

## Family Size and Nutritional Outcomes in Children: Lessons from Pakistan

FILZA AYAZ

Deteriorating child health impacts socioeconomic outcomes and is a critical concern. This study explores how the child nutrition is affected by the family size in Pakistan, utilising data of 4031 individuals from the Demographic Health Survey of Pakistan 2017-18. The indicators like height for age S score, weight for height S score, and weight for age S score are used to estimate child nutrition. To address endogeneity, instrumental variable approach is employed, and the family size is instrumented by gender of the first child (girl). The results show that if there is an increase in the family size the HAS score lowers by 0.19 SD and the probability of stunting increases by 4.2 percent while no significant impact is observed on WHS and WAS. However, if family size increases, it is also associated with a 3.1 percent increase in the child's likelihood of being underweight. Hence, an increase in family size will have a long-term detrimental effect on children's nutritional status.

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*Keywords:* Family Size, Child Nutrition, Stunting, Wasting, Instrumental Variable.

### 1. INTRODUCTION

A child's health, particularly in the early years, is fundamental to leading a prosperous life. Healthy children can learn, grow, and contribute positively to society and the nation, while unhealthy children are more susceptible to diseases and health issues, leading to poorer educational and occupational outcomes (Case, 2005; Currie, 2009; Grunewald, 2010; Villadsen, et al. 2023). Despite extensive literature on child health, further research is necessary, especially given the high rates of stunting, being underweight and wasting in Pakistan. The PDHS survey 2017-18 reveals that in Pakistan 38 percent children are stunted and around 17 percent are severely stunted. The stunting rate is even higher (48 percent) for children aged 24-35 months. Similarly, 15 percent of children aged one year or below and 23 percent of children five years or below are wasted, with 8 percent severely wasted. Alarming, 57 percent of newborns are stunted at birth, and 41 percent are underweight. Additionally, 20 percent of children are both stunted and wasted, whereas 21 percent of children who have large sizes at birth are underweight, and 35 percent of them are stunted. The National Nutrition Survey NNS (2019) further underscores the severity of the situation, showing that 17.7 percent of children below 5

years of age are wasted and 11.8 percent of adolescent girls and 21.1 percent of adolescent boys are underweight. These statistics highlight the urgent need to examine the determinants of child health in Pakistan to address this critical issue.

The impact of an individual's health on their future is well-documented. Previous research has extensively explored the various determinants of child health outcomes and their effects on later life (Sewdie & Abebaw, 2013; Mahgoub, et al. 2005; Koivusilta, et al. 2024). Among these determinants, family size is considered a key factor (Lundborg, et al. 2013). Children in large families often receive less attention, care, time, and financial support from their parents, leading to physical and mental health issues. The quality-quantity model (Becker & Lewis, 1973) posits that as family size increases, the costs of investing in children's health rise, having an adverse effect on children's health outcomes (Mogstad & Wiswall, 2016).

In the existing literature there are various concepts and theories explaining the effect of large families on investment in children and their health outcomes, for instance, the dilution effect, the hygiene hypothesis and some biological arguments (Lundborg, et al. 2015). According to dilution effect, in larger families, the cost of investment and care increases, leading to unequal resource distribution (Keyser & Rossem, 2017; Lwisa, et al. 2023), often favouring the first child (Horton, 1988; Luo, et al. 2022). This hypothesis implies a tradeoff between the quality and the quantity of the children; this concept is same as the Becker's quality-quantity model (Becker & Tones, 1976).

The hygiene effect asserts that as the number of siblings increase, the risk of health issues like infectious diseases also rises. Biological arguments support this view, suggesting that as mothers age and have more children, their health deteriorates, resulting in less healthy offspring (Khalil, et al. 2013). This is particularly relevant in Pakistan, where the average household size is 6.4 persons (Aheron, et al. 2022).

However, some researchers have different perspectives. Bamba, et al. (2010). Mogstad & Wiswall (2016); Spencer (2003), and Wang (2014) highlight the ambiguity in the concept of how child health is affected by the family size. Similarly, Bras, et al. (2010) and Nicoletti & Tonei (2017) also argue that assuming a fixed resource supply is incorrect, as resources can change due to subsidies, career progress, or government support, positively impacting child health. Nevertheless, this aspect cannot be tested in this study due to insufficient data.

This study aims to analyse how family size influences child nutritional outcomes in Pakistan, examining both the short-term and long-term effects. Although there is extensive literature on child health in Pakistan, none has specifically explored family size as a determinant of health outcomes. Most studies focus on socio-economic and demographic indicators, such as parents' education and employment (Arif, et al. 2012; Bhuiya, et al. 1987; Shahidi, et al. 2025), healthcare access, and household factors like household type, water source, and type of sanitation (Shehzad, 2006; Iram & Butt, 2006; Anwar, et al. 2015 and Arif & Arif, 2012). In a study, Monfardini & See (2012) and Collin (2013) examined how the birth order of a child affects their health due to unequal resource distribution in the household, but still there is limited literature on the association of family size and child health. This paper offers two significant contributions to existing literature. First, this study uniquely investigates the impact of family size on child nutrition in Pakistan, emphasising two major challenges prevalent in the country: large family sizes and widespread nutritional deficiencies among children. Though gender of the first child is used as an instrument in other studies however, its use in this kind of analysis in context of Pakistan is an important contribution. Second, this study utilises the most recent and nationally representative PDHS 2017–18 data. It not only examines the

HAS, WHS, and WAS scores but also investigates how family size influences the likelihood of stunting, wasting, and underweight among children under the age of 5 years. Moreover, it includes some unique control variables like childhood diarrhea and access to water and sanitation, which have been rarely used in previous studies, further augmenting the contribution of this paper.

Since, the existing studies often do not account for the heterogeneity within households which may contribute to nutritional deficiencies, this study addresses these gaps by providing empirical evidence of how the child's nutritional status is affected by family size, thereby informing efficient policymaking. Additionally, this research also offers valuable insights for addressing the determinants of poor child health and issues related to increased family size through the implementation of family planning measures and the improvement of existing policies.

In the light of the existing gaps in literature, this paper analyses the causal impact of family size on child nutritional outcomes in Pakistan using recent, nationally representative data from the PDHS 2017-18 and applying an instrumental variable approach. To address the issue of endogeneity the gender of the first child is used as an instrument for family size. The estimation results show that if family size increases it has an adverse effect on children's long-term nutritional outcome i.e., lower HAS score (increase in stunting). It is also associated with a lower WAS score (increase in underweight).

The paper is organised in the following sections: Section 2 is the discussion on the previous literature. Section 3 provides information on the data used and the variables estimated in the analysis. Following this, Section 4 discusses the identification strategy. Section 5 consists of the results while Section 6 concludes the study.

## 2. PRIOR EVIDENCE

Child health is critically important, as it has serious implications not only for a child's development but also for their future outcomes in adulthood. A study by Campisi, et al. (2017) highlighted that there is a high prevalence of stunting across the world with around 156 million children being stunted and belonging to low and middle-income countries. Another study by Ssentongo, et al. (2021) also analysed the prevalence of child nutritional deficiencies in low- and middle-income countries showing that there was 29.1 percent, 6.3 percent and 13.7 percent prevalence of stunting, wasting, and underweight respectively. Additionally, South Asia, Western Africa, and Southeast Asia had the highest prevalence of undernutrition. Supporting the above study, statistics reported in a recent report by UNICEF, WHO, and World Bank Group (2025) indicate that in 2024, approximately 150.2 million children were stunted and 42.8 million were wasted, with around 51 percent of the stunted children residing in Asia.

Hence, there have been numerous studies analysing children's nutritional outcomes however, there is very limited research on how child health varies by the family size in Pakistan. However, the existing research highlights key themes that shed light on this relationship. For instance, the quantity-quality model suggests that larger family sizes strain resources, negatively impacting child health. Kucera & McIntosh (1991) applied the dilution model, showing that as family size increases, available resources like time, money, and energy per child decrease, constraining both physical and social development. Similarly, Baes (2008) in Colombia found that children from larger families had less access to education and essential services like clean water and sanitation, leading to poorer health outcomes.

Several studies highlight how socioeconomic and environmental factors interplay with family size and how it affects the child's health. In a study, Islam, et al. (2003) identified mother's education, income, and breastfeeding duration as significant factors for child nutrition in Bangladesh, alongside family size. Iram & Butt (2006) in Pakistan also noted that household size and childcare practices significantly influence child nutritional status. Okeyo & Kirabira (2016) in Kenya emphasised the compounded effect of large family size and poor living conditions on malnutrition and health outcomes.

Research also points to birth order as a critical factor in the association of child nutrition and family size. Studies by Monfardini and See (2012) and Collin (2013) indicate that higher birth order children receive fewer resources, impacting their health negatively. Hatton & Martin (2008) in Britain found that larger family sizes and higher birth orders negatively affected children's heights, illustrating an inverse relation between the family size and child health outcomes.

In some papers quasi-experimental methods also have been used for the estimation of the relationship between child health and family size. The use of instrumental variable approaches to study family size and child health has provided robust evidence for the negative impacts of larger family sizes. Delpiano (2005) used multiple births to instrument family size, showing that as family size increases there is a reallocation of resources away from each child, consistent with the quantity-quality model. Angrist, et al. (2010) also used instruments of multiple births and same-sex siblings to analyse the data for Israel. The study identified that larger family sizes lead to declines in child health indicators such as stunting, wasting, and underweight.

Despite the prevailing evidence, some studies challenge the notion of a negative effect of family size on the nutritional outcomes of the children. Dasgupta & Solomon (2018) found no substantial evidence to confirm the validity of the quantity-quality model for child health, suggesting that other factors might mediate this relationship. Similarly, Mmopelwa (2019) in Botswana showed that while larger family sizes generally have adverse effects, the impact can vary significantly across different contexts and household dynamics.

In conclusion, while most of the literature supports the idea that larger family sizes negatively impact child health due to strained resources and socio-economic factors, there are nuanced views and debates that suggest the need for context-specific studies. The instrumental variable approach remains a key method for unraveling these complex relationships, particularly in developing countries like Pakistan.

### 3. THEORETICAL FRAMEWORK

Children's nutritional outcomes are measured by stunting (HAS score), wasting (WHS score) and underweight (WAS score). Prior research shows that an increase in family size, due to the birth of additional children, leads to the dilution of household resources among all members. Therefore, an increase in the family size reduces the number of resources available per child, adversely affecting the child's nutritional outcomes. This effect is primarily supported by 'Becker's Quantity and Quality Trade-off Model' (Becker, 1960) and the Resource Dilution Hypothesis (Blake, 1981) which suggest that larger family sizes decrease the resources allocated to each child leading to poor health outcomes.

The gender of the first child influences the family size, as parents who have a daughter may continue having children in pursuit of a son or desired number of sons, often leading to larger families and this is especially common in Asian countries including Pakistan. Hence, it is important to use it as an instrument for this analysis. Similarly, it is

important to include parent's characteristics as controls in the model as they may significantly affect the child's nutritional status. If a child has well-educated parents they may be more aware about the child health issues and needs resulting in better outcomes. Similarly, educated mothers play a significant role in their children's development. Moreover, educated parents are more likely to have better jobs and a stable source of resources for their children, increasing investment in their health outcomes (Lindeboom, et al. 2009). In addition to these factors, parents' age is also important as births in older age are associated with birth defects and low weight at birth (Chung, et al. 2022). It is also observed that if the parents are married, they invest more in children's development and provide them with a better standard of living compared to divorced, separated or widowed parents. Some studies also show that children from single mother households have more chances of being stunted and underweight as compared to children belonging to single father households (Laksono, et al. 2025).

Literature also shows that if a child frequently has diarrhea it may result in stunting (Arief & Nurafifah, 2025). Similarly, access to clean water and sanitation are also important factors affecting child health. If the families do not have access to clean drinking water and improved sanitation facilities the children face health issues and diseases resulting in nutritional deficiencies (World Health Organisation, 2009). Additionally, the location of the household may influence a child's nutritional status, as those living in urban areas often have better access to facilities and healthcare services, positively affecting child nutrition (Ayele & Tadesse, 2025). Similarly, parents in wealthier families invest more in their children, which contributes to better health outcomes.

#### 4. DATA AND VARIABLES

This study utilises data of the Demographic Health Survey of Pakistan from 2017-18, which is conducted by the National Institute of Population Studies (NIPS). This fourth round of the survey provides national data, also consisting of an urban-rural breakdown.

The survey includes data from all the provinces, Punjab, Balochistan, Sindh and Khyber Pakhtunkhwa) as well as regions like Gilgit, Kashmir, the Capital Islamabad (ICT) and FATA.

It includes information on a range of indicators related to men and women, children, and household specific indicators.

The PDHS employs two-stage stratified sample design. Initially, eight regions are divided into rural and urban strata, creating 16 strata for sampling. Samples are then selected using a two-stage process, with systematic sampling of households at the second stage. In total, 28 households were selected from each cluster from the total of 561 clusters, leading to a sample of 16,240 households. Out of these, 12,338 households were occupied, and out of them 11,869 households were successfully interviewed. Additionally, 12,364 eligible women were interviewed, and 4,794 children aged 5 years or below were selected for anthropometric measurements.

The PDHS dataset provides data on child health indicators such as HAS score which is the child's height for their age, WHS score which the weight for child's height, and WAS score which measures the child's weight for their age. These are the dependent variables in this analysis. These child nutrition indicators are computed through the World Health Organisation standards, expressed as z scores that standardise deviations from the median population reference. A z-score within the range of -2 to +2 indicates normal growth, while values outside this range suggest malnutrition. For instance, a child with HAS score of less than -2 standard deviation (SD) is considered stunted and a child who

has z score lower than -3 standard deviation, is considered very highly stunted. Likewise, a child will be wasted or underweight with WHS < -2 SD and WAS < -2 SD, respectively. Hence, along with these scores, the likelihood of stunted, wasted and being underweight is also examined, with 1 being assigned with a score of less -2 SD for these indicators, and 0 otherwise. The distributions of HAS, WHS and WAS scores are shown in Figure 1 Appendix A. All the distributions have single peaks but show some differences. The HAS score distribution represented by the blue line is towards left, showing that many children have low HAS scores indicating the prevalence of stunting. Whereas the WHS scores represented by the red line and WAS scores represented by the green line show that the prevalence of wasting and underweight is less compared to stunting. Hence, stunting is observed to be a more persistent issue than other forms of nutritional deficiencies among children in Pakistan.

In Pakistan the growing population and large family sizes are an important and a persistent issue. Besides this, Pakistan also has a significantly high rate of undernutrition in children below the age of 5 years. Hence, it is important to see how these large family sizes influence HAS, WHS and WAS scores which are used as a measure of undernutrition in this paper. Moreover, in Pakistan the joint family system complicates the identification of nuclear versus extended families within households. In joint families, more household members can constrain available resources for child health investment, or conversely, contribute additional resources. Hence, this analysis uses the total number of household members as proxy for the main explanatory variable which is the family size.

In this analysis total number of people in the household are considered as a measure of family size instead of children under 5 years of age because the resource allocation among the children as well as the supply of resources are both influenced by all the members of the households especially in joint families which are common in Pakistan. Hence, using all household members captures overall resource sharing within the household. However, as a robust check, the number of children under five years of age is also used as an alternative measure as younger children might have more share in the household resources. The distribution of family size is given in the Appendix A in Figure 2. The distribution of family size is right skewed showing that fewer households have household members between 20 to 30.

The other control variables used in the study include child's characteristics like gender, age, child has diarrhea or not. We have controlled for diarrhea as it is a significant health issue among children under 5 years of age in Pakistan and having frequent diarrhea or being vulnerable to it is likely to result in poor nutritional outcomes for children. The some parental controls have been used like parent's age, employment, education and marital status which are also very important and have significant implications for children's health and growth. Similarly, important household characteristics like gender of the household head, household wealth index, type of water and sanitation facilities, region and place of residence are also used as controls. These variables account for children's living conditions and their access to water and sanitation, which have important implications for their health and nutritional status. The correlation matrix for important variables is also given in Table 1 in Appendix B.

## 5. IDENTIFICATION

Endogeneity arises when factors such as fertility, income, migration, autonomy, and mortality, which influence household size, are themselves determined by other underlying factors (Hoddinott & Mekasha, 2017). To address this issue, literature often

employs the instrumental variable approach for family size (Dasgupta & Solomon, 2018). Employing the same instrumental variable approach De Haan (2010) used twin births and sex composition of children to instrument family size. However, some studies also use household fixed effects to analyse the effect of family size (Horton, 1988). For this study as well, an instrumental variable approach is employed, in which gender of the first born is used to instrument family size. To estimate this relationship of family size and child health the below mentioned OLS model is used:

$$Y_{chd} = \beta_0 + \beta_1 FS_{hd} + \beta_2 X_{chd} + \beta_3 Z_{mhd} + \beta_4 \theta_{hhd} + \mu \quad (1)$$

Where  $Y_{chd}$  denotes the child's nutrition indicator for child 'c', living in household 'h', located in district 'd'. It represents the HAS, WAS and WHS scores along with the probability of stunting, wasting and being underweight in separate regressions. Further,  $FS_{hd}$  is family size,  $X_{chd}$ ,  $Z_{mhd}$ , and  $\theta_{hhd}$  are the child, parent, and household related covariates, respectively.  $\mu$  is the error term with usual assumptions. Moreover,  $FS_{hd}$  represents family size where as  $X_{chd}$ ,  $Z_{mhd}$ , and  $\theta_{hhd}$  are vectors of child, parental, and household characteristics, respectively.  $\mu$  is the error term.

### 5.1. Endogeneity and Instrumental Variable Approach

To determine how family size influences the children's health outcomes, it is crucial to account for endogeneity. When estimating the family size and child nutrition simultaneously, the coefficient  $\beta_1$  experiences a problem of endogeneity, in which the independent variable correlates with the error term either due to reverse causality or omitted variables. In such cases,  $\beta_1$  does not accurately approximate the causal effect of family size on the indicators of the child nutrition. This bias due to endogeneity can be upward or downward, and the direction of it depends upon the cause. For example, wealthier households in Pakistan may have fewer children and invest more in their health and education, leading to an upward bias in the quantity-quality tradeoff. Conversely, highly committed parents may have more children while still investing heavily in their quality, resulting in a downward bias.

Hence, an instrumental variable approach is used to resolve this issue of endogeneity, by estimating a 2SLS (two stage least squares) regression model. This captures the exogenous variation in family size however, it requires identifying another variable which only has an influence on the family size but does not correlate with error terms.

Hence, gender of the first born (girl) is used to instrument family size, as parents in Pakistan may continue to have more children if the first-born is a girl, in hopes of having a son. This instrument helps isolate the exogenous variation in family size, allowing for a more accurate estimation of its causal effect on child health outcomes.

### 5.2. Testing the Instrument's Reliability and Exclusion Restriction

The validity of instrumenting family size with first born child's gender (girl) can be assessed using different conditions and arguments. According to the first condition the main explanatory variable family size should have a significant correlation with the instrument variable i.e., gender of the first child.

$$Corr.(FG_{hd}, FS_{hd}) \neq 0$$

In Pakistan, people prefer to have a male child first or to have one or more male children as they are seen as the carriers of the family legacy and primary financial

supporters. Girls, on the other hand, marry and join other families. Additionally, gender inequality in society and the higher likelihood of male children being a support for their parents and having more access to employment and educational opportunities further contributes to son preference. Even in the rural areas of Pakistan, people prefer to have sons because they have more inheritance rights. They usually inherit the agricultural land and assets and are also expected to participate in farming activities. Consequently, if couples first have a daughter they continue having children till they have a boy.

The second condition for testing the validity of the instrument which in this analysis is the gender of first child (FG), is that it should not be correlated with the stunting and the probability of stunting, except through its impact on family size:

$$\text{Corr.}(FG_{hd}, Y_{chd}) = 0$$

The above requirement is met as the child's gender is determined by nature and is random, hence not directly correlated with child health outcomes such as stunting. While this instrument might be less efficient in cases of sex-selective abortions, these are illegal in Pakistan, and there is no reliable data on their prevalence. The statistics reported in the PDHS 2012-13 about 2 percent pregnancies end in abortion, but the rate of sex-selective abortions is lower because abortions occur for several reasons.

Saidi & Morgan (2016) analysed three rounds of PDHS data and found a strong preference for sons, influencing the child rearing and contraceptive use decisions. Their findings indicate that couples keep having children till they have one or more male children, without evidence of increased sex ratios at birth, which would suggest sex-selective abortions. A study by Sathar, et al. (2015) highlights that PDHS 2006-07 had higher sex ratio at birth as compared to PDHS 2012-13 and this decline in 2012-13 could be due to improved reporting. These studies support the use of first child's gender for instrumenting family size, as they provide sufficient evidence that the child's gender is randomly and exogenously determined. However, the exclusion restriction also needs to be proved from biological perspective to prove the validity of this instrument. Biological perspective posits that with an increase in family size mothers' health deteriorates, potentially leading to the birth of more unhealthy children. This indicates that family size significantly affects child health and should be accounted for in the model. However, by using the first-born child's gender as an instrument in this analysis, the exclusion restriction is satisfied, as the instrument impacts child health only through its effect on family size, not directly.

### 5.3. The 2SLS (Two Stage Least Squares) Model

The 2SLS model employed to estimate how family size impacts the child nutrition is presented below:

$$FS_{hd} = \alpha_0 + \alpha_1 FG_{hd} + \alpha_2 X_{chd} + \alpha_3 Z_{mhd} + \alpha_4 \theta_{hhd} + \mu \quad (2)$$

$$Y_{chd} = \gamma_0 + \gamma_1 \widehat{FS}_{hd} + \gamma_2 X_{chd} + \gamma_3 Z_{mhd} + \gamma_4 \theta_{hhd} + \mu \quad (3)$$

In the first stage regression presented in Equation (2), the family size is regressed on the instrumental variable which is the first-born child's gender (taking the value 1 for female child and zero otherwise) and other covariates. In the second stage regression presented in equation (3), the child nutritional status is regressed on the predicted family size obtained through equation (2) and other covariates. Further, two types of first and second stage models are estimated i.e., Model 1 with no control variables and Model 2 with child, parent, and household-related control variables.

## 6. RESULTS AND DISCUSSIONS

Table 1 is the descriptive statistics table. The HAS score indicates that, on average, children are 1.5 Standard Deviations (SD) below population median value whereas WHS score indicates a score of 0.24 SD less than the median value. Moreover, according to the WAS score children are 1.0 SD below the reference population median value. Furthermore, the mean values highlight that in Pakistan the probability of stunting is around 38 percent and the probabilities of wasting and underweight are 8 percent and 22 percent.

Table 1  
*Descriptive Statistics*

| Variable                    | Observation | Mean  | SD    | Minimum | Maximum |
|-----------------------------|-------------|-------|-------|---------|---------|
| HAS                         | 4031        | -1.55 | 1.68  | -5.99   | 5.81    |
| WHS                         | 4031        | -0.24 | 1.29  | -4.94   | 4.99    |
| WAS                         | 4031        | -1.08 | 1.26  | -5.9    | 3.9     |
| Stunted                     | 4031        | 0.39  | 0.49  | 0       | 1       |
| Wasted                      | 4031        | 0.08  | 0.27  | 0       | 1       |
| Underweight                 | 4031        | 0.22  | 0.42  | 0       | 1       |
| Family Size (FS)            | 4031        | 9.41  | 4.64  | 2       | 30      |
| Gender of First Born (Girl) | 4031        | 0.29  | 0.45  | 0       | 1       |
| Mother's Age                | 4031        | 29.08 | 6.07  | 15      | 49      |
| Father's Age                | 4029        | 34.01 | 7.53  | 17      | 81      |
| Child's Age                 | 4031        | 29.22 | 17.38 | 0       | 59      |

*Source:* Own estimations from PDHS Data (2017-18).

*Note:* Age of child is reported in months.

### 6.1. Strength and Relevance of the Instrument

The first-stage regressions in Table 2 and Table 3 show that the instrument (gender of first child) is strongly correlated with the endogenous variable family size as the F statistic of model 1 is 15.48 and F statistic of model 2 is 24.78 which are both greater than 10 hence, satisfying the condition for validity of the instrument. The strength and relevance of the instrument is further tested through the IV diagnostic tests like Anderson LM and weak identification tests. The results of the under-identification test show a value of 24.60 and a P value of 0.00, rejecting the null hypothesis and indicating that the instrument used is relevant. Similarly, the Cragg-Donald Wald F statistic for weak identification is 24.63, which is greater than 10 (F stat > 10) hence the instrument gender of first child is strong.

The 2SLS regression results presented in Tables 2 and 3 for stunting and the probability of stunting, respectively, incorporate different controls for children, household and parent related indicators. In each table both the stages of regressions in Model 1 exclude the control variables. In Model 2, both stages include control variables.

The first stage regression in Model 1 of Table 2 shows that there is a significantly positive relationship between first child's gender and the family size, showing that if a girl is born first then there is an increase in FS (family size). While, in the second stage regression model which regresses HAS score on the predicted family size, the results show an insignificant and negative coefficient, suggesting the omission of important variables. When control variables are added in Model 2, the first stage regressions give the similar positive coefficient. However, in the second stage, when HAS score is regressed on the predicted family size while controlling various factors reveals that when family size increases by one member the HAS score decreases by 0.194 standard deviations. It is a long-term nutritional deficiency and therefore is efficiently captured by the family size.

Similarly, Table 3 reports the results for the 2SLS regression for both models. The first stage regressions for both models are same as those in Table 2. The second stage regression of the stunting probability on the predicted family size in first Model shows a negative and insignificant coefficient. In Model 2 (Table 3), with the addition of control variables the coefficient becomes statistically significant. A plausible explanation can be that temporary fluctuations in income and resources might not immediately affect the probability of having lower height.

Table 2

*Family Size Effect on (Height for Age) HAS score*

| <i>Panel A: The First Stage Regressions using Family Size as Dependent Variable</i> |                   |                    |
|-------------------------------------------------------------------------------------|-------------------|--------------------|
| Variables                                                                           | Model 1           | Model 2            |
| Gender of First Born (girl=1)                                                       | 0.64***<br>(0.16) | 0.86***<br>(0.16)  |
| Obs.                                                                                | 4031              | 4028               |
| F-Stats                                                                             | 15.48***          | 24.78***           |
| Adjusted $R^2$                                                                      | 0.00              | 0.10               |
| <i>Panel B: The Second Stage Regressions using HAS as Dependent Variable</i>        |                   |                    |
| Family Size                                                                         | -0.02<br>(0.09)   | -0.19***<br>(0.07) |
| Obs.                                                                                | 4031              | 4028               |
| Adjusted $R^2$                                                                      | -0.00             | 0.17               |
| Children Controls                                                                   | NO                | YES                |
| Parent Controls                                                                     | NO                | YES                |
| Household Controls                                                                  | NO                | YES                |

Source: Own estimations from PDHS Data (2017-18).

Note: The Standard Errors (SE) are mentioned in parentheses \*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ . The child control variables include the child's age (5 years or below 5), birth order, child's gender and diarrhea (child has diarrhea or not). The parent related controls include the father and mother's age, employment, education and marital status. The household variables used in the model are the place of residence type, region, time taken to reach the water source, type of toilet facility and cooking fuel, household head's gender and wealth.

Table 3

*Family Size Effect on the Probability of Stunting*

| <i>Panel A: The First Stage Regressions using Family Size as Dependent Variable</i>              |                   |                   |
|--------------------------------------------------------------------------------------------------|-------------------|-------------------|
| Variables                                                                                        | Model 1           | Model 2           |
| Gender of First Born (girl=1)                                                                    | 0.64***<br>(0.16) | 0.86***<br>(0.16) |
| Obs.                                                                                             | 4031              | 4028              |
| F-Stats                                                                                          | 15.48***          | 24.78***          |
| Adjusted $R^2$                                                                                   | 0.00              | 0.10              |
| <i>Panel B: The Second Stage Regressions using Probability of Stunting as Dependent Variable</i> |                   |                   |
| Family Size                                                                                      | -0.00<br>(0.03)   | 0.04**<br>(0.02)  |
| Obs.                                                                                             | 4031              | 4028              |
| Adjusted $R^2$                                                                                   | -0.00             | 0.12              |
| Children Controls                                                                                | NO                | YES               |
| Parent Controls                                                                                  | NO                | YES               |
| Household Controls                                                                               | NO                | YES               |

Source: Own estimations from PDHS Data (2017-18).

Note: The Standard Errors (SE) are mentioned in parentheses \*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ . The child control variables include the child's age (5 years or below 5), birth order, child's gender and diarrhea (child has diarrhea or not). The parent related controls include the father and mother's age, employment, education and marital status. The household variables used in the model are the place of residence type, region, time taken to reach the water source, type of toilet facility and cooking fuel, household head's gender and wealth.

Table 4 displays the regression results for the 2SLS model for wasting (WHS score) and probability of wasting. Since the first stage regressions are the same as in Tables 2 and 3, the results are only reported for the second stage for WHS (Panel A) and probability of wasting (Panel B). The results show that exogenous increase in family size affects neither WHS score nor the probability of wasting.

There can be various reasons for the insignificant impact of family size on wasting. First, family size may have a more pronounced effect on long-term nutritional outcomes (e.g., stunting) rather than short-term ones (like wasting). Larger family size can strain resources, but these effects may manifest more significantly over time, affecting height (HAS) rather than weight (WHS), which can fluctuate more rapidly and be influenced by short-term factors. Second, wasting is often a result of recent illness or infection, which can cause rapid weight loss. These health shocks are less likely to be directly correlated with family size and more related to immediate health and environmental conditions. Hence, the variation in WHS might be more influenced by episodic health events rather than the steady resource allocation issues that come with larger family sizes. Finally, in larger families, there might be mechanisms in place to buffer short-term nutritional deficits. For instance, community or extended family support might temporarily mitigate the effects of acute malnutrition (wasting), making the impact of family size less apparent.

Like Table 4, Table 5 presents the results of the second stage of 2SLS on WAS and probability of underweight. While the findings indicate insignificant effect of family size on WAS score consistent with literature (see, for instance, Delpiano, 2005; Iram & Butt, 2006; Mmopelwa, 2019), it is also observed that the family size similarly influences probability of underweight. Though the results are not very significant they show that if family size increases it positively affects the likelihood of being underweight (Panel B, Table 5). This could be because, in larger families, parental attention and care are divided among more children. This division can lead to less individualised care and monitoring of each child's health and nutritional needs, increasing the likelihood of

underweight conditions. Moreover, larger families often face greater economic pressures. With more mouths to feed, parents might be forced to cut back on the quantity or quality of food provided to each child. Economic constraints can also limit access to healthcare and proper nutrition, essential for maintaining a healthy weight. Likewise, larger families may experience barriers to accessing and utilising healthcare services, such as immunisations, regular check-ups, and treatment for illnesses. Limited healthcare access can exacerbate undernutrition, as children may not receive timely interventions for health issues that could affect their weight.

Table 4

| <i>Family Size Effect on (Weight for Height) WHS score and the Probability of Wasting</i>       |                |                 |
|-------------------------------------------------------------------------------------------------|----------------|-----------------|
| <i>Panel A: The Second Stage Regressions using WHS as Dependent Variable</i>                    |                |                 |
| Variables                                                                                       | Model 1        | Model 2         |
| Family Size                                                                                     | 0.10<br>(0.07) | 0.09<br>(0.06)  |
| Obs.                                                                                            | 4031           | 4028            |
| Adjusted $R^2$                                                                                  | 0.00           | 0.03            |
| <i>Panel B: The Second Stage Regressions using Probability of Wasting as Dependent Variable</i> |                |                 |
| Family Size                                                                                     | 0.00<br>(0.01) | -0.00<br>(0.01) |
| Obs.                                                                                            | 4031           | 4028            |
| Adjusted $R^2$                                                                                  | -0.00          | 0.02            |
| Children Controls                                                                               | NO             | YES             |
| Parent Controls                                                                                 | NO             | YES             |
| Household Controls                                                                              | NO             | YES             |

Source: Own estimations from PDHS Data (2017-18).

Note: The Standard Errors (SE) are mentioned in parentheses \*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ . The child control variables include the child's age (5 years or below 5), birth order, child's gender and diarrhea (child has diarrhea or not). The Parent related controls include the father and mother's age, employment, education and marital status. The household variables used in the model are the place of residence type, region, time taken to reach the water source, type of toilet facility and cooking fuel, household head's gender and wealth.

Table 5

| <i>Family Size Effect on (Weight for Age) WAS score and the Probability of Underweight</i>          |                 |                 |
|-----------------------------------------------------------------------------------------------------|-----------------|-----------------|
| <i>Panel A: The Second Stage Regressions using WAS as Dependent Variable</i>                        |                 |                 |
| Variables                                                                                           | Model 1         | Model 2         |
| Family Size                                                                                         | 0.04<br>(0.07)  | -0.05<br>(0.05) |
| Obs.                                                                                                | 4031            | 4028            |
| Adjusted $R^2$                                                                                      | -0.00           | 0.10            |
| <i>Panel B: The Second Stage Regressions using Probability of Underweight as Dependent Variable</i> |                 |                 |
| Family Size                                                                                         | -0.00<br>(0.02) | 0.03*<br>(0.02) |
| Obs.                                                                                                | 4031            | 4028            |
| Adjusted $R^2$                                                                                      | -0.00           | 0.09            |
| Children Controls                                                                                   | NO              | YES             |
| Parent Controls                                                                                     | NO              | YES             |
| Household Controls                                                                                  | NO              | YES             |

Source: Own estimations from PDHS Data (2017-18).

Note: The Standard Errors (SE) are mentioned in parentheses \*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ . The child control variables include the child's age (5 years or below 5), birth order, child's gender and diarrhea (child has diarrhea or not). The parent related controls include the father and mother's age, employment, education and marital status. The household variables used in the model are the place of residence type, region, time taken to reach the water source, type of toilet facility and cooking fuel, household head's gender and wealth.

The above results have also been re-estimated using number of children under 5 years of age as a measure of family size. The results show a little decline in significance for HAS score, stunting and being underweight, though HAS scores and probability of stunting remain statistically significant. The relationship directions remain consistent even after changing the independent variable however, the standard errors significantly increased indicating less precision in the estimates. The coefficients changed and only the coefficient of being wasted remains consistent.

To check for robustness OLS model results are shown in Appendix B Table 3. The results of the OLS model show that family size significantly and negatively affects HAS, WHS and WAS scores. Whereas, it has a positive and significant effect only on the probability of stunting and being underweight.

For comparative analysis, 2SLS models were also estimated separately for urban and rural areas, as shown in Table 4 and Table 5 in Appendix B. The results are not statistically significant, with small coefficients indicating no meaningful effects. However, when comparing father and mother's employment in Table 6 Appendix B (for HAS score and stunting) results show that in households where father is employed, an increase in family size lowers the HAS score and increases probability of stunting. Similar is the case with households with unemployed mothers. The results for WHS score show that for households with employed fathers an increase in family size positively affects WHS score while for rest of the indicators the results are insignificant.

## 7. CONCLUSION AND POLICY RECOMMENDATION

In conclusion, this study highlights how significantly the size of family effects the children's nutritional outcomes in Pakistan, with important implications for labour force productivity and economic growth. Using the Demographic & Health Survey of Pakistan 2017-18 data with an instrumental variable approach, the 2SLS (two stage least squares) model is employed to estimate the effects of family size on HAS score (height for child's age), WHS score (weight for child's height), and WAS score (weight for child's age), and the likelihoods of stunting, wasting and underweight. Findings of this paper reveal that with an increase in the size of the family, the children's nutritional outcomes are adversely affected, with significant decline in HAS scores by 0.19 SD and increase in the probability of stunting by 4.2 percent. Conversely, family size showed an insignificant effect on WHS scores. Similarly, the increase in family size does not significantly affect the WAS scores but has a significant effect on the probability of being underweight, increasing it by 3.1 percent. For robustness check these results have also been estimated by using number of children under 5 years of age as a measure of family size. The results remain statistically significant for HAS scores and stunting regardless of the choice of independent variable. Though there are variations in the coefficients the direction of the relationships remains consistent. In addition to these results, OLS regressions were also done, and the results are presented in Table 3 of Appendix B, showing that family size significantly affects all nutrition indicators except for probability of wasting. For comparative analysis 2SLS models are also estimated for urban and rural areas as well as for parents' employment. However, the results for urban and rural regions are insignificant. Whereas for households where the father is employed or the mother is unemployed, an increase in family size lowers the HAS score and increases the probability of stunting. Contrarily for households with employed fathers, family size lowers the WHS score improving child nutrition.

The positive impact on stunting and underweight probabilities can be attributed to resource dilution within larger families. As siblings increase, the allocation of food, healthcare, and parental attention becomes stretched, leading to chronic undernutrition

and poor growth outcomes. This is particularly evident in stunting, a long-term indicator of nutritional deficiency, which reflects the cumulative effects of sustained inadequate nutrition and healthcare. Similarly, the probability of being underweight increases as larger family sizes exacerbate economic constraints, limiting the quality and quantity of food available to each child.

Similarly, the negative effect of the size of the family (FS) on wasting underscores the nature of wasting as an indicator of acute malnutrition, which is more sensitive to short-term fluctuations in diet and health conditions. Wasting is often influenced by immediate factors such as illness and temporary food shortages, which may not directly correlate with family size. The temporary nature of the conditions leading to wasting means that while family size does impact overall nutritional status, its effect on acute measures like wasting is less pronounced.

This paper makes some important contributions to existing literature as none of the existing studies examine the effect of family size on child nutrition in Pakistan using the instrumental variable approach. For the estimation of the results, the paper uses the most recent, nationally representative PDHS data 2017-18. One major contribution of this study is that it not only analyses the effect of family size on HAS, WHS and WAS scores but also on probability of stunting, wasting and being underweight using important controls which are quite relevant in context of Pakistan, like diarrhea among children and water and sanitation etc.

Overall, these findings emphasise the importance of considering family size in designing new efficient policies and the policy interventions aimed at improving child health outcomes. Addressing the resource constraints and economic pressures faced by larger families can be crucial in reducing the rates of stunting among children. By focusing on long term nutritional support and equitable resource distribution, the adverse effects of larger family sizes on child health outcomes can be mitigated.

The findings also suggest that measures should be taken to address the issues related to child health like diarrhea, access to clean water and sanitation while also focussing on mother's role in decision-making to improve child nutrition, along with implementation of family planning initiatives. Specific origrammes can be designed for targeting the child's nutritional needs in early years to reduce nutritional deficiencies. Besides this, improving the quality and accessibility to child and maternal health services can also yield beneficial results in lowering the family size as well as child nutritional deficiencies.

Given the critical nature of child nutrition for future labour force productivity and economic growth, these findings underscore the urgent need for population control measures in Pakistan, which has the highest population growth rate in South Asia. Successful population control origrammes from countries like Thailand, China, and Iran provide valuable models. Implementing similar strategies in Pakistan could help reduce fertility rates and manage population growth. Moreover, coordinated efforts among the government agencies, effective public-private partnerships, and institutional changes are essential to enhance the capacity of service providers and improve the provision and accessibility of quality food, healthcare, and living conditions for families.

In addition to suggesting important policy implications for Pakistan this study also highlights that child nutrition is an important issue across the world with serious socio-economic causes and implications. Hence, even at a global level investment in children's nutrition, particularly in early years along with parent's education and employment and household living conditions, have long term implications.

Thus, to summarise, the study highlights that larger family sizes adversely affect child nutritional outcomes resulting in serious effects on their development, productivity and adult life outcomes. This reiterates the need for effective policies and programmes which address both the issue of large family sizes and undernutrition.

In Pakistan joint family and extended family systems are quite common, which means more family members residing in a household and a dilution of resources. But this also means more working adults and higher supply of resources. However, in this study it was not possible to include the exact family size and isolate the effects of family size on child nutrition in nuclear family households as compared to joint family households, which is also very important and an area for future research. Besides this, analyse these trends over time to see how the changing family sizes and other factors influence child nutrition with the passage of time may also be an interesting analysis which has not been covered in this study.

#### Declaration of Interest

The author declared no potential conflicts of interest regarding the authorship or the publication of this paper.

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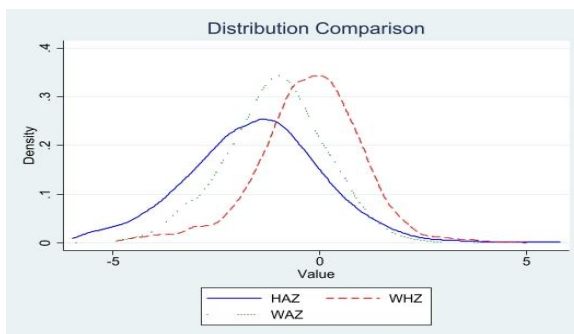
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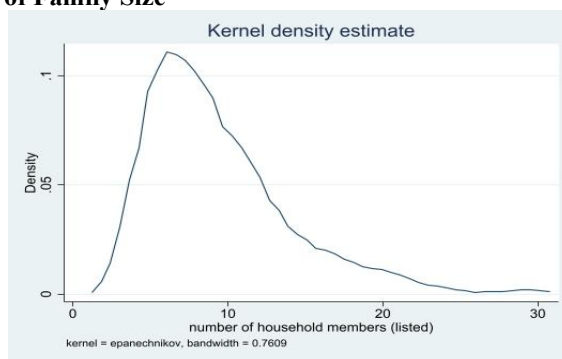
## Appendix A

**Fig. 1. Distribution of HAS, WHS and WAS scores**



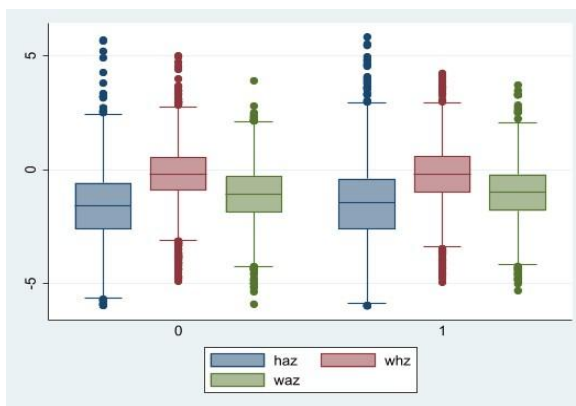
Source: Own estimations from PDHS Data (2017-18).

**Fig. 2. Distribution of Family Size**



Source: Own estimations from PDHS Data (2017-18).

**Fig. 3. Plots for HAS, WHS and WAS scores comparing households with only 1 child aged 5 years or below (child=1) and for households with 2 or more children aged 5 years or below (child=0)**



Source: Own estimations from PDHS Data (2017-18).

## Appendix B

Table 1

### *Correlation Matrix*

| Variables            | Family Size | HAS   | WHS  | WAS  | Gender (First Child) |
|----------------------|-------------|-------|------|------|----------------------|
| Family Size          | 1.00        |       |      |      |                      |
| HAS                  | -0.04       | 1.00  |      |      |                      |
| WHS                  | -0.03       | -0.11 | 1.00 |      |                      |
| WAS                  | -0.05       | 0.70  | 0.62 | 1.00 |                      |
| Gender (first child) | 0.06        | -0.00 | 0.02 | 0.1  | 1.00                 |

Source: Own estimations from PDHS Data (2017-18).

Table 2

### *Correlation between Family Size and Children under 5 Years of Age*

| Variables        | FS   | Children under 5 |
|------------------|------|------------------|
| FS               | 1.00 |                  |
| Children Under 5 | 0.09 | 1.00             |

Source: Own estimations from PDHS Data (2017-18).

Table 3

### *OLS Regression Results*

| VARIABLES          | HAS                | Stunted           | WHS               | Wasted         | WAS                | Underweight      |
|--------------------|--------------------|-------------------|-------------------|----------------|--------------------|------------------|
| Family Size        | -0.02***<br>(0.01) | 0.02***<br>(0.00) | -0.017*<br>(0.00) | 0.00<br>(0.00) | -0.02***<br>(0.00) | 0.00**<br>(0.00) |
| Observations       | 4028               | 4028              | 4028              | 4028           | 4028               | 4028             |
| R-squared          | 0.17               | 0.12              | 0.03              | 0.024          | 0.15               | 0.09             |
| Child Controls     | YES                | YES               | YES               | YES            | YES                | YES              |
| Parent Controls    | YES                | YES               | YES               | YES            | YES                | YES              |
| Household Controls | YES                | YES               | YES               | YES            | YES                | YES              |

Source: Own estimations from PDHS Data (2017-18).

Standard errors in parentheses \*\*\* p<0.01, \*\* p<0.05, \* p<0.1.

Table 4

### *2SLS Regressions Results by Urban and Rural Regions For the Probability of Stunting, Wasting and Being Underweight*

| Variables          | Stunted<br>Urban | Stunted<br>Rural | Wasted<br>Urban | Wasted<br>Rural | Underweight<br>Urban | Underweight<br>Rural |
|--------------------|------------------|------------------|-----------------|-----------------|----------------------|----------------------|
| Family Size        | 0.13<br>(0.10)   | 0.02<br>(0.02)   | -0.05<br>(0.05) | 0.01<br>(0.01)  | 0.06<br>(0.07)       | 0.02<br>(0.02)       |
| Observations       | 1825             | 2203             | 1825            | 2203            | 1825                 | 2203                 |
| R-squared          | 0.00             | 0.12             | 0.00            | 0.01            | 0.00                 | 0.05                 |
| Child Controls     | YES              | YES              | YES             | YES             | YES                  | YES                  |
| Parent Controls    | YES              | YES              | YES             | YES             | YES                  | YES                  |
| Household Controls | YES              | YES              | YES             | YES             | YES                  | YES                  |

Source: Own estimations from PDHS Data (2017-18).

Standard errors in parentheses \*\*\* p<0.01, \*\* p<0.05, \* p<0.1.

Table 5

*2SLS Regressions Results by Urban and Rural Regions for HAS, WHS and WAS Scores*

| Variables          | HAS Urban       | HAS Rural       | WHS Urban      | WHS Rural      | WAS Urban      | WAS Rural       |
|--------------------|-----------------|-----------------|----------------|----------------|----------------|-----------------|
| Family Size        | -0.45<br>(0.36) | -0.11<br>(0.07) | 0.34<br>(0.23) | 0.02<br>(0.05) | 0.01<br>(0.17) | -0.06<br>(0.05) |
| Observations       | 1825            | 2203            | 1825           | 2203           | 1825           | 2203            |
| R-squared          | 0.00            | 0.14            | 0.00           | 0.03           | 0.14           | 0.12            |
| Child Controls     | YES             | YES             | YES            | YES            | YES            | YES             |
| Parent Controls    | YES             | YES             | YES            | YES            | YES            | YES             |
| Household Controls | YES             | YES             | YES            | YES            | YES            | YES             |

Source: Own estimations from PDHS Data (2017-18).

Standard errors in parentheses \*\*\* p<0.01, \*\* p<0.05, \* p<0.1.

Table 6

*2SLS Regressions Results of HAS and Stunting for father and Mother's Employment*

| HAS score          |                |                   |                    |                 |
|--------------------|----------------|-------------------|--------------------|-----------------|
| Variables          | Father Unemp.  | Father Emp.       | Mother Unemp.      | Mother Emp.     |
| Family Size        | 0.14<br>(0.22) | -0.17**<br>(0.07) | -0.24***<br>(0.09) | 0.03<br>(0.11)  |
| Observations       | 134            | 3894              | 3582               | 446             |
| R-squared          | 0.06           | 0.01              | 0.00               | 0.27            |
| Child Controls     | YES            | YES               | YES                | YES             |
| Parent Controls    | YES            | YES               | YES                | YES             |
| Household Controls | YES            | YES               | YES                | YES             |
| Stunting           |                |                   |                    |                 |
| Variables          | Father Unemp.  | Father Emp.       | Mother Unemp.      | Mother Emp.     |
| Family Size        | 0.06<br>(0.06) | 0.04**<br>(0.02)  | 0.06**<br>(0.03)   | -0.02<br>(0.03) |
| Observations       | 134            | 3894              | 3582               | 446             |
| R-squared          | 0.12           | 0.00              | 0.00               | 0.20            |
| Child Controls     | YES            | YES               | YES                | YES             |
| Parent Controls    | YES            | YES               | YES                | YES             |
| Household Controls | YES            | YES               | YES                | YES             |

Source: Own estimations from PDHS Data (2017-18).

Standard errors in parentheses \*\*\* p<0.01, \*\* p<0.05, \* p<0.1.