Economics and Human Biology 28 (2018) 67–78

Contents lists available at ScienceDirect

Economics and Human Biology

journal homepage: www.elsevier.com/locate/ehb

Fertility and the health of children in Indonesia

Timothy J. Hatton[a,b,*], Robert Sparrow[c], Daniel Suryadarma[a,d], Pierre van der Eng[a]

[a] Australian National University, Canberra, ACT 2601, Australia
[b] University of Essex, Colchester CO4 3SQ, UK
[c] Wageningen University, 6708 PB Wageningen, Netherlands
[d] SMERU Research Institute, Jakarta 10330, Indonesia

ARTICLE INFO

Article history:
Received 9 May 2017
Received in revised form 3 December 2017
Accepted 9 December 2017
Available online 13 December 2017

JEL classification:
D19
I19
I31
J13

Keywords:
Height
Child health
Family economics

ABSTRACT

We analyse the heights of children aged 2 to 12 in the Indonesian Family Life Survey (IFLS) focusing on the effect of the number of children in the family. Previous studies of the trade-off between the quantity of children and some measure of their quality have been much concerned with the endogeneity of fertility choices. Here we use the IFLS for 1993, 1997 and 2000 to exploit some unique institutional features that have influenced fertility. We find evidence that family size is influenced both from the supply side, as represented by components of the Indonesian family planning programme, and on the demand side, as represented by exposure to modern media. We use these variables as instruments for family size in regressions for the height z-scores. We find evidence for a significant negative effect of family size on height in the presence of a range of other influences. An increase of one sibling is associated with a decrease of one third of a standard deviation in the z-score of height. This effect is stronger among families with low-educated mothers and is present in both urban and rural settings.

1. Introduction

It is well known that health and physical fitness are influenced by conditions during childhood. A key indicator of the health status of children is their height, which is determined both by nutrition and infection. These in turn are influenced by conditions both within and outside the household. Here we examine the relationship between family size and the heights of children aged 2 to 12 using the first three waves of the Indonesian Family Life Survey (IFLS). In doing so we combine insights from two literatures. The first is the literature on the relationship between height and family size, often interpreted as a 'quality versus quantity' trade-off. The second is the literature on the determinants of fertility, in particular on the effects of family planning programmes and of other factors that influence the choice of family size. In this paper we first estimate the determinants of family size; subsequently we use these variables as instruments in a model of the determinants of height.

There is a large literature on the quality-quantity tradeoff, initially focusing on education, but also on the health and particularly on the heights, of children in households with different sized families. Studies, first of rich countries and later of developing countries, have produced mixed results and one of the key issues has been accounting for the potential endogeneity of family size. While within-family variables (such as twins) have often been used, there remain doubts about whether such variables are truly exogenous. Here we use community-level variables, in particular the establishment in the district of family planning services and the district's access to television broadcasts. For this purpose Indonesia is especially interesting as it was one of the pioneers among developing countries in the establishment of a comprehensive family planning programme. This programme was rolled out from the 1970s to 2000 after which it fell into decline. For this reason we focus on families with mothers aged 21–40 in the first three waves of the IFLS. These families would also have been influenced by the advent of television broadcasts which diffused across the country from the mid-1970s onwards and which have been found by other studies to shift preferences towards small families. Thus we are able to capture both supply side influences (access to contraception) and demand side influences (access to television) on fertility choices.

An important literature models fertility rates as depending either on the advent of family planning or on factors that influence tastes or opportunity costs. By contrast, we focus on family size (the stock rather than the flow) and we explain this by the arrival of

* Corresponding author at: Department of Economics, University of Essex, Colchester CO4 3SQ, UK.
E-mail address: hatton@essex.ac.uk (T.J. Hatton).

https://doi.org/10.1016/j.ehb.2017.12.002
1570-677X/

key facilities in the community at critical points in the life cycle of the mother. In particular we find that the arrival of a contraceptive distribution facility around the time that the mother was aged 20 and the arrival of TV when the mother was around 30 both reduced family size. Using these variables as instruments, we estimate the effect of family size on the heights on 7462 observations for children aged 2 to 12 in the three IFLS waves. We find a significant negative effect of the number of siblings on height. This effect is robust to adding controls for parental education, family expenditure and a range of community facilities. We also find that the family size effect is stronger in families with low educated mothers but is present in both rural and urban settings.

2. Quality and quantity

The tradeoff between the quality and quantity of children has remained a controversial issue since the early studies that focused on sibship size and completed education (Becker and Lewis, 1973; Becker and Tomes, 1976; Willis, 1973). The underlying model is one in which forward-looking parents choose simultaneously the number of children and the amount invested in enhancing the quality of the children, subject to a budget constraint (see Ermisch, 2003, Ch. 6). The model predicts that an exogenous increase in the number of children reduces their average quality. However a number of studies have cast doubt on whether there is a negative correlation between the sibship size of a family and child quality, as measured by education (Angrist et al., 2010; Black et al., 2005). Such results could be due to analyzing families that are small and relatively affluent and in settings where education is free or heavily subsidized and/or constrained by compulsory schooling regulations. Indeed, in China where families are small, possibly due to the one-child policy, the results are mixed. While some studies find a negative relationship between sibship size and a child's education (Li et al., 2008; Rosenzweig and Zhang, 2009), others find a negligible or even a positive effect (Qian, 2009; Liu, 2014).

Here we focus on child health, as reflected by height, in a developing country setting. Height is determined during childhood, especially early childhood, by a combination of nutrition (both its level and its composition) and the incidence of disease. These in turn are conditioned by socioeconomic conditions in the household and in the locality. One such influence is family size, which affects child health not only because there are more mouths to feed for a given income but also due to crowding and the spread of infection. A number of studies find negative effects of sibship size on height as well as on other indicators of health status. The influence of family size on health and height seems to be stronger than that for education, perhaps because its influence comes at earlier ages and is less affected by external influences. For China Liu (2014) finds a negative effect of sibship size on height but no such effect for child educational enrolment or attainment. On the other hand Rosenzweig and Zhang (2009) find negative effects for both outcomes. Other countries for which a negative relationship between height and sibship size have been found include Ghana (Alderman, 1990) and Romania (Glick et al., 2006) although only the latter treats sibship as endogenous.[1]

A few studies have explored the effect of family size on the outcomes for children in Indonesia. Maralani (2008) used the 1993 and 1997 waves of the IFLS to estimate the family size effect on completed education for four cohorts born between 1948 and 1981. She used the number of miscarriages experienced by their mothers as an instrument for completed family size. Negative family size effects were found only for the two most recent cohorts and for those living in urban areas. Millimet and Wang (2011) used the IFLS for 2000 to study the effect of family size on the heights of children aged under the age of 11. Using OLS they find a negative effect of family size, but this becomes insignificant when instrumented with a dummy for the first two children having the same sex. Thus, although there is some evidence that Indonesian families prefer a balanced sex composition (Guilmoto, 2015), this apparently does not provide a sufficiently strong determinant of family size.

Other variables also influenced health and height of children in Indonesia. Using IFLS data for 2000 Cameron and Williams (2009) find a strong positive relationship between child heights and family income or expenditure per capita for Indonesia and similar results have been found for other countries. There is also evidence that the food supply programme implemented in 1998–2000 mitigated some of the effect of the recession on the heights of children under three years of age (Giles and Satriawan, 2015).[2] Environmental influences such as air pollution due to forest fires have also influenced heights in Indonesia (Kim et al., 2017).

The existing studies that have focused on health and height find negative effects in OLS but much weaker effects when using instrumental variables (IV). The instruments used in IV analysis are often within-family variables, which suffer from possible biases.[3] At the same time there is a substantial literature on the relationship between fertility and a range of variables at the local level including policy-driven family planning facilities and media-driven changes in attitudes.

3. Influences on fertility

As in other developing countries, fertility in Indonesia has fallen dramatically since the 1970s. As Fig. 1 shows the crude birth rate fell, from 35.1 per thousand in 1965–70 to 17.4 in 2005–10. The total fertility rate (right scale) fell even more steeply, and especially from the 1970s. Between 1970–5 and 1995–2000 it fell by half, from 5.3 to 2.55 children per woman, declining more slowly thereafter. One possible influence is the spread of family planning. This began in 1968 under President Soeharto's New Order government with the establishment of the National Family Planning Institute, which was superseded in 1970 by the National Family Planning Coordinating Board (BKKBN). Policy was designed to slow population growth and to improve health particularly that of women and children (Lubis, 2003; Hull, 2003). Beginning with Bali and central and eastern Java, the programme was extended in stages, to cover all Indonesian provinces. Policy was directed at the provincial level and was passed down through the political hierarchy to be implemented at the local level. The programme initially involved setting up contraceptive distribution points (PPKBD) at the village level managed by fieldworkers with the assistance of volunteers.[4] In addition to providing subsidized contraceptives PPKBD acquired other functions, notably the provision of information about fertility control.

[1] Different approaches to the identification of family size are discussed by Schultz (2008) and, in the context of China's one child policy, by Zhang (2017).

[2] Historical studies support the association between height and income in Indonesia. Among birth cohorts from 1950 to the 1990s average final height increased by about a centimeter per decade (Baten et al., 2013; Foldvari et al., 2013). This coincides with rapid increase in the supply of proteins, mainly from vegetable sources (Van der Eng, 2000).

[3] Apart from the advent of twins, the most widely used within-family variables are first birth interval (a proxy for fecundity) and the sex composition of the first two children. Such instruments may only be relevant for higher birth order children and they may suffer from endogeneity. For example, in the case of the same-sex instrument, there may be differences in economies of scale of child-rearing for same-sex and mixed-sex families. The use of sex-composition as an instrument is discussed by Baez (2008) and Fernihough (2017).

[4] PPKBD stands for *Pembantu Pembina Keluarga Berencana Desa*, which refers to an assistant manager of family planning at the village level. For details of the development and local organisation of family planning groups see Shiffman (2002).

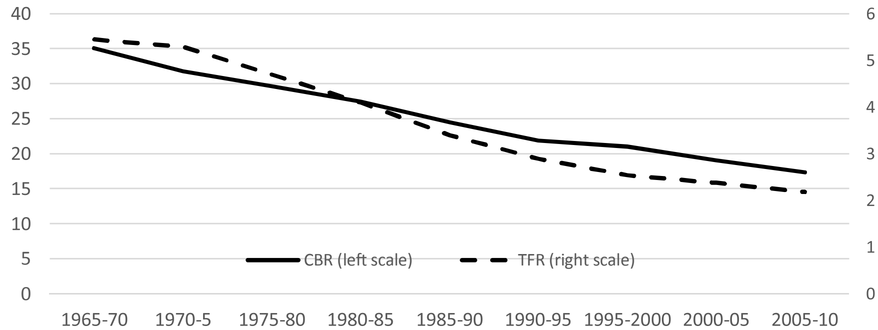

Fig. 1. Indonesian Fertility rates, 1965–2010.
Source: United Nations, World Population Prospects, the 2012 Revision.

From the 1980s some of these functions were also embodied in integrated health posts that became known as *Posyandu*. But the main focus of these was to provide pre- and post-natal health care for women and children under the age of 5. From the late 1980s the BKKBN introduced subsidized family planning provided by the private sector (*KB Mandiri*) in order to ensure long run sustainability. By the end of the 1990s contraceptive prevalence, using official programme methods (mainly the pill, IUD and injection) exceeded 50 percent. From that time onwards the number of acceptors increased more slowly to reach 57 percent by 2007. In part that might be due to decreasing effectiveness of family planning policies. Following the resignation of president Soeharto in 1998 there was a movement to decentralize health and education services down to the district level together with a shift towards private providers. However, there was considerable persistence and the BKKBN itself was not effectively decentralized until 2004 (Hull and Mosley, 2009).

The effects of family planning programmes on fertility have been widely debated (for a recent survey see Miller and Babiarz, 2016). Early studies of Indonesia that focused on the diffusion of family planning clinics at the local and regional level found that the effects on fertility were modest. Estimating at the village level, Pitt et al. (1993) found no effect at all on fertility between 1976 and 1986. Estimating birth hazards, Gertler and Moylneux (1994) found that family planning policy accounted for 4–8 percent of the decline in fertility in 1982–87, while Molyneaux and Gertler (2000) found that contraceptive subsidies accounted for 3–6 percent of the decline in 1985–94. However, using a longer period and treating education and marriage as endogenous, Angeles et al. (2005) found that the long-run effect of the Indonesian family planning programme was to reduce completed fertility by 20 percent, or nearly one child per woman. More recently, Kim (2010) analysed the effect of mother's education and family planning facilities on birth spacing using the IFLS. He found that contraceptive distribution points in the locality accounted for 16 percent of the decline in the hazard of a second birth, and this effect was concentrated among mothers with some post-primary education.

In Indonesia, as elsewhere, much of the emphasis of family planning was on shifting preferences and not just on supplying the means to control fertility (Hull and Hull, 2005). While there was resistance among conservative Muslim groups through the 1980s, these increasingly acquiesced in, and sometimes actively promoted, family planning (Menchik, 2014). Cross-country comparisons of desired and actual family size suggests that there is little evidence that official programmes supplied an unmet need for family planning. For a range of developing countries Pritchett (1994) found that there was a close match between the total fertility rate and the number of children that women desired. Nevertheless there is evidence that both actual and desired fertility declined over time and the gap between them diminished, suggesting that family planning had some independent effect (Bongaarts, 2014; Günther and Harttgen, 2016). Changing preferences for smaller families were also driven by other developments. These include improvements in women's education and employment opportunities (Gertler and Molyneaux, 1994; Molyneaux and Gertler, 2000; Angeles et al., 2005; Kim, 2010), as well as reduced opportunities for labour and increased opportunities for education among children (Suryahadi et al., 2005).

More recently, several studies have suggested that exposure to television programmes, in which small families are presented as the norm, may cultivate a preference for smaller families. Studies for India and Brazil find that access to television, which featured western-style soap operas, had significant fertility-reducing effects (Jensen and Oster, 2009; La Ferrara et al., 2012). TV viewing might also increase the opportunity cost of time as well as providing information about family planning. For Indonesia, Grimm et al. (2015) found that the effects of the diffusion of mains electricity across districts reduced fertility by 18–24 percent. This effect was largely attributable to access to television, as coverage spread rapidly in the 1970s and 1980s. In a recent study of Indonesian villages, Dewi et al. (2017) found that the geographic expansion of TV coverage reduced fertility from 1994 to 2009 by 6 percent. In these villages the advent of TV was also associated with greater use of modern contraception. Taken together this evidence suggests that fertility choices are influenced both by preferences for smaller families and by access to the knowledge and the means of family planning.

4. Data, model, and identification strategy

The principal data source used in this study is the Indonesian Family Life Survey (IFLS). This is a panel study of Indonesian families that began in 1993 with subsequent waves in 1997, 2000 and 2007. Full details can be found in Frankenberg and Thomas (2000) and Strauss et al. (2004). The IFLS surveyed families in 13 provinces, out of a total of 27 in 1993, but they include more than 83 percent of the population of Indonesia. These provinces are chiefly in Java and Sumatra, and they include 312 randomly selected enumeration areas in 149 separate districts (rural *Kabupaten* or urban *Kota*). The survey covers more than 7000 households and 30,000 separate individuals. The sampled households were followed up in subsequent waves, including newly formed households, with 91 percent surveyed in all of the first three waves.

The IFLS contains information on a range of household and individual characteristics for both adults and children. We focus on children aged 2 to 12, whose mothers were aged from 21 to 40 at the time of observation. This ensures that the households in our dataset are at a stage in the life cycle before the children have left home. In this study, we use the first three waves of the IFLS for 1993, 1997 and 2000. One reason for this is to focus on the era

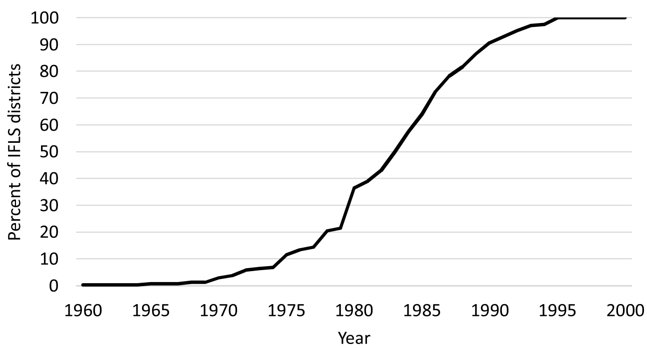

Fig. 2. Diffusion of PPKBD Distribution Points.
Source: Author calculations, see text.

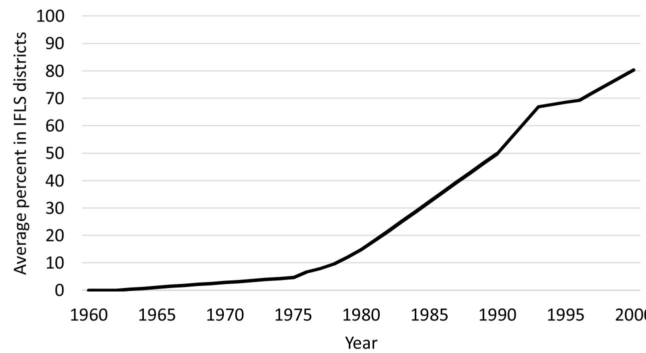

Fig. 3. Diffusion of television in IFLS districts.
Source: Author calculations, see text.

before the deregulation of the family planning programme that took place in the early 2000s. A second reason is to avoid fragmentation of districts in the local government reorganization that took place from 2001 (see Fitrani et al., 2005). As explained further below, we create variables that capture the exposure of mothers to family planning facilities and to TV coverage at different ages. We therefore exclude mothers who, at the age of 12 were living in a different district from that in which they are observed.

The dataset is rich in the context of developing countries, allowing us to control for more sources of bias than has been possible in other developing countries. Strauss et al. (2004) note that the dataset collects economic and non-economic well-being, marriage, fertility, health status, use of health care, various retrospective information, and conditions in the areas where adult respondents had lived when they were born and when they were 12 years old. In addition, IFLS also collects information on communities in which the respondents currently reside, such as infrastructure, food prices, and the availability and quality of health and education facilities.

Our estimating model consist of two equations. The first characterizes the number of children in the family as:

$$Sibs_{fdpt} = X_{fdpt}\alpha_1 + Z_{fdp}\alpha_2 + \theta_p + \delta_{ft} \tag{1}$$

Where $Sibs_{fdpt}$ is the number of children in family f in district d of province p, at time t. $\mathrm{X}_{\mathrm{fdpt}}$ is a vector of other household characteristics, θ_p is a set of province-level fixed effects and δ_{ft} is an individual error term for family f at time t. The term Z_{fdp} aims to capture community-level influences on the family, particularly the mother, that represent preferences over fertility and the knowledge or availability of family planning. These variables are then used as instruments in estimating the following equation for child height.

$$H_{ifdpt} = Sibs_{fdpt}\beta_1 + X_{fdpt}\beta_2 + Y_{ifdp}\beta_3 + \mu_p + \varepsilon_{ift} \tag{2}$$

Where H_{ifdpt} is the height of child i in family f in district d and province p, at time t. $Sibs_{fdpt}$ is the number of children that child i's mother has, observed at time t and, as before, X_{fdpt} is a vector of other household characteristics Y_{ifdp} is a vector of district-level variables observed in the year of the child's birth,[5] μ_p is a set of province-level fixed effects and ε_{ift} is the individual error term for individual i in family f at time t.

The first instrument is availability of contraceptive distribution points. We construct this variable by identifying the dates of the establishment of family planning facilities in the locality using the community survey modules of the IFLS. We take these from the responses of the leader of the women's group to the question of when the facility was first introduced into the district or how many years it had been present. We focus specifically on the establishment of a PPKBD distribution point, which as previously noted, focused specifically on providing the means of fertility control and generally preceded the establishment of integrated health posts.

The second instrument is the spread of access to modern media, specifically television. In order to capture the potential influence of television on the choice of family size we construct a measure of district-level TV access. Public broadcasting began in 1962 with the establishment the public broadcaster TVRI. As part of a wider nation-building programme, TVRI presented information on contraceptive methods as well as providing motivation for small families.[6] Its initially narrow reach was widened to embrace localities beyond the main urban centres with the advent of satellite broadcasting in 1976 (Chu et al., 1991). TV access was further diversified from 1987 with the licensing of private broadcasters. We measure access to TV by using the village census PODES, collected three times every decade by Statistics Indonesia, the country's statistical agency. From 1993 PODES reports the number in each village with access to TV. The question on viewership was not asked in earlier waves and so we carry this back to 1983 using the number of TV sets per capita, also from PODES. This series is then extrapolated back to 1976 and then, for certain urban areas, to the beginning of public broadcasting in 1962.

Fig. 2 illustrates the diffusion of PPKBD distribution points across IFLS districts from 1960 to 2000. It shows for each year the percentage of the 312 enumeration areas in the survey in which a PPKBD post had been established. Diffusion proceeded slowly in the 1970s and more rapidly in the 1980s. By 1995 all localities had at least one such facility. Fig. 3 shows the average percentage TV viewership across IFLS districts in each year. Coverage grew slowly from the late 1960s and then more rapidly following the advent of satellite broadcasting in 1976. TV coverage increased sharply from the late 1980s, as private channels were introduced, and then somewhat more slowly in the late 1990s. By 2000 average TV coverage across IFLS districts had reached 80 percent.

Instrumental variables must satisfy the exclusion restriction, which means that the instruments must be independent of the outcome variable, given the other covariates in the model. Correlation with the residual at the second stage could arise either if the instrument is a direct determinant of the dependent variable or if there is unobserved heterogeneity arising from

[5] The presence of local facilities at the time of birth are subsumed in the child index, *i*.

[6] Using survey evidence for rural areas in 1976 and 1982 Chu et al. (1991) find a positive relationship between television access and contraceptive use, particularly among the lower educated.

Table 1
Descriptive Statistics.

	Mean	SD
Individual characteristics		
Average height (cm)	112.79	16.87
Average height (z-score)	−1.42	1.38
Age (years)	7.15	2.94
Female (Yes = 1)	0.49	0.50
Household and parent characteristics		
Children in family	3.39	1.64
Mother age (years)	32.36	4.58
Mother has at least junior secondary level education (Yes = 1)	0.23	0.42
Father has at least junior secondary level education (Yes = 1)	0.31	0.46
Log (household expenditure/poverty line)	2.19	0.67
Mid-parental height (cm)	155.56	4.84
Household residing in rural area (Yes = 1)	0.65	0.48
District of residence characteristics at birth		
Has improved sewage system (Yes = 1)	0.53	0.50
Has garbage collection system (Yes = 1)	0.15	0.36
Has piped water system (Yes = 1)	0.33	0.47
Has children and mother integrated health clinic (Yes = 1)	0.80	0.40
Immunisation is available (Yes = 1)	0.34	0.47
Instruments		
Proportion of villages in mother's district of residence at age 10 with access to television broadcast	0.06	0.13
Proportion of villages in mother's district of residence at age 20 with access to television broadcast	0.29	0.23
Proportion of villages in mother's district of residence at age 30 with access to television broadcast	0.63	0.22
Mother's district of residence at age 10 had contraceptive distribution points (Yes = 1)	0.10	0.30
Mother's district of residence at age 20 had contraceptive distribution points (Yes = 1)	0.49	0.50
Mother's district of residence at age 30 had contraceptive distribution points (Yes = 1)	0.89	0.30
Observations	7462	

Source IFLS, PODES.

omitted variables. Central administration determined the placement of contraceptive distribution posts, from 1969 in urban centres in Java and Bali, and then from 1974 in ten other provinces. Although we use the first arrival of these facilities rather than the number or the total expenditure on them, there may still be some endogeneity (Angeles et al., 2005; Kim, 2010). To address this concern we include a wide range of variables associated with local development (Y_{ifdp} in Eq. (2)) that might be correlated with both the placement of family planning facilities and the heights of children. These include the availability of infrastructure and health facilities at the child's year of birth as well as dummy variables for province and for rural areas as control variables. Note, however, that the instruments we use are associated with the life cycle of the mother, rather than with the child. Since the residuals in Eq. (2) are associated with the child's height, we would expect little correlation between the instruments and the residual.

Our other instrument is access to television broadcasts. The effects of access to TV on social connections, migration and on fertility have been examined by Olken (2009), Farré and Grimm et al. (2015) using as instruments geographical characteristics and access to electricity. It is possible that, besides highlighting small families, TV broadcasts could also have contained information that could lead to the child receiving better nutrition or avoiding some illness or disease, which would be a direct effect. However this seems unlikely. Kitley (2000) examines the history of television in Indonesia, and finds that most television content focused either on nation building or on foreign films.[7] Again, the inclusion of infrastructure variables may help eliminate any indirect effect on height, although Farré and Fasani (2013) find that TV coverage depends only on distance. In our estimation we include dummy variables for province. Finally, as we have more than one instrument we can also test the over-identifying restrictions as a diagnostic for possible endogeneity.

Our sample consists of 7462 child observations linked to 4284 mothers across the three IFLS waves. Descriptive statistics are presented in Table 1 by child observation. The average height is about 112.8 cm at an average age of 7.1 years. These heights are transformed into z-scores, using as the basis for comparison the US Centers for Disease Control and Prevention growth standard for US children in 2000. This standardization is by year of age. Children in the IFLS are on average 1.4 standard deviations below these reference values. Sibship size is defined as the number of children that a mother in IFLS has and this is constructed from her birth history. The average sibship size is 3.4. As many of the families are relatively young, with mother's average age of 32.3 years, completed sibships would be somewhat higher. Education is measured as a dummy variable for whether an individual has attained junior secondary education (between seven to nine years). Less than a quarter of mothers in the data reach this level of education, while the proportion is 31 percent for fathers. The table also shows that the average height of parents (mid-parental height) is 155.6 cm, which is relatively short by international standards. Finally, 65 percent of the sample lived in rural areas.

From the community level information supplied by the leader of the women's group, we obtain the year of establishment of an integrated health post (*Posyandu*). These came later than the contraceptive distribution points and they focused more on the health of mothers and children in the first few years of life than on family planning. We use a similar method to identify the first year that mass immunization was undertaken in the community. The responses of community leaders were used to identify the dates at which piped water became available, when a sewage system using gutters or pipes was established, and when regular garbage collection was introduced. Across all these variables, it appears that

[7] The programme content in the early years included foreign soap operas such as *Peyton Place*, *Return to Eden*, *Falcon Crest* and *Dynasty*, which were very popular, as well as locally made equivalents such as *Keluarga Rahmat*, which were less successful (Kitley, 2000, p. 151).

Table 2
Explaining the number of children in the family.

	(1)	(2)	(3)	(4)
	All	All	Low-Edu	High-Edu
Mother aged 25–28	0.494***	0.437***	0.548***	0.213***
	(0.054)	(0.052)	(0.064)	(0.082)
Mother aged 29–32	1.017***	0.917***	1.070***	0.577***
	(0.075)	(0.069)	(0.085)	(0.105)
Mother aged 33–36	1.506***	1.380***	1.557***	0.939***
	(0.103)	(0.092)	(0.115)	(0.142)
Mother aged 37–40	1.981***	1.857***	2.017***	1.433***
	(0.134)	(0.118)	(0.146)	(0.193)
Mother has at least junior secondary level education (Yes = 1)	−0.453***	−0.434***		
	(0.067)	(0.067)		
Father has at least junior secondary level education (Yes = 1)	−0.129*	−0.128*	−0.108	−0.207**
	(0.067)	(0.066)	(0.083)	(0.098)
Mother's district of residence at age 10 had contraceptive distribution points (Yes = 1)	−0.013			
	(0.071)			
Mother's district of residence at age 20 had contraceptive distribution points (Yes = 1)	−0.179***	−0.184***	−0.195***	−0.058
	(0.064)	(0.063)	(0.075)	(0.107)
Mother's district of residence at age 30 had contraceptive distribution points (Yes = 1)	−0.093			
	(0.115)			
Proportion of popn. in mother's district of residence at age 10 with access to television	0.536**			
	(0.265)			
Proportion of popn. in mother's district of residence at age 20 with access to television	0.171			
	(0.249)			
Proportion of popn. in mother's district of residence at age 30 with access to television	−1.095***	−0.963***	−0.891***	−1.372***
	(0.241)	(0.207)	(0.258)	(0.334)
Mother number of siblings	0.007			
	(0.011)			
Father number of siblings	−0.008			
	(0.011)			
Rural area = 1	−0.012	−0.040	−0.001	−0.087
	(0.060)	(0.058)	(0.072)	(0.091)
Year = 1997	−0.065	−0.046	−0.056	−0.018
	(0.045)	(0.042)	(0.050)	(0.077)
Year = 2000	−0.189***	−0.153**	−0.163**	−0.110
	(0.066)	(0.060)	(0.074)	(0.099)
Constant	3.501***	3.523***	3.367***	3.610***
	(0.234)	(0.208)	(0.257)	(0.341)
Observations	4284	4296	3256	1040
F-statistic	52.484	64.311	52.821	14.381
R-squared	0.341	0.337	0.311	0.354

Note: 'z' statistics in parentheses from standard errors clustered by mother and by community. Significance levels: ***=0.01; ** = 0.05; * = 0.10. Unit of observation is mother.

availability of an integrated health post is the most prevalent, while garbage collection system is the least.

5. The determinants of family size

In this section we analyse results of estimating Eq. (1), focusing on the effects of the presence of family planning facilities and TV coverage on sibship size, using mothers as the unit of observation. Following Angeles et al. (2005), Miller (2010) and Kim (2010), we assume that effect of family planning facilities or access to television would depend on the timing of its arrival in the individual's life cycle. We used the date of arrival of a PPKBD distribution point and mothers' year of birth to construct dummy variables for whether the facility was present in the district by age 10, age 20 or age 30. These ages are chosen to reflect childhood, early childbearing age, which may influence the starting of childbearing, and later childbearing age when the issue is more likely to be stopping childbearing.[8] We also include dummy variables for the respondent's and her spouse's education beyond primary level as well as the number of siblings of the respondent and her spouse. The latter are aimed at capturing the effects of within-family traditions for larger or smaller families, so that other influences may affect fertility relative to this benchmark.

The dependent variable in Table 2 is the number of children in the family and the unit of observation is the individual mother. The regressions include province dummies with standard errors clustered by mother and by district. They also include the age and education of the mother and father but not variables that would only be realized later in the life cycle. Mother's current age is represented by four dummy variables for different age groups, where age 21–24 is the omitted category. The age group coefficients are highly significant and increasing in size with age, as would be expected when the family expands during the childbearing years. This accounts for two or more children for mothers aged 37–40 as compared with those aged 21–24. In column (1) the dummy for high-educated mothers takes a strong negative coefficient of almost 0.5 children. This is consistent with the widespread finding that more educated mothers have fewer children, either because of the higher opportunity cost of their time, or because education inculcates a taste for smaller families. The father's highest level of education also has a negative coefficient, although the point estimate is smaller.

Column (1) of Table 2 shows that the dummy variables for the arrival of a contraceptive distribution point in the district by age 10 and by age 30 are insignificant. It is not surprising that the availability of contraception has no effect at the youngest age as the women in our data are all mothers and hence we do not fully capture delays in the commencement of childbearing. But there is a

[8] The age 10 is chosen as pre-puberty and prior to leaving school or the transition to junior high school. Age 20 is approximately the median age of marriage for women in the 1970s. The age 30 is somewhat above median childbearing age of 28 in the 1980s.

Table 3
OLS results for height.

	(1)	(2)	(3)	(4)
Number of children	−0.130***	−0.094***	−0.103***	−0.097***
	(0.150)	(0.015)	(0.014)	(0.014)
Female (Yes = 1)	0.123***	0.112***	0.114***	0.111***
	(0.036)	(0.033)	(0.033)	(0.033)
Mother has at least junior secondary level education (Yes = 1)		0.320***	0.280***	0.257***
		(0.052)	(0.051)	(0.051)
Father has at least junior secondary level education (Yes = 1)		0.032	−0.020	−0.043
		(0.048)	(0.047)	(0.047)
Mid−parental height (cm)		0.071***	0.069***	0.067***
		(0.009)	(0.008)	(0.008)
Log (household expenditure/poverty line)			0.160***	0.139***
			(0.032)	(0.031)
Household residing in rural area (Yes = 1)				−0.220***
				(0.047
Has children and mother integrated health clinic in birth year (Yes = 1)				0.079
				(0.051)
Immunisation is available in birth year (Yes = 1)				0.071
				(0.042)
Has improved sewage system in birth year (Yes = 1)				−0.043
				(0.043)
Has piped water system in birth year (Yes = 1)				0.009
				(0.050)
Has garbage collection system (Yes = 1)				0.048
				(0.066)
Constant	−0.925***	12.180***	−12.045***	−11.659***
	(0.153)	(1.340)	(1.293)	(1.254)
Child age dummies	Yes	Yes	Yes	Yes
Mother age dummies	Yes	Yes	Yes	Yes
Province dummies	Yes	Yes	Yes	Yes
IFLS survey wave dummies	Yes	Yes	Yes	Yes
Observations	7462	7462	7462	7462
R-squared	0.559	0.596	0.598	0.601
F-statistic	16.23	21.51	22.70	21.24

Note: 'z' statistics in parentheses from standard errors clustered by mother and by community. Significance levels: ***=0.01; ** = 0.05; * = 0.10.

significant effect for the arrival of a distribution point by the time that the mother reached the age of 20. This suggests that access to family planning becomes relevant from the early in the reproductive cycle. But the effect on family size is not large, reducing the number of children by 0.18 on average.

By contrast, television coverage has larger and contrasting effects. Exposure to TV by age 30 takes a large and significant coefficient. A one-standard deviation increase in television coverage when mothers were 30 years old reduced the average number of children by around 0.3. It suggests that exposure to TV in the later child bearing years tends to promote the completion of smaller families than otherwise By contrast, the coefficient for TV coverage when aged 10 is positive and significant but smaller in size. Existing studies suggest that the effect of TV at young ages could have a positive or negative effect on early childbearing, depending on the content. For American teenagers, Chandra et al. (2009) find that TV programmes with sexual content had a positive effect on the risk of teen pregnancy while other programmes had the opposite effect (see also Collins et al., 2004). On the other hand Kearney and Levine (2015) find that exposure to a programme that emphasized the negative effects of teen births reduced teen pregnancies. Thus the effects of exposure to TV could vary at different points in the life-cycle as the individual matures and the choice of programme viewing changes.

Interestingly, the number of siblings either of the mother or the father has no effect on number of children. This suggests, somewhat surprisingly, that within-family fertility traditions are not important. It seems likely that local influences on fertility might differ for mothers with different levels of education. Separate regressions for low and high educated mothers are presented in columns (3) and (4) of Table 2. For the high-educated mothers in column (4) father's education now has a stronger negative effect. While the negative effect of TV coverage at age 30 remains strong, the presence of PPKBD is no longer significant. By contrast, for low-educated mothers (column 3), who account for three quarters of the total sample, both exposure to TV and the presence of contraceptive distribution points have important negative effects on family size. Overall the results suggest that exposure to TV is a stronger determinant of family size among the high educated whereas the availability of birth control is relatively more important for the low educated. This is consistent with evidence for India that TV exposure increases decision-making autonomy mainly among educated women (Iversen and Palmer-Jones, 2013).[9]

One might have expected differences between rural and urban locations, as both TV coverage and access to birth control arrived later in rural districts. However, separate regressions for urban and rural residents (not shown) reveal only marginal differences. We also experimented with a different definition of the number of children in the family, by using the number of children of the household head from the household roster, rather than using the birth history of the mother. The correlation between these two alternative measures is 0.91 and the coefficient estimates (not shown) are broadly similar.

5.1. The impact of sibship size on height

We begin by presenting OLS regressions for height z-scores in Table 3. These regressions include dummy variables for mother's

[9] Using the IFLS for 2007, Samarakoon and Parinduri (2015) find that women's education reduces fertility, but has little effect on women's domestic decision-making authority in the absence of influences that alter cultural beliefs and attitudes.

Table 4
IV results for height.

	(1)	(2)	(3)	(4)
First stage	Dependent variable: number of children			
Mother's district of residence at age 20 had contraceptive distribution points (Yes = 1)	−0.286***	−0.236***	−0.212***	−0.206***
	(0.079)	(0.078)	(0.076)	(0.076)
Proportion of popn. in mother's district of residence at age 30 with access to television	−1.360***	−1.205***	−1.387***	−1.344***
	(0.265)	(0.259)	(0.259)	(0.263)
F-excluded instruments	23.26	17.61	20.41	19.19
Second stage	Dependent variable: child height z-score			
Number of children	−0.603***	−0.484***	−0.426***	−0.342***
	(0.114)	(0.114)	(0.098)	(0.095)
Female (Yes = 1)	0.105**	0.095**	0.102***	0.104***
	(0.041)	(0.037)	(0.036)	(0.035)
Mother has at least junior secondary level education (Yes = 1)		0.119	0.092	0.117
		(0.083)	(0.080)	(0.076)
Father has at least junior secondary level education (Yes = 1)		−0.044	−0.113*	−0.108**
		(0.059)	(0.059)	(0.055)
Mid-parental height (cm)		0.067***	0.063***	0.063***
		(0.010)	(0.009)	(0.009)
Log (household expenditure/poverty line)			0.254***	0.213***
			(0.047)	(0.045)
Household residing in rural area (Yes = 1)				−0.184***
				(0.051)
Has children and mother integrated health clinic in birth year (Yes = 1)				0.054
				(0.054)
Immunisation is available in birth year (Yes = 1)				0.004
				(0.053)
Has improved sewage system in birth year (Yes = 1)				−0.035
				(0.046)
Has piped water system in birth year (Yes = 1)				−0.007
				(0.052)
Has garbage collection system (Yes = 1)				0.070
				(0.068)
Constant	0.301	−10.359***	−10.483***	−10.517***
	(0.339)	(1.662)	(1.509)	(1.426)
Child age dummies	Yes	Yes	Yes	Yes
Mother age dummies	Yes	Yes	Yes	Yes
Province dummies	Yes	Yes	Yes	Yes
IFLS survey wave dummies	Yes	Yes	Yes	Yes
Observations	7462	7462	7462	7462
R-squared	0.453	0.526	0.551	0.574
F-statistic	9.38	10.52	9.34	10.57
Over-identification test (χ^2)	0.759	1.006	0.181	0.000
P-value	0.871	0.421	0.799	0.780

Note: 'z' statistics in parentheses from standard errors clustered by mother and by community. Significance levels: ***=0.01; ** = 0.05; * = 0.10.

age group, child's year of age, province and survey year. In the most restricted specification in column (1) the coefficient on family size is negative and highly significant, while the coefficient for female children is significantly positive. The second column adds dummy variables for mother's and father's education to junior secondary level and mid-parental height. Mother's education is positive and significant while father's education is not. Not surprisingly, the average height of the parents is strongly positively correlated with child height.[10] This might be thought of as capturing genetic effects, although it may also reflect the intergenerational correlation of socioeconomic conditions during childhood. However, the coefficient is hardly affected by adding household expenditure relative to the poverty line. If the effect of family size on height reflects scarcity within the household then the coefficient on household expenditure should be positive. The positive and highly significant coefficient on household expenditure, interpreted as a proxy for income, implies that a ten percent increase in income is associated with an increase in height of about 0.16 standard deviations.

Column (4) adds a number of locality variables. The significant coefficient of rural residence implies that children living in rural areas are 0.22 standard deviations shorter. But child health may also be influenced by specific local conditions, which are measured around the time of birth and early childhood. Here we explore the effects of support services for the mother and child as well as local sanitary conditions, as measured by the presence of such facilities in the child's year of birth. These variables take the value 1 if the facility was in place in the year of birth, otherwise zero. The establishment in the locality of a *Posyandu*, providing medical support for mothers and under-fives at the time of the child's birth, takes a positive coefficient but is not significant. The coefficient on the commencement of mass immunization is surprisingly negative, but statistically insignificant. Several studies of developing countries have emphasized the negative effect on height of poor sanitary conditions and the positive effects of sanitary improvements (Hammer and Spears, 2016; Hathi et al., 2017). Here we explore the effects on child health of the establishment in the district of piped (PAM) water,[11] sewage systems (gutters or pipes),

[10] There is also a strong intergenerational correlation for BMI in Indonesia as well as in other countries (Dolton and Xiao (2017).

[11] The term PAM, widely used in Indonesia, refers to *Perusahaan Air Minum*, which are the regency- or district-level water supply utilities.

Table 5
IV results for height with single instruments.

	(1)	(2)	(3)	(4)
First stage	Dependent variable: number of children			
Mother's district of residence at age 20 had contraceptive distribution points (Yes = 1)	−0.399***	−0.311***		
	(0.079)	(0.077)		
Proportion of popn. in mother's district of residence at age 30 with access to television			−1.549***	−1.480***
			(0.262)	(0.261)
F-excluded instruments	25.95	16.16	35.00	32.28
Second stage	Dependent variable: child height z-score			
Number of children	−0.494***	−0.342**	−0.650***	−0.342***
	(0.154)	(0.168)	(0.133)	(0.102)
Female (Yes = 1)	0.109***	0.105***	0.103**	0.104***
	(0.039)	(0.035)	(0.042)	(0.035)
Mother has at least junior secondary level education (Yes = 1)		0.117		0.117
		(0.106)		(0.078)
Father has at least junior secondary level education (Yes = 1)		−0.108*		−0.108*
		(0.065)		(0.056)
Mid-parental height (cm)		0.063***		0.063***
		(0.009)		(0.009)
Log (household expenditure/poverty line)		0.213***		0.213***
		(0.055)		(0.047)
Household residing in rural area (Yes = 1)		−0.184***		−0.184***
		(0.055)		(0.051)
Has children and mother integrated health clinic in birth year (Yes = 1)		0.054		0.054
		(0.055)		(0.054)
Immunisation is available in birth year (Yes = 1)		0.005		0.004
		(0.067)		(0.053)
Has improved sewage system in birth year (Yes = 1)		−0.035		−0.035
		(0.046)		(0.046)
Has piped water system in birth year (Yes = 1)		−0.006		−0.007
		(0.053)		(0.052)
Has garbage collection system (Yes = 1)		0.070		0.070
		(0.069)		(0.068)
Constant	0.017	−10.513***	0.424	−10.517***
	(0.430)	(1.585)	(0.386)	(1.430)
Child age dummies	Yes	Yes	Yes	Yes
Mother age dummies	Yes	Yes	Yes	Yes
Province dummies	Yes	Yes	Yes	Yes
IFLS survey wave dummies	Yes	Yes	Yes	Yes
Observations	7462	7462	7462	7462
R-squared	0.497	0.574	0.421	0.574
F-Statistic	11.97	18.089	11.038	18.190

Note: 'z' statistics in parentheses from standard errors clustered by mother and by community. Significance levels: ***=0.01; ** = 0.05; * = 0.10.

and regular garbage collection. These are also linked to the year of birth of the child. As column (4) shows, none of these variables is significant.

The OLS estimates provide consistently negative coefficients on the number of children in the family but these may be biased, for reasons noted above. In Table 4 we present instrumental variable estimation using as instruments the two variables that proved to be consistent determinants of family size in Table 2. These are the availability of contraceptives at the time that the mother was aged 20 and television coverage at age 30.[12] The upper panel of the table reports the coefficients on the excluded instruments. Both the dummy variables for the presence of a PPKBD distribution post at mother age 20 and the level of TV coverage at mother age 30 are negative and significant. This is consistent with the results of Table 2, although here the unit of observation is the child rather than the mother. The F-statistics for the excluded instruments are greater than 10 and so these instruments are relevant. And in each case the validity of the over-identifying restrictions is not rejected on the Hansen J-test.

The lower panel of Table 4 reports the second stage coefficients for specifications that are otherwise equivalent to those in Table 3. In the most restricted model in column (1), the coefficient on family size is more negative than the equivalent OLS coefficient but still statistically significant. This implies that a one standard deviation increase in sibship size decreases height by about 1 standard deviation. When additional controls are included in columns (2), (3) and (4), the coefficient declines quite substantially in size and significance. But the coefficient remains significant, even in the presence of a range of controls, the absence of which could possibly threaten identification. In column (4), the effect of a one standard deviation increase in sibship size reduces height by 0.56 standard deviations. Among the other coefficients, one difference from the OLS estimates is that mother's education is no longer significant although the coefficient remains positive.

While the validity of the over-identifying restrictions is not rejected, one might ask which of the instrumental variables is the more important for identification. Table 5 shows the results when using just one instrument. In the first two columns the instrument is the advent of a PPKDB distribution point by age 20 which is strongly significant at the first stage. The second stage coefficient on family size is negative and significant and, as before, it becomes smaller as the full range of other variables is added. When instead exposure to TV at age 30 is used as the instrument, the first stage coefficient is highly significant and the F-statistic for the excluded instrument is larger. The coefficient on family size is also significant and so either one of the instruments is sufficient for identification. This may seem surprising but it reflects the fact that

[12] These are the two most significant variables in Table 2, but the results are little changed if we also include TV coverage at age 10 as a third instrument.

Table 6
IV results for height by mother's education and residence.

	(1) Mother Low Ed	(2) Mother High Ed	(3) Rural	(4) Urban
First stage	Dependent variable: number of children			
Mother's district of residence at age 20 had contraceptive distribution points (Yes = 1)	−0.225**	−0.047	−0.152	−0.261**
	(0.090)	(0.128)	(0.099)	(0.113)
Proportion of popn. in mother's district of residence at age 30 with access to television	−1.297***	−1.709***	−1.600***	−0.869***
	(0.322)	(0.451)	(0.370)	(0.357)
F-excluded instruments	13.92	7.30	12.73	6.06
Second stage	Dependent variable: child height z-score			
Number of children in family	−0.376***	−0.232	−0.283***	−0.467**
	(0.112)	(0.151)	(0.108)	(0.204)
Female (=1)	0.097**	0.162**	0.116***	0.074
	(0.040)	(0.064)	(0.044)	(0.054)
Mother has at least junior secondary level education (Yes = 1)			0.079	0.098
			(0.091)	(0.163)
Father has at least junior secondary level education (Yes = 1)	−0.113*	−0.022	−0.154**	−0.032
	(0.066)	(0.096)	(0.074)	(0.089)
Mid-parental height	0.058***	0.087***	0.065***	0.059***
	(0.010)	(0.012)	(0.010)	(0.014)
Log (household expenditure/poverty line)	0.231***	0.155***	0.175***	0.289***
	(0.057)	(0.059)	(0.059)	(0.073)
Household residing in rural area (Yes = 1)	−0.147**	−0.367***		
	(0.061)	(0.088)		
Constant	−9.761***	−13.925***	−11.050***	−9.836***
	(1.639)	(1.805)	(1.657)	(2.369)
Facilities at birth year facilities	Yes	Yes	Yes	Yes
Child age dummies	Yes	Yes	Yes	Yes
Mother age dummies	Yes	Yes	Yes	Yes
Province dummies	Yes	Yes	Yes	Yes
IFLS survey wave dummies	Yes	Yes	Yes	Yes
Observations	5764	1698	4816	2646
R-squared	0.582	0.532	0.612	0.478
F-statistic	9.38	10.52	9.34	10.57
Over-identification test (χ^2)	0.027	0.649	0.065	0.078
P-value	0.871	0.421	0.799	0.780

Note: 'z' statistics in parentheses from standard errors clustered by mother and by community. Significance levels: ***=0.01; ** = 0.05; * = 0.10.

these two instruments have a positive correlation coefficient of 0.47.

6. Differences between groups

It is likely that the effects of family size on height differ across families by socioeconomic position, as they face different degrees of resource constraints. Conditions may also differ substantially between urban and rural areas. Table 6 provides comparisons between low- and high-educated mothers and between rural and urban areas. These instrumental variables regressions include the same control variables as in Table 4. The variables representing local conditions at the time of the child's birth are also included but these are uniformly insignificant and they are not reported in the table.

Columns (1) and (2) present the results for families with low and high-educated mothers respectively. While the first stage coefficients are significant and negative for both PPKBD and TV coverage when the mother is low-educated, the former is insignificant when the mother is high-educated, consistent with the results in Table 3. But the first stage F-statistics are relatively low and the second-stage coefficient on the number of children is insignificant for high-educated mothers (col. 2), implying that our instruments fail the relevance assumption when limited to this sub-sample. For the low-educated mothers, however, the instruments perform well, and we observe a large and negative effect of sibship size on height. The coefficients on the instruments at the first stage suggest that high-educated mother's may have better knowledge of contraceptives and perhaps access to alternative sources of supply. But it may also reflect the fact that there are far fewer observations for high-educated mothers. Columns (3) and (4) present the results for rural and urban households. In both rural and urban areas we observe statistically significant effects of sibship on height. Although the coefficient is larger for urban areas, the first stage F-statistic is low, which may also reflect the smaller number of observations for urban mothers.

It is sometimes suggested that the effect of family size may differ between boys and girls, especially in settings where there is a preference for boys (for India, see Pande, 2003). Columns (1) and (2) of Table 7 present separate IV regressions for boys and girls. The effect of family size on height appears to be larger for girls, although the difference is not statistically significant. This suggests that girls are more likely to suffer negative effects in larger households, even though for Indonesia there is little other evidence of son preference (Guilmoto, 2015; Suryadarma, 2015). The effects of family size might also differ by the age of the child. As growth in early childhood is most affected by household conditions, we might expect the effect of family size to be greater among younger children. Columns (3) and (4) of Table 7 report separate regressions for children aged 2–5 and 6–12 respectively. Although the coefficient on family size is more negative for the 2–5 age group the difference is marginal and so it is not possible to draw any strong inference. In summary, we find little evidence of heterogeneity in the impact of family size on height by sex or age.

7. Conclusion

In this paper we have analysed the heights of children and the relationship with family size in Indonesia using the first three waves of the IFLS. Recognising the endogeneity of family size, we construct variables on the timing of the arrival in the community of facilities that could influence fertility. These provided the means to control

Table 7
IV results for height by sex and age.

	(1) Boy	(2) Girl	(3) Age 2–5	(4) Age 6–12
First stage	Dependent variable: number of children			
Mother's district of residence at age 20 had contraceptive distribution points (Yes = 1)	−0.197**	−0.216**	−0.205**	−0.205***
	(0.094)	(0.088)	(0.092)	(0.077)
Proportion of popn. in mother's district of residence at age 30 with access to television	−1.311***	−1.381***	−1.696***	−1.214***
	(0.315)	(0.282)	(0.333)	(0.256)
F-excluded instruments	12.62	17.41	18.80	16.63
	Dependent variable: child height z-score			
Number of children in family	−0.284**	−0.391***	−0.387***	−0.305***
	(0.117)	(0.121)	(0.134)	(0.100)
Female (=1)			0.032	0.139***
			(0.069)	(0.034)
Mother has at least junior secondary level education (Yes = 1)	0.133	0.110	0.136	0.114
	(0.092)	(0.104)	(0.126)	(0.074)
Father has at least junior secondary level education (Yes = 1)	−0.091	−0.121	−0.136	−0.091
	(0.067)	(0.077)	(0.088)	(0.058)
Mid-parental height	0.051***	0.081***	0.073***	0.060***
	(0.010)	(0.009)	(0.013)	(0.009)
Log (household expenditure/poverty line)	0.225***	0.184***	0.202***	0.215***
	(0.055)	(0.058)	(0.076)	(0.046)
Household residing in rural area (Yes = 1)	−0.184***	−0.180***	−0.283***	−0.151***
	(0.065)	(0.065)	(0.098)	(0.051)
Constant	−9.010***	−12.861***	−11.772***	−10.433***
	(1.581)	(1.450)	(2.053)	(1.539)
Birth year facilities	Yes	Yes	Yes	Yes
Child age dummies	Yes	Yes	Yes	Yes
Mother age dummies	Yes	Yes	Yes	Yes
Province dummies	Yes	Yes	Yes	Yes
IFLS survey wave dummies	Yes	Yes	Yes	Yes
Observations	3739	3723	2398	5064
R-squared	0.606	0.549	0.367	0.691
F-statistic	11.34	12.09	8.18	13.66
Over-identification test ($\chi 2$)	0.018	0.072	0.717	0.294
P-value	0.892	0.788	0.397	0.588

Note: 'z' statistics in parentheses from standard errors clustered by mother and by community. Significance levels: *** = 0.01; ** = 0.05; * = 0.10.

fertility and the desire to do so and therefore influenced family size from both the demand side and the supply side. We find that the arrival in the district of PPKBD distribution point by the time that the mother was aged 20 reduces family size. We also find that the spread of TV coverage had a negative effect on family size. Exposure to TV seems to be most important around the age of 30, which suggests that it has most influence in the life cycle stage at which families are completed, while TV exposure in childhood may have had the opposite effect. And family planning has a greater effect in rural areas while access to TV has more influence in urban areas.

Using these variables as instruments we find a strong negative effect of the number of children in the family on the z-scores of the heights of children aged 2 to 12. This result provides support for a trade-off between the quality and quantity of children in Indonesia, while avoiding the use of family-level instruments. Interestingly there is some evidence that family size has a greater negative effect in families with low-educated mothers. But we find that parental education has very little effect on the heights of children once we allow for its effect working though family size. On the other hand, we find a strong positive income effect on height, consistent with the notion of resource scarcity determining health within the family. Interestingly, we find little effect on child height of the presence in the community of local medical facilities or improved sewage and water systems from the time of birth.

Our results are consistent with other studies that find that the Indonesian family planning programme contributed to the decline in fertility depicted in Fig. 1 (Gertler and Molyneaux, 1994; Molyneaux and Gertler, 2000; Angeles et al., 2005; Kim, 2010). Also important was the effect of the advent of modern media as found in other studies (Jensen and Oster, 2009; La Ferrara et al., 2012) and only recently identified for Indonesia (Dewi et al., 2017). Taken together these effects imply a greater reduction in family size than those found in existing studies of Indonesia and a greater contribution to the decline in the total fertility rate depicted in Fig. 1. When these variables are used as instruments we find more significant negative effects on height than previous studies that use different identification strategies (Millimet and Wang, 2011). So, while improved nutrition and better hygiene contributed to gains in child health and stature as living standards increased (Cameron and Williams, 2009), falling family size also mattered. It is now well established that height is correlated with a range of adult outcomes (Currie and Vogl, 2013). Taller adults tend to be healthier and have longer life expectancy; they also have more education and higher incomes. For example, the high observed levels of hypertension among adults in Indonesia are negatively associated with height (Sohn, 2017). Indonesian evidence also indicates that taller individuals have significantly higher earnings, even controlling for education, cognitive skills and family background (Sohn, 2015; LaFave and Thomas, 2017). Thus the effects of declining family size, through its influence on height, is likely to have important long run consequences for improving the health and prosperity of Indonesians.

Acknowledgements

This work was supported by the Australian Research Council, Discovery Grant No. DP140103603.

References

Alderman, H., 1990. Nutritional Status in Ghana and Its Determinants. World Bank SDA, Washington DC (Working Paper No. 3).

Angeles, G., Guilkey, D.K., Mrotz, T.A., 2005. The effects of education and family planning programs on fertility in Indonesia. Econ. Dev. Cultural Change 54, 165–201.

Angrist, J., Lavy, V., Scholsser, A., 2010. Multiple experiments for the causal link between the quantity and quality of children. J. Labor Econ. 28, 773–824.

Baez, J.E., 2008. Does More Mean Better? Sibling Sex Composition and the Link Between Family Size and Children's Quality. IZA, Bonn (Discussion Paper 3472).

Baten, J., Stegl, M., Van der Eng, 2013. The biological standard of living and body height in colonial and post-Colonial Indonesia, 1770–2000. J. Bioecon. 15, 103–122.

Becker, G.S., Lewis, H.G., 1973. On the interaction between the quantity and quality of children. J. Political Econ. 81, S279–S288.

Becker, G.S., Tomes, N., 1976. Child endowments and the quantity and quality of children. J. Political Econ. 84, S143–S162.

Black, S., Devereux, P.J., Salvanes, K.G., 2005. The more the merrier? the effect of family composition on children's education. Q. J. Econ. 120, 669–700.

Bongaarts, J., 2014. The impact of family planning programs on unmet need and demand for contraception. Stud. Fam. Plann. 45, 247–262.

Cameron, L., Williams, J., 2009. Is the relationship between socioeconomic status and health stronger for older children in developing countries? Demography 46, 303–324.

Chandra, A., Martino, S.C., Collins, R.L., Elliott, M.N., Berry, S.H., Kanouse, D.E., Miu, A., 2009. Does watching sex on television predict teen pregnancy? findings from a national longitudinal survey of youth. Pediatrics 122, 1047–1054.

Chu, G., Alfian, C., Schram, W., 1991. Social Impact of Satellite Television in Rural Indonesia. Asian Mass Communication, Singapore.

Collins, R.L., Elliott, M.N., Berry, S.H., Kanouse, D.E., et al., 2004. Watching sex on television predicts adolescent initiation of sexual behavior. Pediatrics 114, 280–289.

Currie, J., Vogl, T., 2013. Early-Life health and adult circumstance in developing countries. Ann. Rev. Econ. 5, 7.1–7.36.

Dewi, R.K., Suryadarma, D., Suryahadi, A., 2017. The impact of the media on behaviour: evidence from television coverage expansion and declining fertility in Indonesia. Dev. Policy Rev. online first.

Dolton, P., Xiao, M., 2017. The intergenerational transmission of body mass index across countries. Econ. Hum. Biol. 24, 140–152.

Ermisch, J.F., 2003. An Economic Analysis of the Family. Princeton University Press, Princeton NJ.

Farré, L., Fasani, F., 2013. Media exposure and internal migration –Evidence from Indonesia. J. Dev. Econ. 102, 48–61.

Fernihough, A., 2017. Less Is More? The Child Quality-Quantity Trade-off in Early 20th Century England and Wales. Queen's University Belfast Working Paper 2017–2007.

Fitrani, F., Hofman, B., Kaiser, K., 2005. Unity in diversity? the creation of new local governments in a decentralising Indonesia. Bull. Indonesian Econ. Stud. 41, 57–79.

Foldvari, P., Van Leeuwen, B., Marks, D., Gall, J., 2013. Indonesian regional welfare development, 1900–1990: new anthropometric evidence. Econ. Hum. Biol. 11, 78–89.

Frankenberg, E., Thomas, D., 2000. The Indonesia Family Life Survey (IFLS): Study Design and Results from Waves 1 and 2. (DRU-2238/1-NIA/NICHD).

Günther, I., Harttgen, K., 2016. Desired fertility and number of children born across time and space. Demography 53, 55–83.

Gertler, P.J., Molyneaux, J.W., 1994. How economic development and family planning programs combined to reduce Indonesian fertility. Demography 31, 33–63.

Giles, J., Satriawan, E., 2015. Protecting child nutritional status in the aftermath of a financial crisis: evidence from Indonesia. J. Dev. Econ. 114, 97–106.

Glick, P.J., Marini, A., Sahn, E., 2006. Estimating the consequences of unintended fertility for child health and education in Romania: an analysis using twins data. Oxford Bull. Econ. Stat. 69, 667–691.

Grimm, M., Sparrow, R., Tasciotti, L., 2015. Does electricity spur the fertility transition? evidence from Indonesia. Demography 52, 1773–1796.

Guilmoto, C.Z., 2015. Mapping the diversity of gender preferences and sex imbalances in Indonesia in 2010. Population Stud. 69, 299–315.

Hammer, J., Spears, D., 2016. Village sanitation and child health: effects and external validity in a randomized field experiment in rural India. J. Health Econ. 48, 135–148.

Hathi, P., Haque, S., Pant, L., Coffey, D., Spears, D., 2017. Place and child health: the interaction of population density and sanitation. Demography 54, 337–360.

Hull, T.H., Hull, V.J., 2005. From Family Planning to Reproductive Health Care: A Brief History. In: Hull, T.H. (Ed.), People, Population and Policy in Indonesia. Equinox Publishing, Jakarta, pp. 1–69.

Hull, T.H., Mosley, H., 2009. Revitalization of Family Planning in Indonesia. Government of Indonesia and United Nations Population Fund, Jakarta.

Hull, T.H., 2003. The political framework for family planning in Indonesia: three decades of development. In: Niehof, A., Lubis, F. (Eds.), Two Is Enough: Family Planning in Indonesia Under the New Order 1968–1998. KITLV Pres, Leiden, pp. 57–82.

Iversen, V., Palmer-Jones, R., 2013. TV, Female Empowerment and Demographic Change in Rural India. 3ie, Washington DC (Replication Paper 2).

Jensen, R., Oster, E., 2009. The power of TV: cable television and women's status in India. Q. J. Econ. 124, 1057–1094.

Kearney, M.S., Levine, P.B., 2015. Media influences on social outcomes: the impact of MTV's 16 and pregnant on teen childbearing. Am. Econ. Rev. 105, 3597–3632.

Kim, Y., Knowles, S., Manley, J., Radoias, V., 2017. Long-run health consequences of air pollution: evidence from Indonesia's forest fires of 1997. Econ. Hum. Biol. 26, 186–198.

Kim, J., 2010. Women's education and fertility: an analysis of the relationship between education and birth spacing in Indonesia. Econ. Dev. Cultural Change 58, 739–777.

Kitley, P., 2000. Television, Nation, and Culture in Indonesia. Ohio University Center for International Studies, Athens OH.

La Ferrara, E., Chong, A., Duryea, S., 2012. Soap operas and fertility: evidence from Brazil. Am. Econ. J.: Appl. Econ. 4, 1–31.

LaFave, D., Thomas, D., 2017. Height and cognition at work: labor market productivity in a low income setting. Econ. Hum. Biol. 25, 52–64.

Li, H., Zhang, J., Zhu, Y., 2008. The quantity-quality trade-off of children in a developing country: identification using Chinese twins. Demography 45, 223–243.

Liu, H., 2014. The Quality–quantity trade-off: evidence from the relaxation of China's one-child policy. J. Popul. Econ. 27, 565–602.

Lubis, F., 2003. History and structure of the national family planning program. In: Niehof, A., Lubis, F. (Eds.), Two Is Enough: Family Planning in Indonesia Under the New Order 1968–1998. KITLV Press, Leiden, pp. 31–56.

Maralani, V., 2008. The changing relationship between family size and educational attainment over the course of economic development: evidence from Indonesia. Demography 45, 693–717.

Menchik, J., 2014. The Co-evolution of sacred and secular: Islamic law and family planning in Indonesia. South East Asia Res. 22, 359–378.

Miller, G., Babiarz, K.S., 2016. Family planning: program effects. Popul. Dev. Rev. 42, 7–26.

Miller, G., 2010. Contraception as development? new evidence from family planning in Columbia. Econ. J. 120, 709–736.

Millimet, D.L., Wang, L., 2011. Is the quantity-quality trade-off a trade-off for all, none, or some? Econ. Dev. Cultural Change 60, 155–195.

Molyneaux, J.W., Gertler, P.J., 2000. The impact of targeted family planning programs in Indonesia. Popul. Dev. Rev. 26 (Supplement), 61–85.

Olken, B.A., 2009. Do television and radio destroy human capital? evidence from Indonesian villages. Am. Econ. J. 1, 1–33.

Pande, R.P., 2003. Selective gender differences in childhood nutrition and immunization in rural India: the role of siblings. Demography 40, 395–418.

Pitt, M.M., Rosenzweig, M.R., Gibbons, D.M., 1993. The determinants and consequences of the placement of government programs in Indonesia. World Bank Econ. Rev. 7, 319–348.

Pritchett, L.H., 1994. Desired fertility and the impact of population policies. Popul. Dev. Rev. 20, 1–55.

Qian, N., 2009. Quantity-quality and the One Child Policy: The Only-child Disadvantage in School Enrolment in Rural China. NBER, Cambridge MA (Working Paper 14973).

Rosenzweig, M., Zhang, J., 2009. Do population control policies induce more human capital investment? twins, birth weight and China's 'One-Child' policy. Rev. Econ. Stud. 76, 1149–1174.

Samarakoon, S., Parinduri, R.A., 2015. Does education empower women? evidence from Indonesia. World Dev. 66, 428–442.

Schultz, T.P., 2008. Population policies, fertility women's human capital and child quality. In: Schultz, T.P., Strauss, J.A. (Eds.), Handbook of Development Economics, vol. 4. Elsevier, Amsterdam, pp. 3049–4036.

Shiffman, J., 2002. The construction of community participation: village family planning groups and the indonesian state. Soc. Sci. Med. 54, 1199–1214.

Sohn, K., 2015. The height premium in Indonesia. Econ. Hum. Biol. 16, 1–15.

Sohn, K., 2017. The association between height and hypertension in Indonesia. Econ. Hum. Biol. 27 (Part A), 74–83.

Strauss, J., Beegle, K., Sikoki, B., Dwiyanto, A., Herawati, Y., Witoelar, F., 2004. The Third Wave of the Indonesia Family Life Survey (IFLS3): Overview and Field Report, WR-144/1-NIA/NICHD. .

Suryadarma, D., 2015. Gender differences in numeracy in Indonesia: evidence from a longitudinal dataset. Educ. Econ. 23, 180–198.

Suryahadi, A., Priyambada, A., Sumarto, S., 2005. Poverty, school and work: children during the economic crisis in Indonesia. Dev. Change 36, 351–373.

Van der Eng, P., 2000. Food for growth: trends in Indonesia's food supply, 1880–1995. J. Interdisciplinary Hist. 30, 591–616.

Willis, R.J., 1973. A new approach to the economic theory of fertility behaviour. J. Political Econ. 81, S14–S64.

Zhang, J., 2017. The evolution of China's one-child policy and its effects on family outcomes. J. Econ. Perspect. 31, 141–160.