Intergenerational Transmission of Capabilities: Mothers and Children in Sub-Saharan Africa

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Abstract

Childhood conditions are important for adult capabilities (health and education). Child health and educational attainment are to some extent determined by capabilities of parents to insure adequate care and investments. Even in developed countries with low disease exposures and good health service there has been observed intergenerational transmission of health and socioeconomic status from parents to children through childhood conditions. In sub-Saharan Africa (SSA) transmission is expected to be greater due to poverty, lack of health care, harmful disease environment and vulnerable food security. Many mothers have not lived up to their genetic potentials in capabilities which may negatively influence children's capabilities. In this paper intergenerational transmission of capabilities from mother to child in SSA will be studied. The focus will be on maternal capabilities determined by mother's childhood conditions. The main results are that maternal height has an influence on child capabilities formation especially regarding health.

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Draft

Introduction

People in many parts of sub-Saharan Africa (SSA) face harsh living conditions due to rampant diseases and vulnerable food security. Infant and child mortality is the highest in the world and many children are underweight and stunted (Horton, Alderman, & Rivera, 2008; UNICEF, 2007). Low levels of education and poor adult health as well as low nutrition, bad sanitation, and contagious diseases play an important role for determining child health in the developing world (Caldwell, 1979; Schell, Reilly, Rosling, Peterson, & Ekström, 2007).

Health is not only determined by current living conditions but by a number of factors throughout the life course. Exposures to diseases and malnutrition in early in life can have permanent effects on health, cognitive functions, abilities and physical stature (Barker, 2004; Gluckman, Hanson, & Buklijas, 2010) as well as on education and income (Case & Paxson, 2006). Many women in sub-Saharan Africa do not live up to their full potentials in physical health and cognition as reflected by their short stature (Moradi, 2010) and generally low levels of education (United Nations, 2012).

Young children need to be given adequate care and sufficient investments in favorable conditions in order to live up to their full potentials in terms of health and cognition. Investments concern for example nutrition, immunization, and education. Adequate care relates to parental capabilities and knowledge of childrearing practices such as feeding and the ability to prevent and respond to diseases. Living conditions should be hygienic and disease free. Due to limited publicly provided services and inefficient national governance in many parts of SSA, households and communities are to a larger extent left on their own in terms of securing the health of their children (Deaton, 2013, p. 121). The ability of parents to provide favorable conditions is partly determined by their health, and socioeconomic status (SES). In turn these are partly determined by the conditions they faced in their own childhood. Health of children is a function of capabilities of their parents which is intimately connected to parental early-life conditions. Hence, the risk that poor health is transferred between generations is greater in SSA than in more developed countries.

Since women SSA generally hold a greater responsibility for childrearing, providing sufficient nutrition, and preventing and responding to diseases, their capabilities for child rearing are of special importance for child capability formation (FAO, 2014). Healthier and more capable mothers are more likely to effectively use information and have more energy for successful child rearing (Bishai et al., 2014; Caldwell, 1979). Understanding how to enhance capability of mothers for childrearing and their coping mechanisms when faced with adverse conditions is important for improving child health and potentials and can be used as a supplementary strategy to improved health care access, sanitation etc.(Shonkoff, Richter, van der Gaag, & Bhutta, 2012).

The aim of this paper is to study the role of mother's health, as measured by height, in determining child capability formation in sub-Saharan Africa. By capability formation we are referring to child health and education. The main research questions are: Does maternal height affect health and education outcomes of children? If so, which socioeconomic and demographic pathways are important and for which groups is the intergenerational transmission of capabilities strongest? Height has been found to be associated with many outcomes such as cognitive ability, income, education (Case & Paxson, 2006), longevity (Crimmins & Finch, 2006) and various other aspects of health (Leon, Smith, Shipley, & Strachan, 1995; Macintyre, 1988; Nyström Peck & Vägerö, 1989; Song, Smith, & Sung, 2003). Even though height is to a large extent genetically determined at the individual level (Silventoinen et al., 2003) insufficient nutrition and exposure to disease early in life can lead to stunting and failure to reach full genetic potential (Bozzoli, Deaton, & Quintana-Domeque, 2009; Case & Paxson, 2006; Crimmins & Finch, 2006; Peracchi

& Arcaleni, 2011; Silventoinen, Zdravkovic, et al., 2006; Silventoinen, Kaprio, & Lahelma, 2000; Steckel, 1995). Height has been used to study intergenerational transmission of health from mother to child in developing countries using outcomes such as child mortality, infant mortality, and growth failure (Bhalotra & Rawlings, 2011; Özaltin, Hill, & Subramanian, 2010), child's height (Venkataramani, 2011), and birth weight (Victora et al., 2008).

The main problem with studying the effect of mother's health on child health and education is that children and mothers share a similar environment, for example regarding disease environment, and access to health facilities and schools, which is likely to determine child health and education as well as mothers' height independently. Another problem is the lack of information on fathers which may bias these estimates upwards due to assortative mating. In this study shared environment is controlled for in two ways. Firstly by using community fixed effects where unobserved characteristics at the community level are controlled for by comparing children living in the same community. Secondly we use father fixed effects to control for unobserved household and father characteristics by comparing children born to different mothers but the same father in polygynous households, which also solves the problem of missing information on fathers.

In many studies mother's height is intended to capture the effect of environmentally determined health (by disease exposure and nutrition), and the aim is to estimate how it is reproduced between generations within households. There are potential problems when height is intended to capture mostly non-genetic influence of mother's health and cognitive abilities on child health since it is possible that the genetically determined component of height also plays a role in determining child outcomes. Research has, for example, indicated that the association between cognition and height can at least to some extent be attributed to genetic (Silventoinen, Posthuma, Van Beijsterveldt, Bartels, & Boomsma, 2006). Although researchers have found mother's early life disease and nutritional environment to influence child health directly (D. Almond, Currie, & Herrmann, 2012; Coneus & Spiess, 2012) it has not been tested whether it is an environmentally determined component of height which influences child health. To test this we use an instrumental variable (IV) approach. The main instrument used is whether the mother was a first born child or not, and additionally an indicator for whether the mother was born in a multiple birth or not. The intuition behind the instruments is that they do not relate to mother's height through any purely genetic pathways and therefore allow us to capture the environmentally determined component of height and estimate how it relates to child health and education.

We use individual-, household-, and community-level data from multiple Demographic and Health Surveys (DHS) from 33 countries. Child health is measured by the probability of dying before age 5, and height-for-age z-scores of children under 5 which represent deviations from the growth trajectory of healthy children.

The results show a consistent relationship between mother's height, and under-5 mortality. This relationship is robust to both community and father fixed effects and is present in all but 6 countries. Association between mother's height and child educational outcomes are also found although they are smaller and less robust There are also strong indications that the relationship between child's growth and mother's height is not environmentally determined to any great extent. The IV estimation indicates that the environmentally determined component of mother's height is associated with child's under-5 mortality. The association with the education outcome and *Child's height* seems to be present but is less robust.

Using mother's height to estimate a SES gradient in the intergenerational transmission does not appear to be meaningful since different socioeconomic groups are likely to have lived up to their genetic potentials in height to a different extent, and therefore the components of height are different between groups which drives the observed gradient. These interactions also give a weak indication that it is mostly environmentally determined height which is associated with under-5 mortality and child education while not for child growth.

Theory and previous research

Mosley & Chen (1984) suggested to model child health using five broad categories of proximate determinants; maternal factors (e.g. mother's age, parity and birth interval); injuries; nutrition; environmental contamination (e.g. disease environment, poor hygiene); and illness control (e.g. preventive measures such as vaccination). SES determinants can be used as proxies operating through proximate determinants, for example mother's education and household living standards. They capture skills for child rearing, e.g. regarding knowledge of adequate feeding practices, ability to prevent infections and respond to symptoms in children, the resources available for health related investments, and the ability to provide sanitary living conditions. Heckman (2007) developed a production function based on previous work by Grossman (1972), which complements the Mosley and Chen framework. In this model child capability formation (health and education) θ at each stage *t+1* is determined by investments I at previous stages and parents' capabilities *p.*

$$\theta_{t+1} = f_t(p, \theta_1, I_1, \dots, I_t)$$

Capabilities at each stage are also determined by capabilities at previous stage θ_t. θ_1 represents capabilities at the first stage or initial endowments, which is the capability stock the child starts out with at birth (or even at conception). This framework implies that good conditions and sufficient care and investments should be insured already in early life since children are the most vulnerable to environmental impact, and since later capabilities are partly determined by earlier investments and capabilities at earlier stages. As can be seen from figure 1, the pathways of intergenerational transmission of capabilities are interwoven with genetic determinants, early-life environmental determinants and SES. What is of primary interest in this paper is how capabilities are transmitted between generations through mother's exposures to malnutrition and diseases and the resulting height in adulthood.

[Figure 1 Here]

As discussed before, diseases and malnutrition can have a direct effect on maternal capabilities for child rearing, as well as through living standards in adulthood which determines the resources available for investments in child's health and education. However, it may also determine maternal education which affects both mothers' capabilities for child rearing and her living standards in adulthood. Maternal capabilities could also influence how effectively means for investments in child health are utilized. Mother's cognition, abilities and health determined by early life conditions are not completely independent of genetic factors and other initial endowments, since it may influence how an individual responds to these conditions. The flow chart could be mirrored at child capabilities to demonstrate determinants stemming from the fathers. Assortative mating would bias estimates upwards, while marriage complementarity might bias it downwards.

In a study of a UK cohort born in 1958, Palloni et al. (2009) find that a part of the intergenerational transmission of social class can be attributed to health in childhood. These effects run through effects of childhood health on human capital formation and cognitive skills. They further find early life health to relate to the SES gradient observed in adulthood. The effects are small but the authors argue that they are lower bounds. Environmental conditions in the U.K. are likely to be far superior to most of SSA, so the intergenerational transmission is likely to be much more persistent in our case.

Bhalotra & Rawlings (2013) find a considerable intergenerational persistence in health using a large sample from 38 developing countries for children born 1970 - 2000. They use mother's height to indicate her health and infant mortality to measure child health. They firstly find that a one standard deviation increase (7.3 cm) in mother's height decreases the probability of dying before the age of one by around 0.7% (or 8% of the average mortality rate in their sample), while controlling for country and household living standards. They find the effects to be asymmetric and gains from being born to tall mothers lower than the penalty for being born to shorter mothers. The effects increase by the deviation in height from the country specific mean. Favorable environmental factors, related to community education, and country level immunization status and income, were estimated to benefit children of mothers who were at the lower end of the health distribution more than those at the higher end. Some of these effects are large, e.g. a one year increase in mother's education lowers the persistence of intergenerational transmission of health by 17%, and a one standard deviation increase in log of GDP and immunization rates was associated with a 20% and 18.5% decreases in the persistence. When controls for parental SES and demographics were removed the intergenerational correlation increased by 45%, which indicates that much of the effects run through SES.

In a study of Vietnam Venkataramani (2011) attempts to sort out environmentally determined height using an instrumental variable approach with several instruments relating to both mother's and father's early life environment, such as region and year of birth, rainfall, population density and education of grandparents to obtain a local treatment effect of height determined by early life environmental conditions of parents. This approach yields a 2-3 times higher estimate than the OLS estimate, about 0.4 - 0.6 z-scores for mothers.

Studies have also been done on the effects of mother's education on child health showing a strong correlation as indicated by height, mortality and immunization status. Some of the association between education and health could undoubtedly be accounted for by higher SES, but some is likely due to increased knowledge and capabilities. When controls for household wealth and husband's education are included, the coefficient for mother's education is reduced but remains statistically significant (Desai & Alva, 1998).

Height and growth as an indicator

Although individual height is mostly determined by genetic factors it is also influenced by environmental factors (Silventoinen, 2003). Height has become a widely used indicator of accumulated health and net-nutritional history, i.e. the nutrition that has been available for growth after claims for maintenance, physical activity, and fighting diseases are accounted for. It is affected by nutrition and disease exposure in early life, which influences growth of children and finally adult height.[1] It has been shown to relate to characteristics such as health, cognition, education and income. Case & Paxson (2006) find a relationship between height of children and their cognitive test scores and that this difference in cognition also explains the higher wages of taller people. Observed differences over time and space are mostly determined by changes in early-life conditions (Malcolm, 1974; Steckel, 1995; Victora et al., 2008). This assumes that height determines child health and education only through this environmentally determined component. Whether the component of height determined by genetic factors is related to health and capabilities is unclear but there are indications that it is not or at least to a much lower extent (Case & Paxson, 2006; Sundet, Tambs, Harris, Magnus, & Torjussen, 2005). There is however research that has indicated that the association between cognition and height can at least to some extent be attributed to genetics (Silventoinen, Posthuma, et al., 2006).

Data

We use data from Demographic and Health Surveys (DHS) for 25 – 33 sub-Saharan African countries. Sample sizes differ between outcomes and estimation strategies. The DHS aims to

[1] It may also be influenced by living conditions during late childhood and adolescence but not as strongly as during early life (Steckel, 1995).

provide nationally representative and reliable data using standardized household surveys. The sampling procedure is a stratified two-stage sampling process; most commonly by geographic or administrative regions crossed with type of residence (urban/rural). Clusters (census enumeration areas) are randomly selected from each strata, and then households are sampled from these clusters. Oversampling and probability weights are used to obtain reliable and representative estimates (The DHS Program, 2015).

Outcome variables

The main outcome variables are child's height-for-age z-scores (*Child's height*), a binary variable for whether the child died before the age of 5 (*Died by 5*), a binary variable for whether a child of compulsory schooling age (7-12) attended school during the year of the survey (*Attending school*), and whether a child started primary school before the age of 10 (*School by 10*).

Both health outcomes are linked to the birth history of mothers so they only include biological children of respondents. The *Child's height* is a standardized distribution of height which represents deviations from the median height of a healthy population by age and gender) using the National Center for Health Statistics/WHO international growth standards (De Onis, Onyango, Borghi, Garza, & Yang, 2006). It is measured at the time of the survey, generally for children under 5 (in few cases 3.For *Died by 5*, children born at least 5 years prior to the survey are included to avoid complications with censoring. Both these outcomes have the advantage of indicating a process with chronic conditions or multiple exposures to diseases and undernutrition rather than an acute phenomenon (Mosley & Chen, 1984).

The education outcomes come from the household questionnaire where basic characteristics of all individuals present in the household are recorded at the time of the survey. These are then linked to the birth histories of mother's so they only include their biological children. The *Attending school* outcome includes children born 7-12 years prior to the survey.

Compulsory age range varies slightly in sub-Saharan Africa but this age range is always compulsory (UNESCO, 2011). For the *School by 10* outcome children born 10-15 years prior to the survey are included. The lower bounds avoid complications with censoring and upper bounds reduce potential bias due to children leaving home since this variable is only recorded for children present in the household at the time of the survey.

Main exposure variable

The main indicator for maternal health is mother's height-for-age z-scores (*Mother's height*). It is recorded as deviation from the expected height of healthy women. It is specified as a continuous measure.

Other independent variables

Several basic control variables are entered in every specification. These are *sex of child*, continuous measure for *child's year of birth*, and *mother's age at interview* which may influence her observed height as well as other covariates such as number of siblings. For two of the outcomes, *Attending school* and *Child's height*, the age of child in months is entered in natural logarithm scale since exposure time needs to be controlled for.

Other control variables relating to living standards of households, capabilities of mothers, and demographic and birth related factors are considered as pathways of the intergenerational transmission and added to the model. Some of these factors relating to living standards and capabilities of mother are also entered in interaction with *Mother's height* to see if there is a gradient in the associations.

Mother's education is categorized into three categories; no education for those who have not started or completed primary education; primary for those who have completed primary education; and more than primary for those who have secondary education or more. Mother's education is important for capabilities of mothers for child rearing, and can be expected to be a mediating factor for the effect of mother's early life conditions on child outcomes.

A relative index for household living standard (*wealth*) calculated from data on ownership of certain assets, material of housing, access to water, and sanitation using principle component analysis. It is categorized into quintiles (tertiles when used in interaction with height). This measure relates to child health through both means to invest into child health and education, as well as to disease exposure and sanitation.

Father's education is divided into 4 categories; No education; completed primary; more than primary; and don't know for when the respondent does not know. Father's education is likely to capture household SES but may also capture attitudes which influence childcare and investments into children.

Mother's age at birth may relate to child outcomes in various ways. Firstly children of young mothers may have worse outcomes due to less capabilities for childrearing, physiological immaturity, and socioeconomic disadvantages (Fraser, Brockert, & Ward, 1995). Older mothers may have more experience and have more resources but biological factors may also cause worse outcomes for children. Therefore mother's age is specified as quadratic polynomial.

Mother's age at first birth is also specified as quadratic polynomial. If a mother gives birth at a very young age, before she reaches she reaches adult height, it may lead to shorter adult stature. But if a mother has her first child very late it may also lead to negative consequences for the health of her children.

Short *Birth interval*, less than two years, have been found to have harmful effects on children and appears to be more common in households with lower socio economic status (Orji, Shittu, Makinde, & Sule, 2004; Rasekh & Momtaz, 2007). We categorize birth interval into three categories; first born; birth interval more than 30 months; birth interval between 18 – 30 months; and birth interval less than 18 months.

Birth order, independent of mother's age, may influence allocation of resources to children within the household. It is specified as a continuous measure.

Number of siblings can relate to strains on household resources as well as other factors. This variable is defined as all siblings ever born and is specified as a continuous measure. Alternative definition was to only include surviving children. This variable had larger influence on the association of interest but is likely to relate to sibling deaths which complicates interpretations.

Instruments

We use two instruments for *Mother's height* for obtaining an local average treatment effect (LATE) (Angrist & Pischke, 2014, p. 109) to establishing a link between environmentally determined component of *Mother's height* and child outcomes. Both the instruments are constructed from sibling histories reported by respondents (mothers). Firstly we use a binary indicator for whether the mother was the oldest among her siblings (*mother oldest*) and secondly a binary indicator for whether a mother was born in a multiple birth (*mother multiple*).We observe that both the oldest, and multiples are considerably shorter, as can be seen in the first stage output in table 7 although the estimates are not robust to father fixed effects.

There are some indications that fetal growth is restricted for the first born child which could explain why birth weight has been shown to increase with parity (Elshibly & Schmalisch, 2009). The negative association between being a fist born and health is also likely to have to do with young age and inexperience of grandmother, especially since women in the region are generally very young when having their first child. There are no variables indicating grandmother's age at mother's birth but doing this analysis on the sample of the children indicates this. But whatever the mechanisms it is unlikely to be related to genetic factors. *Mother's number of siblings* is controlled for since proportionally more children are the first-borns in larger sibling groups and fertility of grandmother may be genetically determined.

We observe that mother's that are multiples are considerably shorter as can be seen in the first stage regression in table 7 The lower height of mothers born as multiples is likely to be determined both by in utero nutrition and childhood conditions. Since nutrition allocated to the womb is shared between the two twins there individual intake is likely to be lower than for singletons, which is likely to be an even bigger factor where resources are scarce. Birth weight often differs between twins which have been attributed to different allocation of intrauterine resources due to location of the placenta in the womb for dizygotic twins, and the insertion of the umbilical cord into the placenta for monozygotic twins (D. V. Almond, Chay, & Lee, 2002). Multiples are more commonly born at higher parity and to older mothers. It is believed that the higher prevalence at higher parity relates to fecundity of mother's while mother's age relates to hormonal changes. There are some indications that taller mothers are more likely to give birth to twins although these results have been mixed. In addition twin births seem to be familial to some extent (Bortolus et al., 1999). Twins more commonly have shorter duration of gestation and lower anthropomorphic measures in childhood in Sudan (Elshibly & Schmalisch, 2010). Conception of multiples is much more common than births of multiples (Landy & Keith, 1998) so births might be selective which could explain why mothers with these favorable characteristics give birth to more multiples but to our knowledge there is no existing research that tests this. Allocation of resources to individual twin is also likely to be lower after birth. We suppose that mothers born as multiples are shorter on average due to less nutrition in utero and further complication after birth. Occurrences of twin births in our sample is only about half of what is expected which indicates greater mortality of multiples.

These instruments are unlikely to relate to any genetic factors although that possibility cannot be ruled out. There have been indications that birth of twins is genetically determined and if it also relates to height determining genes the identification would be jeopardized. Leaving out the twin instrument and only using the *mother is oldest* instruments gives largely similar coefficients for *Mother's height* on child outcomes, although only *Mother's height* on *Died by 5* is statistically significant.

There are also some complication with *mother is oldest* instrument. Sibling histories are recorded from respondents and there is likely to be a recall bias especially when older siblings died at a very young age. When comparing national under-5 mortality rates constructed from sibling histories to World Bank data it is clear that it is severely underestimated and many under-5 deaths are missing from the sibling data. There are also clear indications in our data that these deaths are not randomly missing, and contrary to what we observe from deaths from the respondents birth histories, more educated women in wealthier households (better off) are more likely to have had siblings that died before the age of 5. Assuming that worse off mothers have shorter height in general, that under-5 sibling deaths are more likely to be under recorded for worse of mothers, and that the association between being the first born and height is due to young age of grandmother at first birth then it is clear that that association would be attenuated. This attenuation would cancel out to the extent to which better off grandmothers had their first child at older ages. Excluding all siblings that died before the age of 5 appears to reduce the attenuation since the association becomes stronger. Including all sibling births in construction of the *mother is oldest* only gives a significant estimate for *Died by 5* although all coefficients are the same as when only the siblings surviving until age 5 are included.

Having two instruments allows the exclusion restriction of the instruments to be tested since the IV identification requires that the instruments relate to child outcomes only through *Mother's height* (Murray, 2006).

Descriptive statistics

Descriptive statistics are reported in table 1. The average of each outcome variable is displayed in the first row. They are much in accordance with other sources. Although the samples do not overlap much the descriptive statistics look similar although those in the *Died by 5* sample are slightly worse of in some indicators. This could be an indication of a slight selective mortality in the other groups but could also be related to earlier birth years. Those in the *Child's height* sample also have considerably fewer siblings which is likely to be a result of decreasing fertility.

[Table 1 here]

There are some differences in the descriptive statistics of the full sample and the sample restricted to only those in polygynous marriages. All outcomes are less favorable and the difference is quite large. For example education of parents are considerably worse. The sample sizes are naturally much smaller and are very small for the child education outcomes.

[Table 2 here]

Analysis

We first estimate OLS and linear probability models for the four child outcomes *y* for child *i* living in *k* including fixed effects δ_k as well as a vector of *l* number of controls *x*.

$$y_{ik} = \alpha + mHAZ_{ik}\beta_k + x'_{ikl}\gamma_{kl} + \delta_k + \varepsilon_{ik}$$

The basic controls in *x´* are always child's sex, child's year of birth, mother's age at interview, and child's age at time of survey where exposure time needs to be controlled for. Then additional controls are added in three steps; firstly mother's education; secondly household living standards and husbands education; and finally birth order, mother's age at birth, mother's age at first birth, birth interval, and number of siblings. The main coefficients of interest are β for *Mother's height* $mHAZ$.

The *k* subscript in δ_k indicates the level of the fixed effects which is firstly at the country level, secondly at the community level and finally for polygynous households to account for unobserved factors at each level respectively while the father fixed effects control for unobserved father characteristics in addition to household heterogeneity. Communities are identified with the sampling clusters which generally consist of an area such as a village or a neighborhood in an urban area. Polygynous households are identified through several questions. Women are defined to be in a polygynous marriage if the answer that they have 1 or more cowives, are married to the household head, and at least 1 of their cowives has been interviewed and has non missing values for all variables used. Education of husbands was compared between the cowives and showed only a very few mismatches which were excluded.

Interactions of several characteristics with *Mother's height* using community fixed effects are used to test for difference in strength of the association between *Mother's height* and child outcomes. *d* number of dummy variables D for *d +1* characteristics with one omitted baseline category are interacted with *Mother's height* as

$$y_{ik} = \alpha^I + (D_{ikd} * mHAZ_{ik})\ '\beta^I_{kd} + D'_{ikd}\rho^I_{kd} + mHAZ_{ik}\beta^I_k + x'_{ikl}\gamma^I_{kl} + \delta^I_k + \varepsilon^I_{ik}$$

Where β^I_{ik} is the baseline association of *Mother's height* (for the omitted category), β^I_{ikd} is the additional association of mother height above the baseline for characteristic *d.* ρ^I_{ikd} is the net association of characteristic *d* with child outcome. So the interaction estimation allows each characteristic to have varying slopes for *Mother's height* as well as varying intercepts.

The IV estimation is done using two stages least squares estimation (2SLS) where *Mother's height* is first predicted by the instruments while controlling for $mSib_{ik}$ number of siblings of mother as well as all other controls in *x* and the respective fixed effects *k*.

$$mHAZ_{ik} = \alpha^{f} + \beta_{1k}^{f} oldest_{ik} + \beta_{2k}^{f} multiple_{ik} + x_{ikl}' \gamma_{kl}^{f} + \delta_{k}^{f} + mSib_{ik}\varphi_{k}^{f} + \varepsilon_{ik}^{f}$$

These predicted values for *Mother's height* $\widehat{mHAZ}_{ik}$ are then entered into the main equation.

$$y_{ik} = \alpha^{iv} + \widehat{mHAZ}_{ik}\beta_{k}^{iv} + x_{ikl}'\gamma_{kl}^{iv} + \delta_{k}^{iv} + mSib_{ik}\varphi_{k}^{iv} + \varepsilon_{ik}^{iv}$$

This gives a local average treatment effect (LATE) which gives the association between child outcomes and *Mother's height* as predicted by the instruments. Looking at figure one it should reduce the influence of the dotted lines indicating genetic pathways determining child outcomes. Only basic controls are used in the IV estimations since the other controls may be endogenous in the first stage regression. All estimations are done using limited information maximum likelihood (LIML). The results are largely when using traditional two stage least squares estimation (2SLS) but the LIML is known to be more robust for weak instruments. In additions test statistics are provided for weak instruments in the first stage. If the instruments only predict *Mother's height* weakly it may bias the results (Stock & Yogo, 2005). Test statistic is also provided for the exclusion restriction which tests whether one of the instruments relates to child's outcomes through other pathways than *Mother's height* (Murray, 2006). It should only be regarded as an indication that the exclusion restriction holds since the test relies on at least one of the instruments being valid.

Results

The results for *Died by 5* are presented in table 3. It shows a very consistent association between *Mother's height* and *Died by 5* in all specifications ranging from -.0158 for models with only country fixed effects to -.00768 for father fixed effects with full controls, which is similar to estimates from other research. Considering a baseline mortality risk of .17 for the full sample and .24 for the polygyny sample these estimates are considerable. It can also be seen that the coefficient for *Mother's height* is more sensitive to addition of controls when using country fixed effects. It responds only slightly to addition of controls in the community and father fixed effects which indicate that they are only minor pathways. The association with *Mother's height* is smaller when using father fixed effects compared to community fixed effects, which indicates that these estimates are biased upwards by assortative mating bias or unobserved household characteristics. Community fixed effects also seem to control for some bias possibly due to shared environment in the country fixed effects models. The Country and community level fixed effects used on the polygynous sample shows that this difference is unlikely to be due to sample characteristics since they indicate similar results as for the full samples.

[Table 3 here]

Looking at the results for *Child's height* in table 4 shows that it responds very little to addition of control variables except for slight changes in the country fixed effects models. The coefficient for *Mother's height* ranges from .220 to .292 z-score increase in *Child's height* for a single z-score increased in *Mother's height*. It is reduced for community fixed effects models compared to country fixed effects, and again slightly for father fixed effects models compared to community fixed effects, which indicates that it was upwards biased by unobserved community characteristics as well as unobserved household characteristics and assortative mating. Since the association does not respond to addition of controls it indicates that this relationship may be largely genetically determined.

[Table 4 here]

The two child education outcomes show similar patterns for country, community, and father fixed effects as can be seen in tables 5 and 6. They are both more responsive to addition of controls than the child health outcomes when using community and country fixed effect. For these specifications the association with a on z-score increase in *Mother's height* ranges from a .0194 to 0.00645 increase in probability of *Attending school* and 0.0189 to 0.00402 for *School by 10*. Considering a baseline probability of *Attending school* and *School by 10* of .7 these are not large associations. The father fixed effects model are not significant for neither of the outcomes but country and community fixed effects models on the polygynous sample indicate that there are sample differences with regard to these outcomes.

[Table 5 here]

[Table 6 here]

Estimating separate community fixed effects models with basic controls for each country shows a consistent relationship for *Died by 5* and *Child's height* outcomes. For *Child's height* it is significant for all countries while for *Died by* it is significant in all but 6 countries. . The association with *Mother's height* is significant in 9 countries for *School by 10* and 11 countries for *Attending school*. Samples for some countries are small as can be seen in table 9.

In Table 7 interaction terms are included to the community fixed effects specification using all control variables. The first part looks at the interaction of *Mother's height* and mother's education which shows that it is only children born to mothers with no education or primary education that show a positive association between *Mother's height* and the child education outcome. *Attending school* it is close to 0 and for *School by 10* it is actually positive. For *Died by 5* there is less of an intergenerational effect for mother's with more than primary education, but all groups show a negative association between *Mother's height* and *Died by 5*. For *Child's height* there is a clear gradient - the more education a mother has the stronger the association between *Mother's height* and *Child's height*.

[Table 7 here]

Turning to interaction with household *wealth*, the effect of *Mother's height* on child education it is strongest in the poorest households, lower in the second tertile, and close to 0 or even slightly positive in the third tertile. Similarly for *Died by 5* children in the third tertile show a weaker association than the reference category while there are no statistically significant differences between other quintiles For child health on the other hand, the effect of *Mother's height* is stronger the richer the households..

Interaction between *Mother's height* and tertiles of *Mother's height* shows that the association is lowest and statistically non-significant for the tallest groups for the educational outcome. For *Child's height* the association with *Mother's height* is much lower for the tallest tertile of *Mother's height* although there is still a strong statistically significant association. For *Died by 5* the association with *Mother's height* is much weaker and statistically not significant for the tallest group.

The interaction between *Mother's height* and mother's age at birth shows a somewhat inconsistent difference between the two child education outcomes. *School by 10* shows a quite strong negative association for the oldest group while those 20 – 25 years old show the strongest positive association, while 25-35 is lower but still significant. There is no significant difference in the association for *Attending school.* For *Child's height* there are significant differences in the association where children born to the youngest mothers have the strongest association, those born to 20 – 25 year old mothers have the lowest association. Then the next group 25 – 35 years old has a higher association while the oldest one has almost as low are 20 - 35 years old. The pattern for *Died by 5* outcomes is largely similar, although the oldest group has the second highest association.

There is only significant difference in the association with *Mother's height* for rural residence for the *Child's height* outcome, where rural residences have a lower association. Girls generally seem to have a lower association between *Mother's height* and all outcomes, except for *School by 10* where it is slightly higher but only significant at 10% significance level.

Turning to the IV estimation in table 8 shows that the father fixed effects models do never give significant results, and all first stage models are too weak. The results from the community fixed effects IV models show much greater statistically significant coefficients for the child education outcomes and *Died by 5* and considerably larger for *Child's height* although only significant at 10% significance level. The estimates for the country fixed effects models are also considerably larger although only significant for *Died by 5* and *Child's height*. The Hansen J statistic indicates that the instruments are not valid for the *Child's height* outcome with only country fixed effects.

[Table 8 here]

Discussion

Our results of the effect of *Mother's height* on health outcomes of children are quite consistent across the different outcomes. Results are also similar across different countries in sub-Saharan Africa. The height of the mother has some impact on the educational outcomes of her children as well although the relationship is less robust. The effect is somewhat mediated by maternal education, especially in the case of the educational outcomes while less so for health outcomes. Nonetheless, there is a direct effect as well of maternal health, as measured by her height.

The father fixed effects seem to control for some unobserved household characteristics and possibly assortative mating. The interactions between *Mother's height* and a number of variables related to capabilities and living conditions of the mother also show interesting results. Effects of older mothers are smaller than for younger mothers for mortality. Education and survival of children in better-off households, with better educated mothers are less affected by the height of their mothers, while the opposite is true when looking at *Child's height*. This is likely to be explained by the different components determining *Mother's height* driving the association. Better-off mothers are more likely to have lived up to their genetic potential in terms of height, and their height is therefore largely genetically determined. Hence, the association between mother's and *Child's height* will then not necessarily indicate transfer of health, but simply of shared genes. The opposite is true for mothers in poor households, whose height is to a greater extent is determined by environmental factors, such as disease exposure and nutrition in early life, which seems to be more important for child health as measured by mortality, and education outcomes.

The IV estimations also indicate that there is a link between environmentally determined height of mother's and child health and even education outcomes, although the results are not robust. Interpreting the magnitudes of the observed association since it relates to height as predicted by the instruments.

The magnitudes of the association of between *Mother's height* and child morality are considerable and indicate intergenerational transmission of health, which are likely to be through mother's exposures to diseases and under nutrition. These associations were lower and less robust for child education but still give indications of an important relationship. Considering that early life conditions determine only a component of height the link may be stronger than indicated by these estimates.

Poor health of mothers affects both schooling and health of her children, which in turn has great implications for both productivity and later life mortality of these individuals. Poor capability formation during childhood can trap families in a vicious circle of underinvestment in children, leading to low adult capabilities. It is important to break this circle by making sure that children in disadvantaged household get external support and monitoring for adequate care and investments. It not only concerns individual wellbeing but also future human capital formation, which is of crucial importance if these countries are to reap the potential benefits of the demographic dividend, stimulating economic growth and societal development.

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Figure 1: Pathways of intergenerational transmission of capabilities

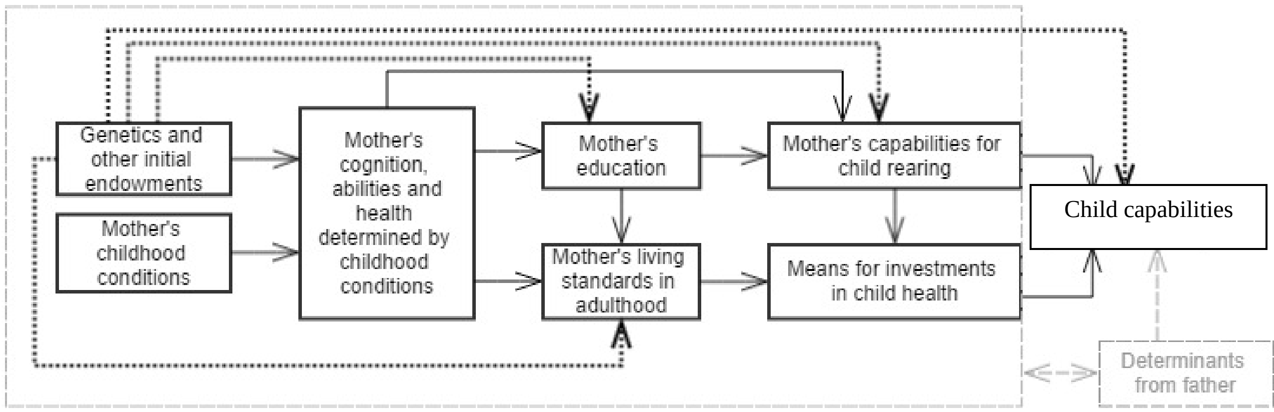

Table 1: Descriptive statistics for whole sample

Variables:	School by 10	Attending school	Child's height	Died by 5	Specification
	Means by outcome				
Outcome	0.690	0.701	-1.413	0.174	Binary/Continuous
Mother height (HAZ)	-0.867	-0.886	-0.887	-0.844	Continuous
Female	0.488	0.493	0.497	0.491	Binary
Mother's age at interview	37.472	34.934	29.137	37.381	Continuous
Child year of birth	1993.130	1996.655	2002.967	1992.119	Continuous
Mother's education: Primary	0.389	0.389	0.371	0.339	Binary
More than primary	0.167	0.171	0.175	0.136	Binary
Husbands education: Primary	0.362	0.361	0.339	0.320	Binary
More than primary	0.272	0.276	0.278	0.233	Binary
Don't know	0.023	0.023	0.025	0.026	Binary
Household wealth quintile: 2nd	0.200	0.205	0.209	0.212	Binary
3rd	0.199	0.200	0.201	0.203	Binary
4th	0.188	0.183	0.187	0.188	Binary
5th	0.177	0.167	0.168	0.159	Binary
Mother's age at birth	18.699	18.800	18.894	18.257	Quadratic
Mother's age at first birth	25.603	26.467	27.244	24.248	Quadratic
Birth interval: First born	0.217	0.197	0.178	0.263	Binary
less than 20 months	0.094	0.093	0.057	0.110	Binary
20 - 30 months	0.297	0.297	0.275	0.312	Binary
Birth order	3.482	3.724	3.906	3.216	Continuous
Number of siblings	6.252	5.706	4.240	6.420	Continuous
Age in months		106.773	27.602		Natural log
Mother multiple	0.014	0.014	0.015	0.015	Binary
Mother oldest	0.231	0.229	0.225	0.241	Binary
Mother number of siblings	5.227	5.224	5.173	5.020	Continuous
Rural	0.738	0.746	0.732	0.736	Binary
Number of observations	163,526	181,150	381,080	1,242,440	
Number of communities	18,359	19,042	30,939	31,775	

Data source: DHS, 2015

Table 2: Descriptive statistics for polygyny samples

Variables:	School by 10	Attending school	Child height	Died by 5	Specification
	Means by outcome				
Outcome	0.484	0.465	-1.609	0.241	Binary/Continuous
Mother height (HAZ)	-0.626	-0.655	-0.645	-0.647	Continuous
Female	0.479	0.487	0.492	0.490	Binary
Mother's age at interview	38.020	35.726	30.064	37.365	Continuous
Child year of birth	1993.158	1996.587	2001.172	1990.717	Continuous
Mother's education: Primary	0.149	0.148	0.172	0.134	Binary
More than primary	0.041	0.037	0.037	0.031	Binary
Husbands education: Primary	0.143	0.146	0.189	0.145	Binary
More than primary	0.104	0.100	0.106	0.089	Binary
Don't know	0.008	0.008	0.008	0.007	Binary
Household wealth quintile: 2nd	0.237	0.240	0.238	0.250	Binary
3rd	0.225	0.226	0.221	0.225	Binary
4th	0.176	0.163	0.188	0.173	Binary
5th	0.116	0.097	0.098	0.096	Binary
Mother's age at birth	18.300	18.341	18.353	17.923	Quadratic
Mother's age at first birth	26.173	27.237	28.225	24.326	Quadratic
Birth interval: First born	0.159	0.133	0.109	0.226	Binary
less than 20 months	0.104	0.105	0.056	0.125	Binary
20 - 30 months	0.322	0.341	0.295	0.347	Binary
Birth order	3.936	4.304	4.634	3.483	Continuous
Number of siblings	6.988	6.508	4.965	7.094	Continuous
Age in months		107.035	26.937		Natural log
Mother multiple	0.013	0.014	0.013	0.013	Binary
Mother oldest	0.239	0.244	0.243	0.263	Binary
Mother number of siblings	4.743	4.805	4.935	4.630	Continuous
Rural	0.829	0.850	0.846	0.842	Binary
Number of observations	6,565	8,246	18,180	81,230	
Number of fathers	2,062	2,776	6,526	8,697	

Data source: DHS, 2015

Table 3: Results for *Died by 5* on *Mother's height*

	Outcome: Died by 5				
					Obs.
Country fixed effects					
Mother's height	-0.0158***	-0.0133***	-0.0119***	-0.0118***	1,242,440
	(0.000510)	(0.000501)	(0.000499)	(0.000476)	
Community fixed effects					
Mother's height	-0.0107***	-0.0101***	-0.00969***	-0.00941***	1,242,440
	(0.000504)	(0.000505)	(0.000504)	(0.000483)	
Father fixed effects					
Mother's height	-0.00753***	-0.00739***	-0.00739***	-0.00768***	81,230
	(0.00270)	(0.00270)	(0.00270)	(0.00264)	
Country fixed effects[1]					
Mother's height	-0.0144***	-0.0134***	-0.0125***	-0.0126***	81,230
	(0.00205)	(0.00204)	(0.00202)	(0.00194)	
Community fixed effect[1]					
Mother's height	-0.0102***	-0.0100***	-0.00976***	-0.00986***	81,230
	(0.00222)	(0.00222)	(0.00221)	(0.00211)	
Main controls	x	x	x	x	
+ mother's education		x	x	x	
+ father education and wealth[2]			x	x	
+ birth/maternal factors				x	

Robust cluster adjusted standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Main controls: Child's year of birth; sex of child; mother's age at interview

Birth/maternal factors: Mother's age at birth; mother's age at first birth; birth order; first born; number of siblings

1 Restricted to same sample as the father fixed effects

2 Father's education and household wealth implicitly controlled for with father fixed effects

Data source: DHS, 2015

Table 4: Results for *child's height* on *Mother's height*

	Outcome: Child's height				
					Obs.
Country fixed effects					
Mother's height	0.292***	0.272***	0.259***	0.259***	381,080
	-0.00347	-0.00342	-0.00341	-0.0034	
Community fixed effects					
Mother's height	0.248***	0.244***	0.241***	0.241***	381,080
	-0.00342	-0.00342	-0.00342	-0.00342	
Father fixed effects					
Mother's height	0.223***	0.222***	0.222***	0.220***	18,180
	-0.0209	-0.021	-0.021	-0.0209	
Country fixed effects[1]					
Mother's height	0.232***	0.226***	0.222***	0.221***	18,180
	-0.0152	-0.0152	-0.0153	-0.0152	
Community fixed effects[1]					
Mother's height	0.234***	0.233***	0.232***	0.230***	18,180
	-0.0173	-0.0173	-0.0174	-0.0173	
Main controls	x	x	x	x	
+ mother's education		x	x	x	
+ father education and wealth[2]			x	x	
+ birth/maternal factors				x	

Robust cluster adjusted standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Main controls: Child's year of birth; sex of child; child's age in months; mother's age at interview

Birth/maternal factors: Mother's age at birth; mother's age at first birth; birth order; first born; number of siblings

1 Restricted to same sample as the father fixed effects

2 Father's education and household wealth implicitly controlled for with father fixed effects

Data source: DHS, 2015

Table 5: Results for *School by 10* on *Mother's height*

	Outcome: School by 10				
					Obs.
Country fixed effects					
Mother's height	0.0189***	0.00870***	0.00370***	0.00365***	163,526
	-0.00148	-0.00138	-0.00129	-0.00127	
Community fixed effects					
Mother's height	0.00834***	0.00590***	0.00408***	0.00402***	163,526
	-0.00128	-0.00126	-0.00125	-0.00125	
Father fixed effects					
Mother's height	0.0084	0.00803	0.00803	0.0078	6,565
	-0.0071	-0.00711	-0.00711	-0.00707	
Country fixed effects[1]					
Mother's height	0.0140*	0.00761	0.00342	0.00372	6,565
	-0.00735	-0.00719	-0.00655	-0.00658	
Community fixed effects[1]					
Mother's height	0.0075	0.00678	0.00542	0.00543	6,565
	-0.00691	-0.00688	-0.0068	-0.00675	
Main controls	x	x	x	x	
+ mother's education		x	x	x	
+ father education and wealth[2]			x	x	
+ birth/maternal factors				x	

Robust cluster adjusted standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Main controls: Child's year of birth; sex of child; mother's age at interview

Birth/maternal factors: Mother's age at birth; mother's age at first birth; birth order; first born; number of siblings

1 Restricted to same sample as the father fixed effects

2 Father's education and household wealth implicitly controlled for with father fixed effects

Data source: DHS, 2015

Table 6: Results for *Attending school* on *Mother's height*

	Outcome: Attending School				
					Obs.
Country fixed effects					
Mother's height	0.0194***	0.00993***	0.00544***	0.00568***	181,150
	-0.00137	-0.00127	-0.00122	-0.00121	
Community fixed effects					
Mother's height	0.0104***	0.00821***	0.00646***	0.00645***	181,150
	-0.00118	-0.00117	-0.00116	-0.00116	
Father fixed effects					
Mother's height	0.00758	0.00781	0.00781	0.0077	8,246
	-0.00564	-0.00562	-0.00562	-0.00562	
Country fixed effects[1]					
Mother's height	0.00692	0.000765	-0.00135	-0.00156	8,246
	-0.00676	-0.00653	-0.00598	-0.00597	
Community fixed effects[1]					
Mother's height	-0.00427	-0.00504	-0.00604	-0.00589	8,246
	-0.00622	-0.00622	-0.00605	-0.00601	
Main controls	x	x	x	x	
+ mother's education		x	x	x	
+ father education and wealth[2]			x	x	
+ birth/maternal factors				x	

Robust cluster adjusted standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Main controls: Child's year of birth; sex of child; child's age in months; mother's age at interview

Birth/maternal factors: Mother's age at birth; mother's age at first birth; birth order; first born; number of siblings

1 Restricted to same sample as the father fixed effects

2 Father's education and household wealth implicitly controlled for with father fixed effects

Data source: DHS, 2015

Table 7: Interactions with *Mother's height*

	Outcome:			
	School by 10	Attending school	Child's height	Died by 5
Mother's education * mother's height				
No education (rc)	0.00416**	0.00664***	0.218***	-0.00981***
+ Primary	0.00361	0.00176	0.0471***	-0.000176
+ More than primary	-0.00913***	-0.00514**	0.0377***	0.00339***
Residency * mother's height				
Urban (rc)	0.00145	0.00525***	0.256***	-0.00820***
+ Rural	0.0034	0.00158	-0.0199**	-0.00159
Wealth tertile * mother's height				
Poorest (rc)	0.00844***	0.0133***	0.224***	-0.0103***
+ Middle	-0.00348	-0.0101***	0.0214***	9.13E-05
+ Highest	-0.0101***	-0.0117***	0.0286***	0.00264**
Mother's height tertile * mother's height				
Shortest (rc)	0.00644***	0.00841***	0.257***	-0.0117***
+ Middle	-0.000213	-0.00234	-0.00506	0.00107
+ Tallest	-0.0108***	-0.00886**	-0.0742***	0.00979***
Sex * mother's height				
Male (rc)	-0.0100***	0.00657***	0.00875***	0.244***
+ Female	0.00125*	-0.00523***	-0.00466**	-0.00516
Mother's age at birth*mother's height				
Younger than 20 (rc)	-0.000564	0.00818***	0.260***	-0.0135***
+20 – 25	0.00825***	-0.00243	-0.0290***	0.00528***
+25 – 35	0.00620**	-0.00118	-0.0166**	0.00439***
+ Older than 35	-0.00736*	-0.00395	-0.0233**	0.0124***

*** p<0.01, ** p<0.05, * p<0.1

All models use community fixed effects

Controls: Child's year of birth; sex of child; (child's age in months); Mother's age at time of interview; Household wealth; father's education; Mother's age at birth; mother's age at first birth; birth order; first born; number of siblings

Data source: DHS, 2015

Table 8: Instrumental variable estimation

	Died by 5			School by 10			Attending school			Child's height		
Mother's height	-0.159***	-0.0847***	-0.275	0.112	0.155**	-0.324	0.163*	0.0959	-0.601	0.580**	0.346*	-1.043
	(0.0381)	(0.0272)	(0.443)	(0.0891)	(0.0706)	(0.425)	(0.0950)	(0.0627)	(7.605)	(0.259)	(0.191)	(0.858)
Fixed effects	Country	Comm.	Father	Country	Comm.	Father	Country	Comm.	Father	Country	Comm.	Father
Basic controls	x	x	x	x	x	x	x	x	x	x	x	x
Mother nr. of sibl.	x	x	x	x	x	x	x	x	x	x	x	x
First Stage[1]												
Mother multiple	-0.0394	-0.0699***	-0.0661***	-0.0626	-0.108***	-0.194	-0.0502	-0.113***	-0.0603	-0.0601***	-0.0790***	-0.00928
Mother oldest	-0.0396***	-0.0423***	-0.0215***	-0.0373***	-0.0385***	0.01	-0.0374***	-0.0347***	-0.0105	-0.0370***	-0.0324***	-0.0812***
Kleibergen-Paap F[2]	**19.418**	**29.06**	5.599	7.659	**10.987**	1.138	8.605	**12.946**	0.196	**44.72**	**21.642**	7.714
Hansen's J statistic[3]	0.396	0.106	0.628	0.017	0.832	0.001	0.494	0.363	0.065	12.416***	0.023	0.963
Observations	1,242,440	1,242,440	81,230	163,526	163,526	6,565	181,150	181,150	8,246	381,080	381,080	18,180

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Main controls: Child’s year of birth; child’s sex; child’s age in months (child in school and child’s height) ; mother's age at interview

[1] First stage regressions coefficients only for the excluded instruments

[2] Bold type indicates that first stage is not too weak

[3] Non-significance indicates valid instruments

Table 9: Proportion of full sample for each country

Countries:	School by 10	Attending school	Child's height	Died by 5
	% of sample in each country by outcome			
Burkina Faso	3.68	3.63	4.72	4.89
Benin	4.52	4.75	3.71	3.6
Burundi	1.14	1.16	0.87	0.66
Congo (DR)	3.93	4.09	2.8	2.4
Central African Republic	x	x	0.54	0.39
Congo (Brazzaville)	2.58	2.6	1.97	1.81
Ivory Coast	x	x	1.5	1.4
Cameroon	2.69	2.83	2.41	2.32
Ethiopia	10.91	10.55	5.72	6.44
Gabon	1.12	1.04	1.46	1.32
Guinea	1.09	1.11	2.18	2.46
Kenya	4.33	4.09	3.44	3.09
Comoros	x	x	0.61	0.65
Liberia	1.32	1.61	1.71	2.14
Lesotho	1.46	1.23	0.68	0.84
Madagascar	4.76	4.7	2.96	3.04
Mali	3.87	4.05	7.44	7.64
Malawi	8.63	8.65	6.35	6.12
Mozambique	2.92	3.03	4.95	4.65
Nigeria	8.07	8.54	11.1	12.81
Niger	1.49	1.6	2.18	2.17
Namibia	1.33	1.3	1.21	1.52
Rwanda	5.72	5.37	3.41	3.28
Sierra Leone	0.72	0.75	1.45	1.95
Senegal	1	1.02	1.6	1.6
Sao Tome and Principe	0.68	0.62	0.36	0.41
Swaziland	0.83	0.67	0.34	0.58
Chad	x	x	2.57	1.71
Togo	1.3	1.35	1.67	1.48
Tanzania	2.71	2.6	4.76	4.26
Uganda	3.35	3.45	3.51	2.98
Zambia	8.86	9	6.66	6.13
Zimbabwe	4.99	4.6	3.16	3.28
Observations	163,526	181,150	381,080	1,242,440

Table 10: Proportion of polygyny sample for each country

Countries:	School by 10	Attending school	Child's height	Died by 5
	% of sample in each country by outcome			
Burkina Faso	20.67	19.33	16.06	16.33
Benin	11.91	12.55	9.98	9.38
Burundi	0.05	0.1	0.08	0.05
Congo (DR)	1.05	1.01	0.98	0.85
Central African Republic	1.4	x	0.77	0.5
Congo (Brazzaville)	x	1.21	0.79	0.95
Ivory Coast	x	x	1.27	0.9
Cameroon	4.07	3.64	3.67	3.39
Ethiopia	0.61	0.55	0.44	0.4
Gabon	0.38	0.25	0.25	0.37
Guinea	4.6	4.16	5.44	6.11
Kenya	0.29	0.45	0.64	0.36
Comoros	x	x	x	x
Liberia	0.14	0.39	0.35	0.45
Lesotho	x	x	x	x
Madagascar	0.08	0.02	x	0.01
Mali	14.91	14.5	20.99	23.06
Malawi	0.78	0.95	1.13	0.78
Mozambique	1.66	1.77	2.05	1.4
Nigeria	22.39	23.66	13.88	18.62
Niger	4.23	4.89	3.01	3.13
Namibia	x	x	0.13	0.09
Rwanda	0.03	0.04	0.03	0.02
Sierra Leone	0.59	0.74	0.61	0.78
Senegal	2.65	2.32	1.47	1.7
Sao Tome and Principe	x		0.04	x
Swaziland	x	x	x	0.03
Chad	x	x	5.75	3.18
Togo	3.82	3.59	4.63	3.74
Tanzania	0.44	0.55	1.43	0.78
Uganda	0.84	0.82	1.55	0.81
Zambia	1.72	1.73	1.84	1.34
Zimbabwe	0.69	0.79	0.75	0.49
Observations	6,565	8,246	18,180	81,230