the mother and household head are the full years of education reported; and 'Household in urban area' is a binary variable equal to 1 if the household resides in an urban area. All regressions also include controls for birth spacing in the family (birth spacing < 1 is a dummy variable for when the birth spacing is less than 1 year; 0 otherwise (Chaudhry et al. 2019)., whether the mother has ever used contraceptives and a count of household assets. All regressions control for district and year fixed effects. All errors are clustered at the mother level and reported in parentheses. *** Significant at 1%, ** Significant at 5%, * Significant at 10%.

Table A.3 Sub-sample analysis: the impact of family size on child Weight-for-age z-scores

Subsample:	*Male child*	*Female child*	*Mother is 35+ (years)*	*Mother is < 35 (years)*
	(1)	**(2)**	**(3)**	**(4)**
Family Size	-0.197*	-0.371***	-0.063	-0.299***
	(0.102)	(0.096)	(0.152)	(0.070)
Mother's age (years)	0.040**	0.071***		
	(0.018)	(0.017)		
Male child			0.028	-0.003
			(0.025)	(0.013)
Mother years of education	0.023***	0.001	0.026	0.018***
	(0.009)	(0.009)	(0.023)	(0.006)
Child birth order in family	0.071	0.165***	-0.028	0.145***
	(0.047)	(0.043)	(0.050)	(0.034)
Household in urban area	-0.010	-0.010	0.039	-0.005
	(0.019)	(0.019)	(0.028)	(0.016)
Household head education (years)	0.020***	0.018***	0.017***	0.024***
	(0.002)	(0.002)	(0.003)	(0.002)
Constant	-3.140***	-3.467***	-1.859***	-2.005***
	(0.407)	(0.397)	(0.480)	(0.121)
No. of obs	30544	29881	13558	46867
R^2	0.079	-0.026	0.120	0.020

Notes: This table presents results from an IV regression of family size on child health indicator (weight for age zscores), with mothers fertility instrumented by a dummy variable for if the mother has ever given birth to twins. F-stat on excluded instruments from the first stage is 47.39, 69.93, 11.95 and 148.30 for columns 1-4 respectively and are significant at the 1% level. Montiel Olea and Pflueger (2013) F-stat is 47.39, 69.93, 11.95 and 148.30 for columns 1-4 respectively and are significant at the 5% level. Columns (1) and (2) presents the second stage results for sub-sample of male and female children, respectively. Columns (3) - (4) present the second stage results for a sub-sample of children whose mothers are 35 years or older, and younger than 35 years, respectively, with family size instrumented by twin birth. 'Male child' is a binary variable equal to 1 if the child is a male, 0 otherwise; 'Child birth order in family' is the child's birth rank in the household; 'Mothers age' is as reported in years; years of education of the mother and household head are the full years of education reported; and 'Household in urban area' is a binary variable equal to 1 if the household resides in an urban area. All regressions also include controls for birth spacing in the family(birth spacing < 1 is a dummy variable for when the birth spacing is less than 1 year; 0 otherwise (Chaudhry et al. 2019)., whether the mother has ever used contraceptives and a count of household assets. All regressions control for district and year fixed effects. All errors are clustered at the mother level and reported in parentheses. *** Significant at 1%, ** Significant at 5%, * Significant at 10%.

Table A4 Sub-sample analysis: the impact of family size on child mortality

Subsample:	*Male child*	*Female child*	*Mother is 35+ (years)*	*Mother is < 35 (years)*
	(1)	(2)	(3)	(4)
Family size	0.104***	0.060**	0.097*	0.079***
	(0.029)	(0.027)	(0.056)	(0.019)
Mother's age (years)	-0.009	0.000		
	(0.006)	(0.005)		
Mother years of education	-0.001	-0.005*	-0.001	-0.002
	(0.003)	(0.003)	(0.008)	(0.002)
Household in urban area	-0.019**	-0.013***	-0.032***	-0.013***
	(0.006)	(0.006)	(0.010)	(0.005)
Household head education (years)	-0.003***	-0.003***	-0.0326*	-0.004***
	(0.001)	(0.001)	(0.009)	(0.001)
Constant	0.249***	0.099	0.057	0.034
	(0.082)	(0.076)	(0.218)	(0.050)
No. of obs	20792	19821	10211	30402
R^2	0.205	0.194	0.217	0.172

Notes: This table presents results from an IV regression of family size on child mortality, with mothers fertility instrumented by a dummy variable for if the mother has ever given birth to twins. F-stat on excluded instruments from the first stage is 60.95, 82.57, 12.93 and 140.97 for columns 1-4 respectively and are significant at the 1% level. Montiel Olea and Pflueger (2013) F-stat is 60.95, 82.57, 12.93 and 140.97 for columns 1-4 respectively and are significant at the 5% level. Columns (1) and (2) presents the second stage results for sub-sample of male and female children, respectively. Columns (3) - (4) present the second stage results for a sub-sample of children whose mothers are 35 years or older, and younger than 35 years, respectively, with family size instrumented by twin birth. 'Mothers age' is as reported in years; years of education of the mother and household head are the full years of education reported; and 'Household in urban area' is a binary variable equal to 1 if the household resides in an urban area. All regressions also include controls for whether the mother has ever used contraceptives and a count of household assets. All regressions control for district and year fixed effects. All errors are clustered at the mother level and reported in parentheses. *** Significant at 1%, ** Significant at 5%, * Significant at 1%.

Table A.5 -Effect of Birth Order on Child's Health: Estimated by Family Size

	All families		Two child family		Three child family		Four child family		Five child family	
	HAZ	WAZ	HAZ	WAZ	HAZ	WAZ	HAZ	WAZ	HAZ	WAZ
Second child	-0.002	-0.003	-0.109	-0.159	0.017*	0.021***	-0.005	-0.005	-0.005	-0.005
	(0.004)	(0.004)	(0.121)	(0.119)	(0.008)	(0.008)	(0.009)	(0.00900)	(0.013)	(0.012)
Third child	-0.029***	-0.0145			-0.054***	-0.038**	-0.025	-0.008	-0.017	-0.004
	(0.009)	(0.009)			(0.016)	(0.016)	(0.018)	(0.017)	(0.025)	(0.024)
Fourth child	-0.006	0.0506					-0.005	0.116	-0.034	0.0245
	(0.042)	(0.040)					(0.074)	(0.077)	(0.076)	(0.070)
Fifth child	-0.526***	-0.360***								
	(0.020)	(0.021)								
No. of obs:	60,425		13,767		13,561		10,456		6,251	

Notes: All regressions also include controls for mothers age, mothers' education, household education and whether the mother has ever used contraceptives and a count of household assets. All regressions control for district and year fixed effects. All errors are clustered at the mother level and reported in parentheses