Polygynous Family Structure and Child Undernutrition in Nigeria

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ABSTRACT Interest is growing in the research literature in exploring how child nutrition is affected by sociocultural practices, such as polygyny. However, evaluation of the effect of polygyny on child nutrition is hindered by the complexity of the relationship. This paper investigates the effect of polygyny on anthropometric outcomes while recognising that unobservable household characteristics may simultaneously influence both the decision to form a polygynous union and the ability of the household to adequately nourish children. We apply an instrumental variable approach based on the occurrence of same-sex siblings in a woman’s first two births to generate exogenous variation in polygyny. Using data from the 2008 and 2013 Nigeria Demographic and Health Surveys, we find a detrimental effect of polygyny on child undernutrition. Our results show that the effect of polygyny is substantially reduced when we control for household characteristics, suggesting that part of the link between polygyny and child undernutrition is mediated through these channels. Nevertheless, the estimated coefficients of polygyny remain sizeable and strongly statistically significant even after controlling for these characteristics. Polygynous families may have different behavioural childcare practices, and/or the reduced bargaining power of women associated with polygynous families could be associated with higher rates of child undernutrition.

1. Introduction

Undernutrition in sub-Saharan Africa remains pervasive due to insufficient food intake, widespread micronutrient deficiencies, and health challenges, including a significant disease burden and the adverse public health impacts of poor water and sanitation facilities. Across sub-Saharan Africa, one-third of children under five years of age are stunted in their growth and 8.5 per cent are acutely undernourished (World Health Organization [WHO], 2017). Undernutrition imposes high social and economic burdens that may amount to between 3 per cent and 16 per cent of gross domestic product annually (Benson, Amare, Oyeyemi, & Fadare, 2017, Hoddinott, 2016). A lack of substantial gains in reducing undernutrition may necessitate looking beyond socioeconomic factors to sociocultural dimensions to explain the drivers of undernutrition in children.

At the same time, a growing literature is trying to explore how child undernutrition is affected by social and cultural practices such as polygyny (Oyimah, 2009, Smith-Greenaway & Trinitapoli, 2014, Westof, 2003). The focus of this paper is on the nexus between polygyny and child undernutrition in Nigeria, the most populous country in Africa, with a rapidly growing population of about 200 million in 2017. One-third of Nigerian women are in polygynous unions, a share that has

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remained steady over time (National Population Commission, Nigeria [NPC] & ICF International, 2014, National Population Commission, Nigeria [NPC] & ICF Macro, 2009). Similar to many countries in sub-Saharan Africa, Nigeria made gains in reducing child undernutrition in recent years, but it remains high. In 2013, an estimated one out of three young children were stunted in their growth, although this represented a reduction from the 42 per cent of children estimated to be stunted in 2008 (NPC & ICF Macro, 2009; NPC & ICF International, 2014). Moreover, while undernutrition is prevalent throughout the country, significant heterogeneity is seen across geopolitical zones.

While research on the relationship between polygynous family structure and child undernutrition is growing (Bourdier, 2019, Gyimah, 2009, Wagner & Rieger, 2015, Westoff, 2003), relatively little is known about the effect of polygyny on child undernutrition because of the complexity of the relationship. The same factors that affect child undernutrition may also affect family structure decisions. This makes estimating cause and effect relationships between polygyny and child undernutrition complicated. Polygyny can affect children’s nutrition through several mechanisms, such as low parental educational attainment, increased family size, encouraged early marriage, and reduced investment in children’s health.

This paper contributes to the relevant literature by addressing the following two hypotheses: (1) children in polygynous families are more likely to be undernourished than their peers in monogamous unions; and (2) polygyny is more likely if the first two children born are the same sex. This study tackles the issue of identifying the effect of family structure on child undernutrition by using an instrumental variable approach. First, building on previous studies (Angrist & Evans, 1998, Black, Devereux, & Salvanes, 2005, Conley, 2000, Conley & Glaube, 2006), we instrument polygyny with the gender of the first two births to the first wife in a household, specifically same-sex first-and second-born children, that is, only sons [boy boy] or only daughters [girl girl]. We base this choice of instrument on evidence indicating a preference in Nigeria for families composed of children of both sexes. When the first two births result in same-sex siblings, the desire for mixed-sex composition may trigger polygyny, which provides exogenous variation. Second, we explore the effect of the polygynous family structure on child undernutrition in Nigeria. In Nigeria, as in much of West Africa, significant life choices, such as fertility and childcare decisions, are influenced by numerous cultural or religious beliefs and practices (Arthi & Fenske, 2018, Briones Alonso, Cockx, & Swinnen, 2018). The combination of both widespread polygyny and widespread child undernutrition makes Nigeria a particularly interesting country study for assessing this relationship and to elucidate appropriate policymaking interventions to reduce child undernutrition. The paper uses the 2008 and 2013 Nigeria Demographic and Health Surveys (NDHS) to assess this complex relationship. Both surveys contain information on child anthropometric outcomes and the polygyny status of women who are married or living together, which make the surveys well suited for this analysis.

The remainder of the paper is organised as follows. Section 2 presents the conceptual framework to better understand the direct and indirect interactions and linkages between polygyny and undernutrition in children. Section 3 presents the data and key variables used in the empirical analysis, whereas Section 4 presents the empirical model and the identification strategy adopted. The results are presented in Section 5 before we conclude in the final section, highlighting the main findings and the possible limitations of the analysis.

2. Polygyny and child welfare

The literature provides numerous explanations for the practice of polygyny in Africa, including increased labour supply from multiple wives in agrarian societies; men’s wealth and power; and the child-rearing capability of the first wife (Boserup, 1970, Ezeh, 1997). In certain tropical regions, some societies have postpartum sex taboos, which forbid a married woman from sexual activities for up two years after her child is born to ensure good lactation and healthy child development (Caldwell & Caldwell, 1987). During this period, wives consent to share their husbands with another wife to
deter the husband from engaging in sexual relations outside the family. In combination with early marriage, the polygynous marriage system has helped to maintain high fertility rates of between six and eight children per family in many African countries (Arthi & Fenske, 2016, Caldwell & Caldwell, 1987, Fenske, 2015). In some cultures, large family size and polygyny are attributed to a higher social ranking (Ezeh, 1997); hence, it is desirable for a man to have multiple wives and to marry early if he desires a large family.

There is a growing interest in the research literature to explore how child nutritional outcomes are affected by social and cultural practices such as polygyny (Arthi & Fenske, 2018, Munro, Kebede, Tarazona-Gomez, & Verschoor, 2019, Smith-Greenaway & Trinitapoli, 2014, Strassmann, 2011). However, the relationship between polygyny and child growth has not been conclusive. Some studies suggest that the presence of multiple wives in the household could enhance child welfare (Akresh, Chenand, & Moore, 2016, Ukwuani, Cornwell, & Suchindran, 2002), demonstrating that children in polygynous families could have the advantage of more frequent care and supervision by adults than those in monogamous families (Akresh et al., 2016). Polygyny may also delay the resumption of and/or reduce the frequency of intercourse after childbirth, which affects outcomes by improving breastfeeding practices and child spacing (Ukwuani et al., 2002).

Although the above studies showed the possibility of positive contributions of polygyny to child development, a large body of research has documented a detrimental association with child growth and survival (Arthi & Fenske, 2018, Hadley, 2005, Sellen, 1999, Smith-Greenaway & Trinitapoli, 2014, Wagner & Rieger, 2015). Smith-Greenaway and Trinitapoli (2014) review theories as to why polygyny may be associated with poor child outcomes, specifically increased child mortality. They argue that this association might occur due to both the characteristics of environments that are more conducive to polygyny and to characteristics of polygynous families.

Polygyny could influence child nutritional outcomes through different channels. First, polygyny is associated with large family size and characterised by many young children from different wives of similar age. Consequently, children may compete for nutritional and financial resources and parental time, adversely affecting nutritional outcomes, especially in resource-poor environments (Arthi & Fenske, 2018, Basu, 2000, Milazzo, 2018, Strassmann, 2011). Second, the poor nutritional and health status of children in polygynous families could be associated with gender discrimination and low parental education attainment (Mammen, 2009). This is because less educated parents have limited exposure to nutrition information and limited skills to recognise, process, and apply the nutrition and health knowledge they have acquired. As a result, parents with low education levels are less able to improve their own nutritional status and that of their families (Behrman & Rosenzweig, 2002, Fadare, Amare, Mavrotas, Akerele, & Oggunyi, 2019a, Fadare, Mavrotas, Akerele, & Oyeyemi, 2019b, Plug, 2004). Furthermore, a polygynous family structure encourages early marriage. Not only do girls who marry young experience higher rates of malnutrition, isolation, and depression, but a long-term impact on child growth also occurs (Le Strat, Dubertret, & Le Foll, 2011). Finally, children of young mothers are likely to have lower birth weight, suffer poor nutritional status due to poor physical health outcomes, and experience higher rates of infant mortality (Rahman, Howlader, Masud, & Rahman, 2016). However, even where a relationship between marital choice and child welfare is established, these studies do not attempt to evaluate whether polygyny is a causal factor (Gyimah, 2009, Wagner & Rieger, 2015, Westoff, 2003).

3. Data and descriptive results

Our analysis uses individual and household data collected in the 2008 and 2013 Nigeria Demographic and Health Surveys (DHS). These surveys are well suited for this study because they contain information on both the polygyny status of women who are married and on child nutritional outcomes. The surveys capture mother, child, and household information, including socioeconomic characteristics, anthropometric measurements, household assets (wealth index), and demographic
information, among others. These nationally representative surveys cover both urban and rural households.

The unit of analysis for this study is children under five years of age whose mothers are married and have had at least two surviving births. The final combined sample comprised 13,935 children from the 2008 survey and 18,058 children from the 2013 survey.

The DHS data provide information on GIS coordinate data (latitude and longitude) of each survey cluster, which enables merging night-time light data from the Operational Linescan System (OLS) sensors of the Defence Meteorological Satellite Program (DMSP) of the United States Air Force. Various studies have shown that satellite-based night-time light intensity is a valid continuous measure of urbanisation and urban settlements (Amare, Arndt, Abay, & Benson, 2020, Henderson, Storeygard, & Weil, 2012, Imhoff, Lawrence, Stutzer, & Elvidge, 1997, Storeygard, 2016, Sutton, 1997).

3.1. Anthropometrics

We measure child growth based on child anthropometry for all children under five as captured by height-for-age z-scores (HAZ), weight-for-height z-scores (WHZ), as well as the prevalence of stunting and wasting derived from HAZ and WHZ, respectively. A child is considered stunted if the HAZ for the child is less than −2 (two standard deviations below the median measurement for the reference group), while a child with WHZ less than −2 is considered wasted (WHO Multicentre Growth Reference Study Group, 2006). Stunting in children represents linear growth that has failed to reach genetic potential as a result of a child receiving inadequate nutrition over a sustained period or experiencing recurrent or chronic illness (Black et al., 2013). Stunting results from chronic undernutrition and, therefore, measures long-term nutritional deprivation. Stunting is predictive of a reduction of both future physical and cognitive potential. Wasting results from acute undernutrition that has produced a substantial weight loss, usually as a consequence of severe food shortage and/or disease. Wasting is an indication of ongoing nutritional deficiencies. Children who experience wasting frequently become stunted over time (Amare, Benson, Fadare, & Oyeyemi, 2018, Black et al., 2013, Hoddinott, Maluccio, Behrman, Flores, & Martorell, 2008).

3.2. Polygynous family structure

We create a polygyny dummy variable that takes a value of one if a child’s mother reports having co-wives. The variable is created for women who are married or living with a partner.

In Nigeria, polygyny is not recognised under Nigerian civil law, but it is still widespread in many parts of the country. Table 1 shows that 33 per cent of married women reported having one or more co-wives. The results also show that significant regional differences exist in the level and practice of polygyny. Within Nigeria, marriage practices differ by region and ethnic group. Polygynous families are most prevalent in Hausa society (about 46 per cent of women in the sample practice polygyny), but the practice also exists across all ethnic groups, ranging from 3 per cent of Igbos to 11 per cent of Fulani ones. Similarly, polygynous families are most prevalent in the largely Muslim northwestern region of Nigeria, while the practice exists across all parts of the country, ranging from 3 per cent in the southeast region to 22 per cent in the northeast region.

Table 1 summarises outcome variables, family structure measures, and child and parental characteristics. The average values of child HAZ and child WHZ in the pooled sample are −1.46 and −0.41, respectively. The prevalence of child stunting and wasting is high at 40 per cent and 15 per cent, respectively, among children under five. Although the prevalence of stunting fell from 43 per cent in 2008 to 37 per cent in 2013 (by 15 per cent), the proportion of stunted children is still high in Nigeria. Furthermore, the prevalence of wasting increased from 14 per cent in 2008 to 16 per cent in 2013 (by 10 per cent). This again highlights the pervasive levels of child undernutrition in Nigeria. Wasting may result in the death of a child, but the long-term consequences of nutritional deprivation associated with stunting have significant adverse transgenerational effects. The average age of children in the sample is
Table 1. Descriptive statistics

| Variables                                      | Pooled       | Year 2008 | Year 2013 | Family structure | Polygynous families | Polygynous families |
|------------------------------------------------|--------------|-----------|-----------|------------------|--------------------|--------------------|
|                                                 |              |           |           | Non-polygyn       | Two wives           | Three wives        | Four or more wives |
| Panel A: Outcome variables                     |              |           |           |                  |                    |                    |                    |
| Height-for-age z score                         | -1.44 (2.04) | -1.48     | -1.41     | -1.29            | -1.79              | -1.68              | -1.56              |
| Child stunting (HAZ<-2), 0/1                   | 0.39         | 0.41      | 0.38      | 0.35             | 0.47               | 0.45               | 0.41               |
| Weight-for-age z score                         | -0.45(1.65)  | -0.20     | -0.64     | -0.40            | -0.55              | -0.55              | -0.32              |
| Child wasting (WHZ<-2), 0/1                    | 0.16         | 0.14      | 0.18      | 0.15             | 0.18               | 0.19               | 0.17               |
| Panel B: Family structure                      |              |           |           |                  |                    |                    |                    |
| Polygynous family, 0/1                         | 0.32         | 0.32      | 0.33      |                  |                    |                    |                    |
| Number of wives, number                        | 1.40(0.66)   | 1.40      | 1.41      | 1.00             | 2.24               |                    |                    |
| Panel C: Child & parental characteristics      |              |           |           |                  |                    |                    |                    |
| Child is boy, 0/1                              | 0.50         | 0.50      | 0.50      | 0.50             | 0.50               | 0.49               | 0.51               |
| Age of child, months                           | 29.93(17.23) | 29.74     | 30.07     | 30.01            | 29.75              | 29.68              | 30.14              | 29.75              |
| Children ever born, number                     | 4.78(2.41)   | 4.77      | 4.78      | 4.46             | 5.44               | 5.36               | 5.87               | 5.65               |
| Mother’s educational attainment, years         | 4.69(5.16)   | 4.80      | 4.61      | 5.76             | 2.45               | 2.42               | 2.38               | 3.42               |
| Father’s educational attainment, years         | 6.32(5.72)   | 6.32      | 6.31      | 7.24             | 4.38               | 4.33               | 4.42               | 5.11               |
| Age of mother at first birth, years            | 19.27(4.19)  | 19.31     | 19.24     | 19.68            | 18.43              | 18.41              | 18.40              | 18.91              |
| Poorest quintile wealth index, 0/1              | 0.20         | 0.21      | 0.23      | 0.19             | 0.30               | 0.31               | 0.25               | 0.10               |
| Poorer quintile wealth index, 0/1               | 0.20         | 0.22      | 0.22      | 0.19             | 0.28               | 0.28               | 0.27               | 0.23               |
| Middle quintile wealth index, 0/1               | 0.21         | 0.20      | 0.19      | 0.19             | 0.20               | 0.19               | 0.23               | 0.29               |
| Richer quintile wealth index, 0/1               | 0.20         | 0.19      | 0.19      | 0.20             | 0.15               | 0.14               | 0.17               | 0.22               |
| Richest quintile wealth index, 0/1              | 0.19         | 0.19      | 0.18      | 0.23             | 0.07               | 0.07               | 0.08               | 0.15               |
| Household has access to electricity, 0/1       | 0.48         | 0.46      | 0.49      | 0.53             | 0.37               | 0.36               | 0.42               | 0.49               |
| Household has own TV, 0/1                       | 0.42         | 0.38      | 0.44      | 0.48             | 0.29               | 0.27               | 0.34               | 0.47               |
| Reads newspaper, 0/1                           | 0.14         | 0.16      | 0.14      | 0.19             | 0.05               | 0.05               | 0.05               | 0.07               |
| Visited family planning agents, 0/1            | 0.10         | 0.07      | 0.13      | 0.12             | 0.06               | 0.06               | 0.05               | 0.08               |
| Ethnicity – Fulani 0/1                         | 0.08         | 0.07      | 0.08      | 0.07             | 0.11               | 0.11               | 0.10               | 0.03               |
| Panel D: Ethnicity                             |              |           |           |                  |                    |                    |                    |
| Ethnicity – Hausa, 0/1                         | 0.32         | 0.29      | 0.35      | 0.25             | 0.46               | 0.47               | 0.46               | 0.32               |
| Ethnicity – Igbo, 0/1                          | 0.12         | 0.13      | 0.11      | 0.16             | 0.03               | 0.03               | 0.04               | 0.10               |
| Ethnicity – Yoruba, 0/1                        | 0.13         | 0.15      | 0.12      | 0.15             | 0.09               | 0.09               | 0.08               | 0.12               |
| Ethnicity – Other, 0/1                         | 0.35         | 0.36      | 0.34      | 0.37             | 0.31               | 0.30               | 0.31               | 0.42               |
| Panel E: Urbanisation                          |              |           |           |                  |                    |                    |                    |
| Night lights, = 0                              | 0.57         | 0.58      | 0.57      | 0.50             | 0.72               | 0.72               | 0.73               | 0.63               |
| Night lights, > 0 and ≤13                       | 0.19         | 0.19      | 0.20      | 0.21             | 0.17               | 0.17               | 0.14               | 0.23               |

(continued)
Table 1. (Continued)

| Variables                  | Pooled | 2008 | 2013 | Non-polygyny | Polygyny | Two wives | Three wives | Four or more wives |
|-----------------------------|--------|------|------|--------------|----------|-----------|-------------|-------------------|
| Night lights, >13 and ≤48   | 0.14   | 0.15 | 0.13 | 0.17         | 0.08     | 0.08      | 0.10        |                   |
| Night lights, > 48          | 0.09   | 0.08 | 0.10 | 0.12         | 0.04     | 0.04      | 0.05        | 0.05              |
| Rural, 0/1                  | 0.66   | 0.68 | 0.64 | 0.60         | 0.77     | 0.78      | 0.75        | 0.63              |
| Panel F: Zones              |        |      |      |              |          |           |             |                   |
| Zone – North Central 0/1    | 0.14   | 0.13 | 0.14 | 0.14         | 0.14     | 0.14      | 0.23        |                   |
| Zone – North East 0/1       | 0.17   | 0.16 | 0.17 | 0.14         | 0.22     | 0.22      | 0.20        |                   |
| Zone – North West 0/1       | 0.33   | 0.29 | 0.36 | 0.27         | 0.45     | 0.46      | 0.27        |                   |
| Zone – South East 0/1       | 0.09   | 0.10 | 0.09 | 0.12         | 0.03     | 0.03      | 0.09        |                   |
| Zone – South South 0/1      | 0.11   | 0.13 | 0.09 | 0.13         | 0.05     | 0.05      | 0.06        |                   |
| Zone – South West 0/1       | 0.16   | 0.18 | 0.15 | 0.19         | 0.11     | 0.11      | 0.16        |                   |
| Panel G: Instruments        |        |      |      |              |          |           |             |                   |
| Same sex                    | 0.51   | 0.51 | 0.50 | 0.50         | 0.51     | 0.51      | 0.51        |                   |
| N                           | 36,282 |15,916|20,366|24,221        |12,061    |9,680      |1,858        |523                |

Source: Authors and Nigeria Demographic and Health Survey (NDHS), 2013 and 2008; and NOAA’s National Geophysical Data Center.

Notes: DN = digital number; values range from 0 to 63.
29.7 months. The average number of siblings is 4.8. On average, mothers’ complete fewer years of education than their spouses, 4.6 and 6.2 years, respectively. The average age of mothers at first birth is about 19 years. Approximately 57 per cent of children live in areas with zero-night light.

Table 1 also reports outcome variables and child and parental characteristics by family structure status. On average, 33 per cent of the children in our sample live in polygynous families. Children in polygynous families have 33 per cent lower HAZ scores than children in monogamous families. Moreover, this difference can be detected not only on average but also across the entire distribution of the anthropometric status (Figure 1). Similarly, children in polygynous families are 31 per cent more likely to be stunted compared to those in monogamous families. Polygynous families are characterised by greater numbers of siblings. Mothers in polygynous unions complete three fewer years of education and give birth earlier than their monogamous counterparts.

4. Empirical methods and identification strategies

This section presents our empirical approach to estimating the effect of polygyny on child anthropometric measures. We follow previous research to guide our choice of control variables (Black et al., 2013, Smith, Ruel, & Ndiaye, 2005). Specifically, we control for the age of the child, number of siblings, mother’s educational attainment, mother’s age at first birth, spouse’s educational attainment, and household wealth status. We control for number of siblings and mother’s age at first birth because polygyny is associated with larger household sizes, which is associated with a higher risk of stunting (Black et al., 2013, Jayachandran & Pande, 2017, Kugler & Kumar, 2017, Pande, 2003). We also control for household wealth status$^8$ (Munro et al., 2019).

We first estimate the following standard ordinary least squares (OLS) regression for each survey year:

$$Y_{ch} = \beta_0 + \beta_1 polygyny_{ch} + \beta_2 X_{ch} + \beta_3 Z_{ch} + \mu + \varepsilon_{ch}$$ (1)
where $Y_{ch}$ stands for our anthropometric measures of a child (c) in household (h). Polygyny is denoted by a dummy variable that takes the value of one if a child’s mother reports her partner to have one or more co-wives. $X_{ch}$ represents a vector of child characteristics (including age and number of siblings), while $Z_{ch}$ captures a vector of parental characteristics, including mother’s educational attainment, mother’s age at first birth, spouse’s educational attainment, religion, and household wealth status. $\mu_v$ represents village-level dummies that may capture spatial differences in child undernutrition and related early child outcomes.

The parameter of interest is $\beta_1$ in Equation (1). A negative value implies that polygyny leads to child undernutrition, measured by HAZ and WHZ. Polygyny decisions are expected to be correlated with unobservable parental characteristics, which may also affect child nutritional investments. Thus, OLS estimation of Equation (1) may produce biased estimates of $\beta_1$.

We use an instrumental variable (IV) approach to investigate the effect of polygynous family structure on child undernutrition. An extensive literature exploits exogenous variation in birth patterns (for example, twinning or the sex composition of siblings) to assess issues such as labour choices, the child quantity-quality tradeoff, and child growth (Kaestner, 1997, Rosenzweig & Wolpin, 1980). Angrist and Evans (1998) were the first to propose an instrument constructed from the sex composition of the first two children born in a family. They argue that parents have preferences for a mixed-sex composition of children; hence, parents whose first two children are the same sex have a higher probability of adding children than those whose first two children have a mixed-sex composition.

We extend the argument to assert that men with two children of the same sex are consistently more likely to form a polygynous family (the desire for mixed-sex composition may trigger polygyny) than men whose first two children are of the opposite sex. We use a separate men’s questionnaire to construct a Gender Preference Index using ideal numbers of male and female children. The Gender Preference Index is defined for all men in the men’s sample (married, unmarried, with or without children) who indicate the ideal number of children is more than zero. We measure the Gender Preference Index through information on the ideal number of boys, girls, and children of either gender (such that 0 = ideally only girls, 0.5 = ideally equal numbers of boys and girls, 1 = ideally only boys). Table 2 shows that men’s desire for a balanced sex composition in their children is strong, but slightly different across zones (see Table A1 for more detailed information). The desire for a balanced sex composition is in line with previous evidence that shows fertility behaviour in Sub-Saharan African countries is characterised by the desire for mixed-sex composition (Norling, 2018, Rossi & Rouanet, 2015).

We also checked whether sufficient time existed between successive marriages to allow for two births. The average number of years between successive marriages is about 7.8 and 7.5 in 2008 and 2013, respectively (Table A2). The time between successive marriages is higher in urban areas than in rural areas. The overall results show that sufficient time exists between successive marriages to observe two births.

As we are focusing on early child nutritional outcomes in a context where preferences for mixed-sex composition are dominant (Kaestner, 1997, Norling, 2018, Rossi & Rouanet, 2015), we construct an instrument identifying children born to first wives whose first- and second-born children are of the same sex, that is, only sons [boy-boy] or only daughters [girl-girl]. Only the first two children of the first wife are considered. Identification of the effects of polygyny on child undernutrition is not without potential empirical challenges, as discussed in Section 4.

We exploit the exogenous variation in polygyny generated by the presence of first- and second-born same-sex siblings and estimate the following two-sample IV approach:

$$polygyny_h = \alpha_0 + \alpha_1 same_{-sex_{ch}} + \alpha_2 X_h + \alpha_3 Z_h + \mu_v + \varphi_h$$

(2)
Table 2. Men’s preferences for balanced sibling sex composition by area, geopolitical zone, and ethnicity

|                        | Married men in polygynous unions (%) | Sample of married men | Mean gender preference index | Sample of men who want children |
|------------------------|--------------------------------------|-----------------------|-----------------------------|---------------------------------|
|                        | 2008   | 2013   | 2008   | 2013   | 2008 | 2013 | 2008   | 2013   |
| National               |        |        |        |        |      |      |        |        |
| By sector              |        |        |        |        |      |      |        |        |
| Urban                  | 11     | 9      | 2552   | 3083   | 0.58 | 0.59 | 4541   | 6763   |
| Rural                  | 22     | 21     | 6211   | 5474   | 0.59 | 0.59 | 8658   | 9635   |
| By zone                |        |        |        |        |      |      |        |        |
| North Central          | 21     | 16     | 1644   | 1539   | 0.57 | 0.56 | 2644   | 2721   |
| North East             | 25     | 21     | 1759   | 1557   | 0.62 | 0.60 | 2349   | 2485   |
| North West             | 27     | 26     | 2222   | 2301   | 0.59 | 0.62 | 2238   | 4044   |
| South East             | 8      | 4      | 692    | 624    | 0.58 | 0.57 | 1356   | 1600   |
| South South            | 9      | 7      | 1086   | 1255   | 0.57 | 0.58 | 2165   | 2965   |
| South West             | 12     | 9      | 1360   | 1281   | 0.58 | 0.57 | 2447   | 2583   |
| By ethnicity           |        |        |        |        |      |      |        |        |
| Fulani                 | 25     | 23     | 763    | 600    | 0.62 | 0.63 | 862    | 827    |
| Hausa                  | 29     | 27     | 2214   | 2285   | 0.59 | 0.61 | 2226   | 3922   |
| Igbo                   | 7      | 3      | 912    | 848    | 0.58 | 0.57 | 1826   | 2136   |
| Yoruba                 | 14     | 8      | 1295   | 1171   | 0.58 | 0.57 | 2272   | 2336   |
| Other ethnicity        | 16     | 14     | 3579   | 3653   | 0.58 | 0.58 | 6013   | 7177   |
| By number of children  |        |        |        |        |      |      |        |        |
| 1                      | 3      | 3      | 1156   | 1316   | 0.58 | 0.58 | 1218   | 1464   |
| 2                      | 6      | 5      | 1277   | 1326   | 0.58 | 0.58 | 1252   | 1339   |
| 3 or more              | 27     | 26     | 5560   | 5091   | 0.57 | 0.58 | 5049   | 4773   |
| Number of sons         |        |        |        |        |      |      |        |        |
| 0                      | 6      | 6      | 1095   | 1152   | 0.56 | 0.57 | 1095   | 1209   |
| 1                      | 9      | 7      | 2105   | 2301   | 0.56 | 0.58 | 2066   | 2359   |
| 2                      | 15     | 15     | 1834   | 1909   | 0.57 | 0.58 | 1752   | 1839   |
| 3 or more              | 38     | 39     | 2959   | 2371   | 0.58 | 0.59 | 2606   | 2169   |
| Number of daughters    |        |        |        |        |      |      |        |        |
| 0                      | 7      | 5      | 1178   | 1330   | 0.60 | 0.60 | 1207   | 1406   |
| 1                      | 9      | 9      | 2295   | 2346   | 0.58 | 0.59 | 2230   | 2360   |
| 2                      | 16     | 16     | 1775   | 1765   | 0.57 | 0.58 | 1655   | 1695   |
| 3 or more              | 39     | 39     | 2745   | 2292   | 0.55 | 0.57 | 2427   | 2115   |

Sources: Authors; Nigeria Demographic and Health Survey (NDHS), 2013 and 2008.

Note: The index includes information on the ideal number of boys, girls, and children of either gender. 0 = ideally only girls, 0.5 = ideally equal numbers of boys and girls, 1 = ideally only boys. The Gender Preference Index is defined for all men in the sample of men (married, unmarried, or with or without children) who indicate the ideal number of children is more than zero. The Index includes information on the ideal number of boys, girls, and children of either gender.

\[
Y_{ch} = \beta_0 + \beta_1 \text{polygyny}_{ch} + \beta_2 X_{ch} + \beta_3 Z_{ch} + \mu_v + \epsilon_{ch}
\]  

(3)

where Equation (2) stands for the first-stage regression, and Equation (3) represents the second-stage regressions. The variable same.sex<sub><em>k</em></sub> is an indicator for children<sub><em>k</em></sub> whose mother<sub><em>h</em></sub> is a first wife with first- and second-born children of the same sex. The rest of the notation is similar to that in Equation (1). Theoretically, a positive value of \(\alpha_1\) in Equation (2) and a negative value of \(\beta_1\) in Equation (3) imply that a polygynous family structure has a detrimental effect on child nutritional outcomes (Becker, 1974, Rosenzweig & Wolpin, 1980).

To conduct causal inference on the effect of polygyny on early child undernutrition, we must confirm two identifying assumptions of the instrument. First, the same-sex instrument must be relevant and, hence, predict polygyny for those parents with two or more children. This is expected
to hold in view of men’s preferences for children with a mixed-sex composition. This can be empirically tested using the first-stage regression in Equation (2) as well as appropriate statistical tests to verify that this is indeed the case.

Second, the instrument should be valid, and hence uncorrelated with the error term in the second-stage equation. The latter requirement is more demanding as it implies that the sex composition of first-born siblings should not directly affect early childhood nutritional outcomes other than through polygyny and other control variables such as family size, parental education, and wealth indicators. Although the sex of a child is completely determined by nature, this may not be the case if parents have full control over the births and sexes of their children. For instance, abortion decisions based on the sex of the foetus may invalidate the instrument. However, the prevalence of selective abortion can be empirically and indirectly tested in our dataset. For instance, if selective abortion is widespread, the genders of consecutive births are expected to be correlated. We can also explore whether the sex ratio of births varies across birth order.

Recent studies show that birth patterns may influence some parental behaviour and sibling outcomes directly, other than through family structure (Black et al., 2005, Conley & Glaube, 2006, Dahl & Moretti, 2008, Deschênes, 2007, Rosenzweig & Wolpin, 2000, Rosenzweig & Zhang, 2009). For instance, Conley and Glaube (2006) find that the same sex of the first two children increased the likelihood of having three or more children, affecting children’s educational outcomes. As we control for the number of children and focus on early nutritional outcomes, the first challenge may not be a major problem. In an effort to uncover potential correlations, we run simple linear probability estimates of indicator variables for parents whose first two children are the same sex on some observable parent and child characteristics.

Finally, we estimate the effects by decomposing the same-sex indicator into two indicators: both boys and both girls. By doing so, we are able to conduct an overidentification (Sargan) test on the validity of these instruments. Fertility preferences and associated cultural norms as well as other unobserved factors that may influence child undernutrition are expected to be correlated with local attributes. Thus, in all regressions we cluster standard errors at the village level. We also examine whether polygyny’s effects on child nutritional status vary with household wealth status and levels of urbanisation. These results enable us to better understand which children are affected most.

5. Empirical results

5.1. Estimates of the effect of same-sex sibling composition on polygyny

We estimate the first-stage regression of the same-sex sibling indicator on polygyny with and without covariates and state fixed effects for the pooled surveys and for each survey separately (2008 and 2013). The results reported in Table 3 indicate that the same-sex sibling indicator appears with the expected sign. The positive and statistically significant (at 1 per cent) effect on polygyny of the occurrence of same-sex siblings in the first two births is an indication that same-sex siblings predict polygyny. The results also indicate that polygyny is correlated with a range of household characteristics as well as different levels of urbanisation. In particular, the polygynous family structure is explained by household wealth index categories, ethnicity, and urbanisation. Many of these correlations are similar to those in other studies that point to the importance of observable factors such as education, urbanisation, and ethnicity in driving polygyny family structure (Arthi & Fenske, 2018, Smith-Greenaway & Trinitapoli, 2014). For instance, we found that Hausa and Fulani ethnic groups are more likely to form polygynous unions than Igbo and Yoruba ethnic groups. The estimated result for the level of urbanisation (proxied by night-time light) is also interesting. The level affects the probability of polygyny negatively and significantly and the effect increases with level of urbanisation.

Before examining the effect of polygyny on child nutrition, we briefly discuss the quality of the selected instruments. We conduct two tests to probe their validity. First, to investigate whether the
Table 3. The effect of the presence of same-sex siblings on polygyny outcomes

|                                      | Pooled        | 2008          | 2013          |
|--------------------------------------|---------------|---------------|---------------|
|                                       | (1)           | (2)           | (3)           | (4)           | (5)           |
| Same sex                             | 0.018***      | 0.015***      | 0.016***      | 0.014***      | 0.019***      |
|                                       | (0.005)       | (0.006)       | (0.006)       | (0.007)       | (0.008)       |
| Mother’s educational attainment      | -0.018***     | -0.016***     | -0.015***     | -0.014***     |               |
|                                       | (0.001)       | (0.001)       | (0.002)       | (0.001)       |               |
| Spouse’s educational attainment      | -0.003***     | -0.003***     | -0.005***     | -0.002*       |               |
|                                       | (0.001)       | (0.001)       | (0.001)       | (0.001)       |               |
| Age of mother at first birth          | 0.001         | 0.001*        | 0.004***      | 0.000         |               |
|                                       | (0.001)       | (0.001)       | (0.001)       | (0.001)       |               |
| Wealth index quintile (Poorest is base) | 0.034***     | 0.037***      | 0.094***      | -0.031*       |               |
| 2nd quintile                         | (0.012)       | (0.012)       | (0.016)       | (0.016)       |               |
| 3rd quintile                         | 0.058***      | 0.069***      | 0.118***      | 0.006         |               |
|                                       | (0.015)       | (0.015)       | (0.019)       | (0.021)       |               |
| 4th quintile                         | 0.065***      | 0.081***      | 0.139***      | 0.018         |               |
|                                       | (0.017)       | (0.017)       | (0.023)       | (0.024)       |               |
| Richest quintile                     | 0.061***      | 0.073***      | 0.125***      | 0.016         |               |
|                                       | (0.020)       | (0.020)       | (0.027)       | (0.029)       |               |
| Ethnicity (Yoruba is base)            |               |               |               |               |               |
| Hausa                                | 0.068***      | 0.069***      | 0.070***      | 0.061***      |               |
|                                       | (0.015)       | (0.016)       | (0.022)       | (0.020)       |               |
| Fulani                               | 0.006         | 0.001         | 0.052*        | -0.014        |               |
|                                       | (0.020)       | (0.021)       | (0.029)       | (0.029)       |               |
| Igbo                                 | -0.128***     | -0.122***     | -0.103***     | -0.150***     |               |
|                                       | (0.014)       | (0.014)       | (0.018)       | (0.016)       |               |
| Others                               | -0.028*       | -0.031**      | -0.002        | -0.050***     |               |
|                                       | (0.012)       | (0.013)       | (0.017)       | (0.016)       |               |
| Level of urbanisation, night-time lights (DN = 0 is base) |               |               |               |               |               |
| DN > 0 & DN ≤ 13                     | -0.044***     | -0.047***     | -0.056***     | -0.059***     |               |
|                                       | (0.013)       | (0.014)       | (0.020)       | (0.016)       |               |
| DN >13 & DN ≤ 48                     | -0.105***     | -0.105***     | -0.133***     | -0.115***     |               |
|                                       | (0.015)       | (0.016)       | (0.021)       | (0.020)       |               |
| DN > 48                              | -0.126***     | -0.138***     | -0.179***     | -0.124***     |               |
|                                       | (0.017)       | (0.018)       | (0.022)       | (0.022)       |               |
| Year dummy (2013)                    | -0.003        | 0.007         | 0.004         |               |               |
|                                       | (0.005)       | (0.010)       | (0.010)       |               |               |
| State fixed effect                   | No            | No            | Yes           | Yes           | Yes           |
| R-squared                            | 0.05          | 0.10          | 0.11          | 0.11          | 0.11          |
| Observations                         | 31,993        | 31,993        | 31,993        | 13,935        | 18,058        |

Source: Authors; Nigeria Demographic and Health Survey (NDHS), 2013 and 2008; and NOAA’s National Geophysical Data Center.

Notes: DN = digital number; values range from 0 to 63. Standard errors are clustered at village level and given in parentheses. *** p < 0.01; ** p < 0.05; * p < 0.10.

The instrument is likely to be exogenous, we estimate a probit model regressing the same-sex sibling indicator on parental characteristics. Table 4 shows that all parental characteristics are statistically insignificant, which provides additional evidence that the occurrence of same-sex siblings in the first two births is unrelated to observable characteristics and is likely exogenous.

Second, we check whether the same-sex indicator has a direct effect on child nutritional outcomes. To do so, we regress child nutritional outcomes on the same-sex indicator and other covariates. The results show that the occurrence of same-sex siblings in the first two births has no significant effect, confirming that the same-sex indicator has no direct effect on child nutritional outcomes (see Appendix A3). We also
estimate the relationship between child health and the occurrence of same-sex siblings for the sample of monogamous women as a possible placebo analysis (see Appendix A5). We find no significant relationship between child nutritional outcomes and same-sex sibling composition, confirming that no reduced-form relationship exists between child undernutrition and same-sex sibling composition.

Finally, we report misspecification tests to detect whether the instrument suffers from a weak-instrument problem from the first stage and second stage (see the last rows of Tables 5 and 6). All tests are significant, indicating that our analysis does not suffer from a weak-instrument problem.

Table 4. The effect of parental characteristics on the presence of same-sex siblings

| Same-sex siblings: Outcome variable | (1) Pooled | (2) 2008 | (3) 2013 |
|-------------------------------------|-----------|----------|----------|
| Number of children                  | 0.002     | −0.005   | 0.008    |
|                                     | (0.004)   | (0.005)  | (0.005)  |
| Mother’s educational attainment     | 0.003     | −0.002   | 0.006    |
|                                     | (0.003)   | (0.004)  | (0.004)  |
| Spouse’s educational attainment     | −0.001    | −0.001   | −0.001   |
|                                     | (0.002)   | (0.003)  | (0.003)  |
| Age of mother at first birth         | 0.002     | 0.000    | 0.003    |
|                                     | (0.002)   | (0.004)  | (0.003)  |
| Wealth index quintile (Poorest is base) |           |          |          |
| 2nd quintile                        | 0.043*    | 0.054    | 0.039    |
|                                     | (0.026)   | (0.038)  | (0.034)  |
| 3rd quintile                        | 0.035     | 0.064    | 0.015    |
|                                     | (0.029)   | (0.041)  | (0.041)  |
| 4th quintile                        | 0.029     | 0.061    | 0.008    |
|                                     | (0.036)   | (0.050)  | (0.051)  |
| Richest quintile                    | 0.028     | 0.055    | 0.007    |
|                                     | (0.045)   | (0.064)  | (0.063)  |
| Ethnicity (Yoruba is base)          |           |          |          |
| Hausa                               | 0.014     | −0.029   | 0.047    |
|                                     | (0.033)   | (0.051)  | (0.045)  |
| Fulani                              | 0.063     | 0.017    | 0.107*   |
|                                     | (0.042)   | (0.063)  | (0.059)  |
| Igbo                                | −0.085**  | −0.086*  | −0.085*  |
|                                     | (0.034)   | (0.052)  | (0.049)  |
| Others                              | −0.030    | −0.028   | −0.026   |
|                                     | (0.029)   | (0.045)  | (0.039)  |
| Level of urbanisation, night-time lights (DN = 0 is base) |     |          |          |
| DN > 0 & DN ≤ 13                    | −0.027    | 0.012    | −0.055*  |
|                                     | (0.025)   | (0.039)  | (0.033)  |
| DN >13 & DN ≤ 48                    | 0.030     | 0.038    | 0.022    |
|                                     | (0.034)   | (0.050)  | (0.045)  |
| DN > 48                             | −0.036    | 0.047    | −0.081   |
|                                     | (0.044)   | (0.070)  | (0.056)  |
| Year dummy (2013)                   | −0.005    |          |          |
|                                     | (0.003)   |          |          |
| Constant                            | 10.101    | 0.040    | −0.113   |
|                                     | (6.914)   | (0.094)  | (0.088)  |
| Observations                        | 31,993    | 13,935   | 18,058   |

Source: Authors; Nigeria Demographic and Health Survey (NDHS), 2013 and 2008; and NOAA’s National Geophysical Data Center.

Notes: DN = digital number; values range from 0 to 63. Standard errors are clustered at village level and given in parentheses. *** p < 0.01; ** p < 0.05; * p < 0.10.
Table 5. OLS and IV estimates of the effect of polygyny on child height-for-age z-scores

|                          | Pooled OLS | Pooled IV | 2008 IV | 2013 IV |
|--------------------------|------------|-----------|---------|---------|
|                          | (1)        | (2)       | (3)     | (4)     | (5)     | (6)     | (7)     | (8)     |
| Polygyny                 | −0.318***  | −0.158*** | −0.168*** | −0.707*** | −0.510*** | −0.299*** | −0.235*  | −0.323*** |
|                          | (0.013)    | (0.012)   | (0.036) | (0.118) | (0.127) | (0.113) | (0.081) |          |
| Child is boy             | −0.093***  | −0.097*** | −0.010** | −0.010** | −0.010** | −0.010** | −0.016*  | −0.013    |
|                          | (0.010)    | (0.010)   | (0.000) | (0.000) | (0.000) | (0.000) | (0.127) |          |
| Age of child             | −0.012***  | −0.018*** | −0.012*** | −0.012*** | −0.012*** | −0.012*** | −0.011*** | −0.013*** |
|                          | (0.000)    | (0.002)   | (0.000) | (0.000) | (0.000) | (0.000) | (0.002) |          |
| Number of children       | 0.005**    | 0.004**   | 0.021*** | 0.013*** | 0.011*  | 0.015*** |          |          |
|                          | (0.002)    | (0.002)   | (0.004) | (0.004) | (0.006) | (0.005) |          |          |
| Mother’s educ. attainment| 0.013***   | 0.018***  | 0.004   | 0.005*  | 0.007*  | 0.005    |          |          |
|                          | (0.002)    | (0.002)   | (0.003) | (0.003) | (0.004) | (0.003) |          |          |
| Spouse’s educ. attainment| 0.003**    | 0.003**   | 0.002   | 0.000   | −0.002  | 0.003*   |          |          |
|                          | (0.001)    | (0.001)   | (0.002) | (0.002) | (0.002) | (0.002) |          |          |
| Age of mother at first birth| 0.005***  | 0.005***  | 0.010*** | 0.004** | 0.002   | 0.005**  |          |          |
|                          | (0.001)    | (0.001)   | (0.002) | (0.002) | (0.002) | (0.002) |          |          |

Wealth index quintile (Poorest is base)

|                          | 2nd quintile | 3rd quintile | 4th quintile | Richest quintile |
|--------------------------|--------------|--------------|--------------|-----------------|
|                          | (1)          | (2)          | (3)          | (4)             |
| 2nd quintile             | 0.073***     | 0.162***     | 0.251***     | 0.366***        |
|                          | (0.020)      | (0.023)      | (0.023)      | (0.031)         |
| 3rd quintile             | 0.073***     | 0.162***     | 0.251***     | 0.366***        |
|                          | (0.020)      | (0.023)      | (0.023)      | (0.031)         |
| 4th quintile             | 0.103***     | 0.209***     | 0.302***     | 0.414***        |
|                          | (0.022)      | (0.026)      | (0.028)      | (0.034)         |
| Richest quintile         | 0.075***     | 0.159***     | 0.243***     | 0.359***        |
|                          | (0.021)      | (0.026)      | (0.028)      | (0.034)         |
|                          | 0.143***     | 0.122***     | 0.221***     | 0.335***        |
|                          | (0.034)      | (0.040)      | (0.045)      | (0.054)         |

Level of urbanisation, night-time lights (DN = 0 is base)

|                          | DN > 0 & DN ≤ 13 | DN >13 & DN ≤ 48 | DN > 48       |
|--------------------------|------------------|------------------|---------------|
|                          | (1)              | (2)              | (3)           |
| DN > 0 & DN ≤ 13         | 0.037*           | 0.025            | 0.112***      |
|                          | (0.022)          | (0.017)          | (0.032)       |
| DN >13 & DN ≤ 48         | 0.039*           | 0.025            | 0.112***      |
|                          | (0.021)          | (0.017)          | (0.030)       |
| DN > 48                 | 0.013            | 0.041            | 0.049         |
|                          | (0.018)          | (0.022)          | (0.035)       |

Ethnicity (Yoruba is base)

|                          | Hausa           |
|--------------------------|-----------------|
|                          | (4)             |
|                          | (5)             |
|                          | (6)             |
| Hausa                    | −0.160***       |
|                          | −0.170***       |
|                          | −0.097***       |
|                          | 0.049           |
|                          | 0.008           |
|                          | 0.106**         |

(continued)
Table 5. (Continued)

|               | Pooled | Pooled IV | 2008 | 2013 |
|---------------|--------|-----------|------|------|
|               | OLS    | IV        | IV   | IV   |
|               | (1)    | (2)       | (3)  | (4)  |
| Fulani        | (0.024)| (0.024)   | (0.029)| (0.036)| (0.050)| (0.047)|
|               | (0.031)| (0.031)   | (0.035)| (0.037)| (0.056)| (0.046)|
| Igbo          | 0.243***| 0.283***| 0.182***| 0.084**| 0.067| 0.140***|
|               | (0.024)| (0.021)   | (0.027)| (0.039)| (0.057)| (0.049)|
| Others        | 0.035| 0.035     | 0.043*| −0.005| −0.005| 0.022|
|               | (0.021)| (0.021)   | (0.022)| (0.028)| (0.041)| (0.035)|
| Year dummy (2013)| 0.090***| 0.075***| 0.075***| 0.251***| 0.083***| 0.088***|
|               | (0.015)| (0.015)   | (0.015)| (0.017)| (0.016)| (0.015)|
| State Fixed Effect | NO     | NO       | YES  | NO   | YES  | YES   |
| Weak-Identification Tests |       |          |      |      |      |      |
| Keibergen-Paap Wald rk F stat. |       |          | 270.05| 188.67| 153.52| 116.67| 161.32|
| Cragg-Donald Wald F statistic |       |          | 302.09| 98.77| 62.36| 22.09| rk65.97|
| Weak-instrument-robust, inference |       |          |      |      |      |      |
| Anderson-Rubin F statistic |       |          | 27.02| 11.95| 9.72| 9.17| 14.46|
| Stock-Wright S statistic |       |          | 41.31| 33.92| 21.34| 20.49| 48.98|
| R-squared | 0.04| 0.12     | 0.14 | 0.03| 0.06| 0.12| 0.08| 0.14|
| N           | 31993| 31993    | 31993| 31993| 31993| 31993| 13,935| 18,058|

Source: Authors; Nigeria Demographic and Health Survey (NDHS), 2013 and 2008; and NOAA’s National Geophysical Data Center.
Notes: Standard errors are clustered at village level and given in parentheses. *** p < 0.01; ** p < 0.05; * p < 0.10.
Table 6. OLS and IV estimates of the effect of polygyny on child stunting rates

|                          | Pooled OLS | Pooled IV | 2008 IV | 2013 IV |
|--------------------------|------------|-----------|---------|---------|
|                          | (1)        | (2)       | (3)     | (4)     | (5)     | (6)     | (7)     | (8)     |
| Polygyny                 | 0.519***   | 0.235***  | 0.235***| 0.884***| 0.600***| 0.448***| 0.347***| 0.448***|
|                          | (0.008)    | (0.006)   | (0.006) | (0.025) | (0.065) | (0.069) | (0.102) | (0.086) |
| Child is boy             | 0.056***   | 0.056***  | 0.048***| 0.057***| 0.048***| 0.048***| 0.069   | 0.041***|
|                          | (0.005)    | (0.005)   | (0.006) | (0.005) | (0.006) | (0.005) | (0.008) | (0.007) |
| Age of child             | 0.004***   | 0.004***  | 0.004***| 0.004***| 0.004***| 0.004***| 0.006   | 0.006***|
|                          | (0.000)    | (0.000)   | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) |
| Number of children       | 0.007***   | 0.007***  | 0.006***| 0.007***| 0.007***| 0.007***| 0.008   | 0.008***|
|                          | (0.001)    | (0.001)   | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) |
| Mother’s educ. attainment| −0.005***  | −0.005*** | 0.004** | −0.001  | 0.001   | 0.002   | 0.003   | 0.003   |
|                          | (0.001)    | (0.001)   | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) |
| Spouse’s educ. attainment| −0.001     | −0.001    | 0.001   | 0.003   | 0.003   | 0.003   | 0.001   | 0.001   |
|                          | (0.001)    | (0.001)   | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) |
| Age of mother at first birth| 0.010***  | 0.010***  | −0.004***| −0.004***| −0.004***| −0.004***| 0.005   | −0.006**|
|                          | (0.001)    | (0.001)   | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) |

**Wealth index quintile (Poorest is base)**

|                          | 2008 IV | 2013 IV |
|--------------------------|---------|---------|
|                          | (4)     | (5)     |
|                          | (6)     | (7)     |
|                          | (8)     |
| 2008 IV                  | 0.01    | 0.01    |
|                          | (0.010) | (0.010) |
| 30th quintile            | −0.041**| −0.041**|
|                          | (0.011) | (0.011) |
| 40th quintile            | −0.097***| −0.097***|
|                          | (0.013) | (0.013) |
| Richest quintile         | −0.143***| −0.143***|
|                          | (0.016) | (0.016) |

**Level of urbanisation, night-time lights (DN = 0 is base)**

|                          | 2008 IV | 2013 IV |
|--------------------------|---------|---------|
|                          | (4)     | (5)     |
|                          | (6)     | (7)     |
|                          | (8)     |
| DN > 0 & DN ≤ 13         | −0.023**| −0.023**|
|                          | (0.010) | (0.010) |
| DN >13 & DN ≤ 48         | −0.010  | −0.010  |
|                          | (0.013) | (0.013) |
| DN > 48                 | −0.040***| −0.040***|
|                          | (0.015) | (0.015) |

**Ethnicity (Yoruba is base)**

|                          | 2008 IV | 2013 IV |
|--------------------------|---------|---------|
|                          | (4)     | (5)     |
|                          | (6)     | (7)     |
|                          | (8)     |
| Hausa                    | 0.218***| 0.218***|
|                          | 0.151***| 0.143***|
|                          | 0.175***| 0.108***|

(continued)
|                        | Pooled OLS | Pooled IV | 2008 IV | 2013 IV |
|------------------------|------------|-----------|---------|---------|
|                        | (1)        | (2)       | (3)     |         |
| Fulani                 |            |           |         |         |
|                        | (0.012)    | (0.012)   | (0.016) | (0.021) |
|                        | 0.162***   | 0.162***  | 0.118***| 0.121***|
|                        | (0.016)    | (0.016)   | (0.020) | (0.022) |
| Igbo                   |            |           |         |         |
|                        | (0.012)    | (0.012)   | 0.015   | 0.056***|
|                        | −0.047***  | −0.047*** |         |         |
|                        | (0.015)    | (0.021)   |         |         |
| Others                 |            |           |         |         |
|                        | (0.011)    | (0.011)   | 0.087***| 0.116***|
|                        | 0.097***   | 0.097***  |         |         |
|                        | (0.012)    | (0.017)   |         |         |
| Year dummy (2013)      | 0.266***   | −0.035*** | −0.035***| 0.013   |
|                        | (0.007)    | (0.008)   | (0.008) | (0.009) |
|                        | 0.011      | (0.011)   | (0.017) |         |
|                        | (0.008)    | (0.008)   |         |         |
|                        | 0.044***   | −0.047*** |         |         |
|                        | (0.025)    | (0.021)   |         |         |
| State fixed effect     | NO         | NO        | YES     | YES     |
| Keibergen-Paap Wald F stat. | 210.05 | 178.67 | 78.67 | 86.67 |
| Cragg-Donald Wald F statistic | 135.09 | 188.77 | 88.77 | 52.09 |
| Anderson-Rubin F statistic | 72.02 | 25.53 | 21.95 | 10.17 |
| Stock-Wright S statistic | 40.31 | 31.39 | 23.92 | 20.49 |
| R-squared              | 0.03       | 0.10      | 0.12    | 0.03    |
|                        | 0.03       | 0.08      | 0.11    | 0.08    |
| N                      | 31993      | 31993     | 31993   | 31993   |
|                        | 13,935     | 18,058    |         |         |

**Source:** Authors; Nigeria Demographic and Health Survey (NDHS), 2013 and 2008; and NOAA’s National Geophysical Data Center.

**Notes:** Standard errors, clustered at LGA level, are given in parentheses. * p < 0.10, ** p < 0.05, *** p < 0.01.
5.2. Instrumental variable estimates of child undernutrition

Tables 5 and 6 report estimation results using OLS and two-sample IV approaches for child HAZ and stunting, respectively. Columns 1–3 report the OLS estimates, while columns 4–8 report the IV estimates. The IV estimates for child undernutrition are similar in sign to the OLS estimates; the results obtained from the OLS and IV estimates confirm that polygyny has significant, negative effects on child undernutrition. It is notable that the IV estimate is an Average Treatment Effect (ATE). Consequently, comparing IV and OLS results is not straightforward. The IV estimates for the variables of interest are larger than the OLS estimates, since our data show that the likelihood that a household switches to polygyny by drawing same-sex children is a function of wealth. Poorer households switch to polygyny after drawing same-sex children with more likelihood than richer households, which implies that the IV approach is estimating the effect of polygyny for these complier (poorer) households while OLS measures the effect of polygyny on the average household.

Comparing the unconditional and conditional estimates in Tables 5 and 6 provides insights on the potential mechanisms through which polygyny can lead to lower child nutritional outcomes. For instance, the estimates on the effect of polygyny in the pooled regressions almost halve for HAZ when we control for child characteristics, socioeconomic and wealth indicators, and state fixed effects, suggesting, as expected, that part of the link between polygyny and child undernutrition is mediated through these channels. Nevertheless, the estimated coefficients on polygyny remain sizeable and strongly statistically significant even after controlling for these characteristics. It is important to stress, however, that this analysis does not provide insights as to the underlying reasons for this outcome. Indeed, polygynous families may have different behavioural practices towards children, they may be sceptical about modern medical practices, and the reduced bargaining power of women associated with polygynous families could be associated with higher rates of child undernutrition that we did not control for (Arthi & Fenske, 2018, Le Strat et al., 2011, Smith-Greenaway & Trinitapoli, 2014, Wagner & Rieger, 2015). Therefore, our preferred estimates are from the IV models that control for child, parental, and state fixed effects.

Table 7, Panel A, compares these OLS estimates with IV estimates regarding the impact of polygyny on child WHZ. The odd columns report OLS results while the even columns report the IV estimates. The coefficient is only statistically significant in the IV results and larger in magnitude. This difference between the OLS and IV estimates suggests that correcting for sample selection affects the results. Polygyny decreases the child WHZ score by 58 per cent at the mean child WHZ, 0.45 (Column 4). Table 7, Panel B, reports the impact of polygyny on the prevalence of child wasting. The results indicate that polygyny results in a 6 percentage point increase in child wasting (Column 4). When we look at wasting by survey year, we find polygyny results in a 6 percentage point increase in child wasting in 2008 and a 7 percentage point increase in 2013. The impact of polygyny on child wasting is lower compared to child stunting. This is not surprising given that child wasting is a more transitory measure of under-nourishment, while stunting captures relatively longer-term conditions (Haddad, Ruel, & Garrett, 1999).

6. Concluding remarks

Polygyny remains prevalent in Nigeria, where about one out of three children live in polygynous families. The prevalence of polygynous households did not change between the 2008 and 2013 Nigeria DHS. Similarly, child undernutrition remains high in Nigeria with about one out of three children estimated to be stunted in 2013. The persistence of polygyny and child undernutrition suggests that the sociocultural dimensions of polygyny might also serve as drivers of undernutrition in children.

While interest is growing in the research literature to explore how social and cultural practices such as polygyny may affect child nutrition, the nexus has not been decisively established because of the complexity of the relationship. Furthermore, unobservable household characteristics may simultaneously influence both the decision to form a polygynous union and the decision to adequately nourish children. We tackle this issue using an IV approach applied to the 2008 and 2013 Nigeria DHS. Based on evidence that men prefer families composed of both sons and daughters, we
Table 7. OLS and IV estimates of the effect of polygyny on child WHZ and child wasting rates

| Panel A: Child WHZ | Pooled | 2008 | 2013 |
|--------------------|--------|------|------|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| OLS | IV | OLS | IV | OLS | IV | OLS | IV | OLS | IV |
| Polygyny | −0.098*** | −0.127*** | −0.101 | −0.643*** | −0.115 | −0.667*** | −0.118 | −0.551*** |
| | (0.076) | (0.043) | (0.114) | (0.134) | (0.122) | (0.208) | (0.117) | (0.162) |
| Other controls | No | No | Yes | Yes | Yes | Yes | Yes | Yes |
| Year dummy (2013) | −0.098*** | −0.050*** | −0.214*** | −0.210*** | 0.06 | 0.07 | 0.13 | 0.12 |
| | (0.013) | (0.018) | (0.019) | (0.020) | (0.012) | (0.017) | (0.015) | (0.012) |

**Weak-Identification Tests**
- Keibergen-Paap Wald rk F stat.
- Craddock-Donald Wald F statistic

**Weak-instrument-robust, inference**
- Anderson-Rubin F statistic
- Stock-Wright S statistic

R-squared

| Panel B: Child Wasting Rate | Probit | 2008 | 2013 |
|-----------------------------|--------|------|------|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| Probit | IV | Probit | IV | Probit | IV | Probit | IV | Probit | IV |
| Polygyny | 0.091*** | 0.141*** | 0.023 | 0.058*** | 0.049 | 0.056*** | 0.015 | 0.069*** |
| | (0.014) | (0.008) | (0.015) | (0.024) | (0.033) | (0.038) | (0.023) | (0.038) |
| Other controls | No | No | Yes | Yes | Yes | Yes | Yes | Yes |
| Year dummy (2013) | 0.090*** | 0.256*** | 0.078*** | 0.087*** | 0.06 | 0.07 | 0.13 | 0.12 |
| | (0.015) | (0.017) | (0.015) | (0.016) | (0.012) | (0.015) | (0.012) | (0.012) |

**Weak-Identification Tests**
- Keibergen-Paap Wald rk F stat.
- Craddock-Donald Wald F statistic

**Weak-instrument-robust, inference**
- Anderson-Rubin F statistic
- Stock-Wright S statistic

R-squared

Observations

Source: Authors; Nigeria Demographic and Health Survey (NDHS), 2013 and 2008; and NOAA’s National Geophysical Data Center.

Notes: Standard errors, clustered at LGA level, are given in parentheses. * p < 0.10, ** p < 0.05, *** p < 0.01.
instrument polygyny with the gender of the first two births born to first wives and identify same-sex first- and second-born children; that is, only sons [boy boy] or only daughters [girl girl]. We then estimate the effect of polygyny on child anthropometric measures.

Our results show that the occurrence of same-sex siblings in the first wife’s first two births is a predictor of polygyny – men tend to form polygynous families if the first two children born are of the same sex. In line with previous studies (Arthi & Fenske, 2018, Bourdier, 2019, Hadley, 2005, Sellen, 1999, Smith-Greenaway & Trinitapoli, 2014, Wagner & Rieger, 2015), we find a detrimental effect of polygyny on child undernutrition. Our results show that the effect of polygyny is substantially reduced when we control for household and child characteristics and wealth indicators, suggesting that part of the link between polygyny and child undernutrition is mediated through these channels. Nevertheless, the estimated coefficients on polygyny remain sizeable and strongly statistically significant even after controlling for these characteristics.

Childhood growth relates to factors such as care, quality of diet, health of the mother, and sanitary conditions of the household. Polygyny itself is not a direct driver of undernutrition among children. Rather, polygyny is a marker for unobserved factors, particularly socio-cultural factors, that (i) are difficult to capture in standard household surveys and (ii) have deleterious effects on child nutrition. These unobserved factors might include direct effects such as inferior childcare practices or broad-based scepticism of modern practices in medical and other domains or indirect effects, such as low bargaining power of women, that are known to influence nutrition outcomes. In short, while we can conclude that certain socio-cultural factors, as captured by the presence of polygyny, are impeding progress towards the goal of dramatically reducing child nutrition in Northern Nigeria, we are not able here to identify which of these factors are most important. Indeed, polygyny could, in principle, be proxying for an array of factors each of whose individual effects are very small but whose aggregate impact is significant.

Although this might be a shortcoming in our analysis, we still believe that a relatively easy to observe marker like polygyny has considerable value, particularly for policy purposes. For example, community health workers should be aware that young children in polygynous households are at greater risk for undernutrition and that, at the same time, these same households may be more resistant to changes in practices.

The agenda for future research in this important area remains large in order to address further questions. For example, should strategies for reducing child undernutrition in zones with high rates of polygyny, such as Northern Nigeria, focus on discouraging the practice generally on the assumption that the associated impacts on child nutrition will wane along with polygyny itself? Is a focus on enhancing women’s empowerment an effective means for limiting polygyny that also brings a range of other benefits? And, in the meantime, are there actionable ways to reduce the detrimental impact of polygyny on child nutrition?

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Notes

1. The widespread prevalence of polygynous families could explain, in part, why child stunting rates remained stagnant over the past one and half decades in sub-Saharan African countries, where the under-five stunting rate merely reduced from 38 per cent in 2000 to 32 per cent in 2016 (World Health Organization [WHO], 2017).
2. Polygyny, the practice of one man being married to multiple wives at the same time, is a common family structure in many parts of sub-Saharan Africa.
3. In contrast, other highly populated countries have witnessed considerable declines in child undernutrition (Headley, 2013). For example, Bangladesh reduced its stunting prevalence from 51 per cent in 2004 to 36 per cent in 2014.
4. More recently, Anjorin et al. (2020), using a multilevel analysis of cross-sectional surveys for a group of 32 countries in Sub-Saharan Africa, found that polygyny at the contextual level has been a major factor of undernutrition in these countries although the results vary substantially among countries in the group.
5. It is notable that Becker (1974) and Grossbard (1978) were the first to examine to the economic effects of polygyny, with further contributions by Bergstrom (1994). More recently Gould, Moav, and Simhon (2008) and Lagerloef (2005) paid particular attention to the importance of heterogeneity for polygyny and the quality-quantity trade-off for children. Tertilt (2005), by using a quantitative model of the overall impact of polygyny on development in Sub-Saharan Africa, showed that enforcing monogamy lowers fertility, shrinks the spouse age gap, and reverses the direction of marriage payments.
6. Lower resource levels are associated with lower expenditures on food and nutrition-relevant nonfood expenditures, such as health, sanitation, electricity, water, and housing quality. which can deteriorate the nutrition status of children (Omariba & Boyle, 2007).
7. Less educated parents may also achieve less diverse income due to limited labour market participation. A more diverse set of income sources could help to improve the nutritional status of children.
8. Household welfare is measured using a wealth index constructed using a principal components analysis that combines ownership of durable goods, such as radios, bicycles, and cars, and housing characteristics (Rutstein & Johnson, 2004).
9. Rosenzweig and Wolpin (2000) argue that same-sex siblings may involve reduced childbearing expenditures for parents, probably because they can share clothing and footwear.
10. In our robustness exercises we use same sex × wealth interaction as alternative instruments and main results remain similar (see Table A4).

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