Sharing the load: how do co-resident children influence the allocation of work and schooling in north-western Tanzania?

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Abstract

Economic and evolutionary models of parental investment often predict education biases towards earlier-born children, resulting from either household resource dilution or parental preference. Previous research, however, has not always found these predicted biases. This may be because, in societies where children work, older children are more efficient at household tasks and substitute for younger children, whose time can then be allocated to school. The role of labour substitution in determining children's schooling remains uncertain, however, because few studies have simultaneously considered intrahousehold variation in both children's education and work. Here, we investigate the influence of co-resident children on education, work and leisure in north-western Tanzania, using detailed time use data collected from multiple children per household (n=1,273). We find that age order (relative age, compared to co-resident children) within the household is associated with children's time allocation, but these patterns differ by gender. Relatively young girls do less work, have more leisure time, and have greater odds of school enrolment than older girls. We suggest this results from labour substitution: older girls are more efficient workers, freeing younger girls' time for education and leisure. Conversely, relatively older boys have the highest odds of school enrolment among co-resident boys, possibly reflecting traditional norms regarding household work allocation and age hierarchies. Gender is also important in household work allocation: boys who co-reside with more girls do fewer household chores. We conclude that considering children as both producers and consumers is critical to understanding intra-household variation in children's schooling and work.

Introduction

Time allocation can differ substantially between co-resident children, especially in modernizing populations where children attend school alongside making productive contributions to the household economy. This variation can have important long-term implications for individual wellbeing, economic and reproductive success; children's time in both school and work offers opportunities for human capital generation and potential exposure to risks such as the lack of parental supervision or dangerous work activities (Bock, 2002). Demographers, economists and anthropologists have long been interested in intra-household differences in time allocation, including variation by birth order and age order (i.e. relative age within a household). Time allocated to education is frequently framed as a measure of parental investment, as it is costly both directly, and through the opportunity costs of children's lost work contributions. Taking this perspective, both economists and evolutionary anthropologists have predicted that earlier-born children will be favoured by parents, either as an inadvertent consequence of household resource dilution or strategic parental preference (Edmonds, 2006; Hertwig, Davis, & Sulloway, 2002; Jeon, 2008).

Economic models of parental investment focus on the role of siblings as competitors for finite parental resources, predicting a trade-off between the number of dependents and investment in each one, i.e. a child quantity-quality trade-off (Becker, 1960). In studies of educational outcomes, this perspective is also referred to as resource dilution theory (Downey, 2001). Children in larger families are predicted to be disadvantaged, with later-born children being particularly disadvantaged as, unlike earlier-born offspring, they experience sibling competition for finite parental resources without a period of exclusive parental investment (Hertwig et al., 2002; Parish & Willis, 1993). Later-born children may also experience a period of lower competition after older siblings leave the parental home, but exclusivity in parental attention is generally deemed more influential in early childhood (Hertwig et al., 2002). Families may also get wealthier over their life cycle, which could advantage later-borns, but this effect is better considered an impact of parental age, not birth order (Lawson & Mace, 2009).

Evolutionary anthropologists have also modelled the trade-off between quantity and quality of offspring (Lawson & Borgerhoff Mulder, 2016), generally predicting early-born advantage. An evolutionary perspective predicts that parents act to maximize their inclusive fitness i.e. the long-term

production of descendants via both direct reproduction and assisting their relatives. As a consequence, parents are predicted to bias investment towards offspring with the greatest likelihood of survival and successful reproduction (Trivers, 1972). Within a sibship, earlier-born children are closer to maturity, and have lower mortality risk than later-borns, and therefore have greater 'reproductive value' (expected number of future children), so that parents can be more certain of the payoff to their investment (Jeon, 2008; Sear, 2011). Furthermore, biased investment in earlier-born children is anticipated in growing populations, where fitness is maximized by minimizing generation time (Jones & Bliege Bird, 2014).

A close focus on parental investment however neglects the fact that in subsistence contexts, children are typically producers as well as consumers (Kramer, 2002, 2005, 2011). Indeed, opposing predictions about time allocation to education arise from models taking children's work as their starting point, with parents anticipated to allocate children's time to optimize overall household production. Children's time allocation changes with age; very young children devote time largely to leisure, as they begin to develop skills by learning through play. Their ability to carry out productive work increases with age as they gain strength and skill, increasingly specializing in gender-specific tasks (Bock, 2002; Gurven & Kaplan, 2006; Kramer, 2005). In households with multiple children, earlier-born (i.e. relatively older) children, are expected to be more productive (and in the case of paid work command higher wages), and consequently are predicted to be preferentially allocated work. If earlier-born children are more likely to be allocated work, this should free later-born children's time to attend school. A focus on labour substitution therefore predicts, in opposition to parental investment biases, that later-born children will be more likely to be enrolled in school (Basu & Van, 1998; Edmonds, 2006; Lee & Kramer, 2002).

With models of parental investment and labour substitution making contrasting predictions, our attention turns to the empirical literature. As we review below, existing research finds mixed results about the influence of co-resident children on children's time spent in school and work. This may be because it mostly focuses on either education or work, rather than considering the two simultaneously – preventing an explicit consideration of the role of labour substitution in determining education outcomes. Here, we take a holistic approach to children's time allocation and simultaneously investigate

how the presence of co-resident children influence children's time spent in education, work and leisure in north-west Tanzania. As such, we overcome an important methodological limitation common across many prior studies of children's time allocation. We also promote theoretical synthesis by using an adapted version of embodied capital theory, an integrated theoretical framework that draws on both economic and evolutionary models of parental investment (Kaplan, 1996; Kaplan, Bock, & Hooper, 2015). Specifically, embodied capital theory predicts that parents will strategically allocate time and resources across the household in order to optimize long-term investment in children. This parental investment is aimed at maximizing parental reproductive success (or at least parental behaviour is shaped by mechanisms which in the past have maximized reproductive success). Despite this assumption that individuals' behaviour is shaped by maximizing long-term reproductive success, in practice other outcomes, such as education or income, are typically used as proxies of fitness, aligning these models with conventional economic approaches (Kaplan et al., 2015). The economic literature also draws attention towards the short-term needs of the household, highlighting the trade-off between producing enough to sustain the household in the present, while investing in children's education and skills for the future (Edmonds, 2006). Here, then, we assume that children's time allocation is shaped both by parental investment biases towards those who will produce the greatest returns in the long-term, and by decisions to preferentially allocate work to those who are currently most productive, or for whom other uses of time are least valuable (note such allocation may be influenced by decisions taken by both parents and children) (Gurven & Kaplan, 2006).

Below we review evidence regarding birth/age order and children's time allocation from previous empirical studies of low-income settings where education and children's work coexist. We then outline our predictions regarding educational investment and children's work at our study site, where we anticipate strong scope for labour substitution effects in children's time allocation, given the important contributions children make to the household economy in this setting (Hedges, Sear, Todd, Urassa, & Lawson, 2018). We also extend prior research by investigating the influence of all co-resident children, not just siblings, because in this context (as in many others), a high proportion of children are co-resident with children other than siblings. Throughout we integrate a consideration of the gendered aspects of labour substitution; stratifying our analyses by gender and testing whether or not co-resident children of the same and opposite sex play specific roles. Prior research in this region confirms

87 that children's work is highly gendered, with girls taking on the majority of household tasks and boys
88 predominantly involved in farming work (Hedges et al., 2018). As such our study has implications for
89 understanding both birth/age order and gender biases in modernizing contexts.

90 *Prior research on birth/age order and children's time allocation*

91 Studies of high-fertility subsistence populations have reported evidence both for preferred investment
92 in earlier-born children and for labour substitution, with the work of earlier-born children freeing up
93 time for later-born children. For example, in many contexts later-born males receive lower wealth
94 transfers at marriage and inheritance (e.g. Borgerhoff Mulder, 1998; Gibson & Gurmu, 2011; Hrdy &
95 Judge, 1993; Mace, 1996). On the other hand, detailed longitudinal work on children's work among
96 Mayan agriculturalists highlights the role of labour substitution with children taking on different roles as
97 a family matures. Here, earlier-born children's work subsidizes later-born children while they are too
98 young to contribute; then as later-born children grow and become more productive, earlier-born
99 children leave home (Kramer 2005; Lee & Kramer 2002). These results are not necessarily
100 incompatible, because investment in adulthood (e.g. wealth transfers at marriage) does not conflict with
101 time allocation during childhood.

102 Educational investment on the other hand necessarily conflicts with work contributions to the household.
103 Studies from Brazil, Nicaragua, Guatemala, Nepal, and Ethiopia suggest that investment and time
104 allocation patterns reflect labour substitution, with earlier-born children working more and being less
105 likely to be in school (Dammert, 2010; Emerson & Souza, 2008; Fafchamps & Wahba, 2006; Haile &
106 Haile, 2012). Other studies, generally using aggregated, nationally-representative datasets, have
107 found that earlier-born children had lower educational attainment or reduced school attendance and
108 have attributed this to hypothesized labour substitution effects (Huisman & Smits, 2015; Kumar, 2016;
109 Lindskog, 2013; Lloyd & Gage-Brandon, 1994; Parish & Willis, 1993; Rammohan & Dancer, 2008;
110 Ryan, Koczberski, Curry, & Germis, 2017). However, smaller-scale studies in Ethiopia, Malawi, and
111 Tanzania found that later-born children received less educational investment (Gibson & Lawson, 2011;
112 Gibson & Sear, 2010; Hedges, Borgerhoff Mulder, James, & Lawson, 2016). These early-born biases
113 were more evident in wealthier households, perhaps because demand for child labour is lower among
114 these households reducing scope for labour substitution.

All of these studies are cross-sectional, making it difficult to account for how households may be strategic about the timing of investment and household time allocation, potentially levelling out differences between children over the household life cycle. Studies in South Africa and Malawi have reported that earlier-born children progress through school faster, suggesting that parents may invest more in older children in order that they complete their education faster, then become available to substitute for younger children's work (Liddell, Barrett, & Henzi, 2003; Moyi, 2010). Similarly, in Kenya, earlier-born children attained more education, but this effect was lessened in larger families, possibly because older siblings who complete their education are able to work and thus subsidize younger siblings' education (Gomes, 1984).

Labour substitution effects are therefore not mutually exclusive from investment biases, and may differ by gender if boys and girls have different patterns of work. In many modernizing contexts, the work that children do is predominantly household chores and childcare. These are often female responsibilities, and girls generally do more work than boys, meaning labour substitution effects may be seen more strongly for girls than for boys (Edmonds, 2006). Several studies have found evidence of earlier-born disadvantage in schooling or workload for girls but not boys (Dammert, 2010; Edmonds, 2006; Glick & Sahn, 2000; Heissler & Porter, 2010; Kevane & Levine, 2003; Parish & Willis, 1993; Rosati & Rossi, 2003). Additionally, some studies have suggested that having sisters is particularly beneficial for schooling (Canagarajah & Coulombe, 1993; Morduch, 2000).

The question of how the presence of substitute workers affects children's work and education thus remains complicated. As we have noted, a key limitation of previous studies is their focus on education; very few have examined work patterns within households, making it difficult to assess the extent to which differences by birth order represent labour substitution or effects such as parental investment biases. Where work is investigated, many studies have looked only at paid or farm work rather than household chores (e.g. Emerson & Souza, 2008; Patrinos & Psacharopoulos, 1995), often using a binary outcome indicating whether a child works or not, which may obscure the nuances of intra-household time allocation. Studies are also often limited to how biological siblings influence each other (e.g. Huisman & Smits, 2015), but in contexts with child fostering and alternative living arrangements, this neglects many of the substitute workers available to children. Finally, while large, nationally-

representative datasets are important in identifying large-scale trends, smaller-scale studies which compare multiple households within a similar subsistence context avoid the potential for confounding between individual and group-level variables (i.e. the ecological fallacy) to affect results (Lawson & Uggla, 2014). We build on previous literature from both anthropology, economics, and demography, using detailed data on children's time allocation and education from a Demographic Surveillance Site situated in an area undergoing rapid modernization in Tanzania. Reflecting the local context that has high levels of fostering, we include all children of school age within a household.

Setting and predictions

In Tanzania, government primary schools do not charge school fees, but families pay costs such as uniforms, stationery and exam fees. Children generally start school at age seven, though delayed entry and grade repetition are common. There are seven years of primary education, four years of basic secondary education, and two years of advanced secondary education. Primary school is taught in Swahili, which may present a barrier for children who speak their local language at home; in this study, many households speak Sukuma, particularly in the rural village. Further language barriers are encountered at secondary level, where all classes and exams are conducted in English, with a negative impact on students' learning and academic achievement (Brock-Utne, 2007).

The quality of schooling provided is a cause for concern in Tanzania; pass rates for secondary school exams being as low as 40% and many children leaving primary school unable to read or write (Hivos/Twaweza, 2014; Pritchett, 2013). In interviews with local teachers the lack of school infrastructure and equipment was frequently cited as a challenge, with teachers struggling to maintain discipline in large classes. During focus groups adolescents and parents cited the long distances to school and harsh punishments, including beatings, as challenges to school attendance. Youth unemployment is common, and some parents complained that having sent their children to school, they were no longer willing to help with farming activities and often sat idle at home.

In Tanzania fostering is common, even for children who have both parents alive, with many children residing with grandparents or other relatives to provide better access to school, provide help with household work, or just because of family preferences (see also Lawson et al., 2017). In our sample only 65% of children are the biological child of the household head meaning a large proportion of

children live in alternative arrangements. Even among children who are the biological child of the household head many live with school-age step-siblings, half-siblings, cousins, or nieces and nephews. We therefore do not focus on number of siblings or birth order but instead look at age rank within the household, defining children resident in the same household as potential 'substitute labourers' according to their relative age and gender. We derive predictions on the basis of anticipated labour substitution effects, hypothesizing that the availability of substitute workers within a household reduces the amount of time a child spends working, and increases the likelihood of a child being enrolled in school.

Children who are relatively older within the household are likely to be more efficient than younger children at various productive tasks, and previous research shows an increase in work with age (Hedges et al., 2018). We therefore expect that households will favour allocating older children's time to production, freeing younger children's time for school, and predict that *(1) increasing age order (i.e. living with older children) will be associated with increased probability of enrolment in school; decreased time spent in work; and increased leisure time*. Furthermore, those who are not enrolled in school are expected to substitute for the labour of children who are enrolled. Thus, we predict that *(2) those not enrolled in school will work more when co-resident children are enrolled in school, while schoolchildren will work less when co-resident children are not enrolled*. Finally, in Sukuma society, work is gendered, with domestic work and childcare predominantly carried out by girls and women, and farm work and cattle herding being male activities (Hedges et al., 2018; Varkevisser, 1973). For both enrolled and unenrolled children, it is therefore predicted that *(3) the number of opposite-gender children will reduce time spent in gender-inappropriate work, i.e. the number of girls will reduce the time boys spend in household chores, while in households that farm or keep cattle, the number of boys will reduce the time girls spend in farm work*. These predictions assume that within a household, members have similar priorities, and that children have similar levels of autonomy in their time allocation. However, these assumptions may not hold completely in this context. In focus groups, we heard several anecdotes of conflict between parents or guardians and children who did not wish to attend school, and also of children who wanted to attend school but could not due to responsibilities at home. Additionally, it was noted that older teenagers, particularly boys, have more freedom in determining their time allocation. Age and gender effects may therefore also reflect differing levels of autonomy between children.

Data and Methods

Data collection

The data collection for this study took place at the Kisesa Health and Demographic Surveillance Site (HDSS) in Mwanza region, north-western Tanzania. The HDSS was set up in 1994 to collect demographic data in an area comprising six villages (Kishamawe et al., 2015). For this study, data were collected in two of the six villages, representing the most and least rural villages in the HDSS. The Sukuma are the main ethnic group in the area. Traditionally households were reliant on farming and cattle herding, living in dispersed homesteads, but livelihoods have now diversified, with many families engaged in petty trading and small businesses. The least rural village is now better described as a town, situated on a main road, with public transport links to the city and a central market. In the most rural village, the majority of households continue to farm and many own cattle (Hedges et al., in press).

The HDSS provided a sampling frame of all households at the previous round of data collection, together with the ages of household members. This sampling frame was then restricted to households with members aged between 7 and 19 (the ages of formal schooling in Tanzania), from which 550 households were randomly sampled. Households are self-defined in the HDSS as "a group of people living together in the same compound, who regularly eat together from the same pot" (Kishamawe et al., 2015). Data collection was carried out by three fieldworkers who had all previously been trained and employed at the DSS (only two conducted surveys at any given time). Fieldworkers each had one day of training one-to-one with the lead author who was managing data collection. Training emphasized the need for consistency across interviews and the need to take a non-judgmental and sensitive approach, and presented hypothetical scenarios to check for the fieldworker's understanding of the goals of the research. At the beginning of the study one fieldworker was trained, then the other fieldworkers observed a day's worth of interviews, in addition to office-based training, in order to ensure a consistent 'script' and approach between interviewers.

Household surveys were carried out using Google Nexus 7 tablets with Open Data Kit (ODK) Collect software (Brunette et al., 2013). The survey recorded information about household members' age and gender, adult members' education and occupation, and the household head's marital status, ethnicity, and religion. Then a series of questions was asked about the household's assets, land ownership and

uses, livestock ownership, and business involvement. Based on observations made during fieldwork, assets were defined as 'basic' (chair, bed, mosquito net), 'intermediate' (bicycle, radio, sofa, cupboard, clock, or sewing machine), or 'high-value' (TV, fridge, or motorbike). This was followed by a set of nine questions pertaining to food security, based on the Food and Agricultural Organization (FAO)'s Household Food Insecurity and Access Scale (Coates, Swindale, & Bilinsky, 2007). This index asks questions about a household's food security during the past month, including experiencing anxiety about food supply, limiting food quality and reducing food quantity, and the frequency with which these were experienced. For each child in the household aged 7 to 19, an additional survey was answered by their parent or guardian, collecting information on their parents' marital status, education, and occupation, their siblings (though not whether siblings are co-resident), education, and work history.

1,278 children were followed up out of a total of 1,387 eligible children (92.1%). The majority of those not followed up were away at boarding school (3.8% of total sample) or travelling (2.6%). A further five children were dropped from the analysis, three who were listed as the spouse of the household head, and two who were employees of the household. Direct observation of activities through scan sampling is generally preferable to time diary methods as it avoids recall error and social desirability bias, and provides a representative description of all activities (Altmann, 1974; Baksh, 1989; Borgerhoff Mulder & Caro, 1985). However, practical difficulties in conducting scan samples due to large distances between households and ethical concerns precluded the use of observation. Many time allocation studies use proxy reports, but this can lead to underestimation of time spent working (Dammert & Galdo, 2013; Dillon et al. 2010; Janzen, 2015). We therefore asked children to self-report their activities on the previous weekday (or the previous Friday if the interview was done on a Monday), from when they woke up until they went to sleep. Time use was recorded through a diagram, with rows corresponding to different activities, and columns corresponding to half hour time periods. The time and duration of different activities were indicated by shading the corresponding cells (Fig. 1). Data from the diagrams were coded into broader categories, including household chores, farm work, market work, and leisure time (see below). We acknowledge the problems associated with self-report data, and recall bias associated with time allocation reporting. It is likely that there may be some overestimation of school enrolment and attendance due to the social desirability of education in this area. There may also be some error in children's recall of their time

allocation, if for example habitual or short-duration activities are overlooked, or if children overreport time spent working. During interviews, fieldworkers were able to crosscheck some timings, for example meals or leaving for school, between children within the same household, reducing some recall error. The short time frame for recall, of a maximum three days previously but primarily just one day, should also reduce recall error. We include a binary variable indicating whether the time allocation interview was done on a Monday or another day in time allocation analyses to account for the longer recall period for children interviewed on a Monday, who were asked about the previous Friday rather than 'yesterday' as for other days.

Outcome variables

Whether a child was enrolled in school at the time of the study is used as a binary outcome, *enrolled,* where 1 indicates the child was enrolled. Time use was recorded in half-hour blocks, from 5am to 12am, giving a maximum of 38 blocks (equivalent to 19 hours) for any given activity. For each activity category, the outcome is therefore the total count of half-hour blocks spent in that activity. The activity categories used are as follows. *Education* includes travel to and from school, school time, and studying after school. *Household chores* include cleaning, cooking, collecting water or fuel, childcare, running errands, and food processing. *Farm work* includes *cattle herding* (also treated as a separate category in some analyses), working in the fields, feeding animals, and milking. *Market work* includes any work done outside the household, for example petty trading, shop keeping, and making things to sell (e.g. baskets, doughnuts, ice lollies). *Overall work* is the total sum of household chores, farm work, and market work. Finally, *leisure time* includes playing, watching TV, resting or sleeping, and visiting friends or family.

Explanatory variables

Ordering children residing in the same household by age and gender enabled us to sum the number of older and younger children for each child, and the number of older and younger boys and girls. Within households, the numbers of boys and girls enrolled in school were summed to give the total number of schoolboys and girls, and this number was subtracted from the total number of children in the household to give the number of out-of-school children. Similarly, the numbers of boys and girls within households were summed to give the total number of male and female children. We generated

an 'age order' variable by numbering children so that the eldest child in the household has age order 1, the second child age order 2, and so on. We also generated an 'age order by gender' variable by ordering girls and boys separately by age and numbering them.

Data analysis

Multiple children are sampled per household, however, likelihood-ratio tests comparing multi-level models with ordinary least squares regression indicate limited evidence for differences between model forms (Supplementary Material, Table S2), and exploratory analyses confirm that multilevel analysis does not substantively alter our overall pattern of results. For enrolment analyses, we therefore use logistic regression models. Distributions of time use data usually contain many zeros. An individual child may not engage in certain activities, for example a child who is not enrolled in school does not spend time in education, while a child whose household does not keep cattle does not spend time cattle herding, leading to structural zeros. Additionally, sampling zeros arise because a child may not do the activity during the sampling period. These zeros violate the assumption of normality, making common approaches such as linear regression or tobit models inappropriate. Additionally, time use data are often right-skewed and over-dispersed. The Poisson-gamma distribution, or negative binomial regression, is more flexible and can model both exact zeros and a continuous component, so this is the approach we use here (Brown & Dunn, 2011).

Analyses are stratified by gender, but we do not directly test for differences in outcomes between boys and girls because we have explored this in detail elsewhere (Hedges et al., 2018). We include covariates that we believe to be associated with the explanatory variables and outcomes of interest. Child's age is associated with both work and education; previous work suggested a linear relationship between age and work, and a U-shaped relationship between age and education (Hedges et al., 2018). We investigated using an age-squared term but this had no impact on the overall results, and so for simplicity we present analyses using the linear age term. In this area, fostering is relatively common, with many children living with close kin (mainly grandparents) and a few with more distant relatives. As older children are more likely to be fostered, we include a control for child residence (with parents, close kin, or distant kin) in age order analyses, and also repeat age order analyses for non-fostered children only, in order to investigate whether age order effects are separate from fostering

effects. We include a variable indicating town or village residence. Household resource availability is likely to be associated with household composition, and to affect educational investment and time allocation. In this context, food security was felt to be the best measure of household resources, as it provides a contemporary measure of resource availability, meaningful across the different livelihoods in this area. We also use a categorical asset variable, indicating whether households own basic, intermediate, or higher value assets.

We use the number of older children as a predictor together with the number of younger children, to compare the effects of having older substitutes with the effects of having younger children for whom to substitute, but do not include a variable indicating the total number of children in the household to avoid over-adjusting. In order to further compare the effects of being later-born independently of the total number of children, we ran additional sensitivity analyses (presented in Supplementary Material), with models including the overall age variable and the total number of children in the household, acknowledging that there is some multicollinearity between variables. We finally conducted additional analyses to explore age order effects in more detail by using a categorical age order variable to compare oldest, middle, and youngest children. All analyses are carried out in Stata.

Results

Household and child characteristics

Household size ranges widely, with a mean of 7.6 members, and 3.1 children aged 7 to 19 (Table 1). Nearly three-quarters of households farm (i.e. grow crops or keep animals), while around a quarter of households keep cattle. 19% of households have only basic assets, 59% have intermediate assets such as a bicycle or a radio, and 21% have higher value assets such as a TV or fridge. Around half of households are classed as food insecure.

81% of children are currently enrolled in school, with enrolment being higher for girls (Table 2; see also Hedges et al., 2018). Very few children in our sample have no siblings. Around a third only have full siblings, while just over half have both full siblings and half siblings, and around 12% only have half siblings. However, as the household roster is completed with household members' relationship to the household head, we do not have direct information on the relationships of household members to each other, and cannot therefore be sure which children have siblings or half-siblings resident. 26% of

children live apart from their parents; most of these children live with close kin (grandparents, aunts or uncles), while some live with more distant kin. Girls are more likely than boys to live with distant kin.

Seven per cent of children have no co-resident children aged 7-19; girls are more likely than boys to be an only child (chi-squared = 3.7, p=0.06). We exclude these children from our main analyses as they do not have substitute labourers available. Boys who are only children are marginally more likely to be enrolled than other boys, while girls who are only children do not differ in their enrolment, but do spend more time in household chores than girls with co-resident children (Supplementary Material (SM), Table S1).

Prediction 1: Increasing age order (living with older children) will be associated with increased enrolment, decreased work, and increased leisure time

We find different effects of the number of older children for boys and girls (Table 3; Fig. 2). For boys, in contrast to our prediction, an increasing number of older children (both boys and girls) is associated with a lower probability of enrolment, though this association is not statistically significant. The number of younger children in the household however is associated with a greater probability of enrolment. For girls the association is consistent with our prediction; the number of older children in the household increases the probability of enrolment. The same associations are seen when looking at number of older or younger children of the same gender. The effects of the age order variables echo these findings; increasing age order is associated with lower probability of enrolment for boys, and higher probability of enrolment for girls (results shown in SM, Table S2). For both genders, living in town (versus village), and having more household assets increase the probability of being enrolled; while these associations are not always significant, the odds ratios indicate a greater effect for boys than for girls. There is some suggestion that being fostered by distant kin is negative for enrolment, while increasing age is associated with lower odds of being enrolled.

We further predicted that living with older children would be associated with doing less work and having more leisure time. Table 4 presents the incidence rate ratios (IRR) from negative binomial regression models of overall work and leisure time (for boys), and chores and leisure time (for girls). The IRR indicates the effect of the independent variable on the expected number of events. For example, in the first column, a boy enrolled in school experiences 0.3 times the events (half-hours of

work) an out-of-school boy experiences. For both genders, there is little association between the overall number of older and younger children and time spent in work or leisure time. However, as work is primarily shared between children of the same gender, it may be more relevant to examine the effect of older and younger children of the same gender. Again, for boys there is little association between number of older and younger boys and work or leisure time, though there is a non-significant trend of more work and less leisure as the number of younger boys increases (Fig. 2). For girls, the number of older children is associated with marginally more leisure time (Table 4), while the number of older girls is associated with less time spent doing chores and more time spent in leisure (Fig. 2). Models using age order and age order by gender give similar results; there are no associations between age order and work or leisure time for boys or girls, but increasing age order among household girls is associated with more chores and less leisure time for girls, with oldest girls doing more chores and having least leisure time overall (SM, Table S3). Additionally, girls who live only with boys appear to do slightly more work and have slightly less leisure time, while boys who reside only with girls appear to do slightly less productive work (SM, Fig. S1).

There is some evidence for labour substitution between girls, with both older girls, and those living only with boys working more. This appears to improve school enrolment for girls living with more older girls. For boys however, the association between number of older children and enrolment is the opposite to that predicted, and there is little evidence of labour substitution of older boys for younger ones. This may be because cattle herding is traditionally been allocated to younger boys. We therefore tested for an interaction between cattle ownership and number of younger boys, to see whether the positive effect of younger boys on enrolment is confined to households that own cattle, but the interaction was not significant (Table 5). We then looked at time spent herding in households that own cattle, to see if there is evidence of younger boys substituting for older boys' herding work. Having more younger boys in the household was associated with less time spent herding. This suggests that younger boys may substitute for older boys' herding.

Prediction 2: Substitution between schoolchildren and out-of-school children

Our second prediction was that out-of-school children would work more in households with more schoolchildren, while schoolchildren would work less in households with more out-of-school children. For

out-of-school girls, living with more schoolboys marginally decreases time spent doing chores (Table 6). This is the opposite of what we expected. Out-of-school girls may take on schoolboys' other tasks, such as farming or market work, with schoolboys taking on girls' chores, which are more easily combined with school. However, we do not find other evidence of this, for example schoolboys do not affect out-of-school girls' time spent in farm work (results not shown). In line with our prediction, we do see that out-of-school girls do more chores when there are more schoolgirls, suggesting they may be preferentially allocated household chores. We find no evidence that the number of out-of-school children is associated with reduced work for schoolchildren (SM, Table S4).

Prediction 3: Substitution between boys and girls for gendered work

Finally, we predicted that girls would reduce boys' time spent in chores, while boys would reduce girls' time spent in farm work. Figure 3 indicates that girls do appear to substitute for boys' chores, with boys living with five co-resident girls spending around 2 hours less per day doing household chores compared to boys living with no co-resident girls. While the trend for girls suggests boys do substitute somewhat for girls' farm work, this result does not reach statistical significance (SM, Table S5). This may be because girls and boys do different types of farm work. The confidence intervals for girls living with one or zero boys are also very large, suggesting that farming households may have more boys, meaning it is rare for girls to live in farming households with few boys. Households that farm do have slightly more boys on average (1.6 compared to 1.3, $t=-1.79$, $p=0.04$). This may explain why there is not strong evidence that boys substitute for girls' farm work.

Discussion

In contexts where households remain reliant on subsistence livelihoods, the value of children's work according to their age and gender is likely to be an important determinant of educational investment. We investigated predictions derived from embodied capital theory regarding the distribution of investment, and economic theory on labour substitution. Our first prediction was that (relatively) older children within households would be preferentially allocated work and therefore be less likely to be enrolled in school. We support this prediction for girls only, finding that older girls are preferentially allocated work, and that the presence of older girls is associated with a higher probability of school enrolment for younger girls, who also spend less time in household chores and more time in leisure. For

boys, we find the opposite; boys with more younger boys in the household have the highest odds of school enrolment. Older boys do not work less than younger boys, however, except that younger boys in cattle-owning households are preferentially allocated herding work, suggesting that younger boys may be substituting for the labour of older boys in cattle-herding households at least. We discuss our interpretation of this pattern of results below.

Our second prediction was that out-of-school children would substitute for the work of schoolchildren, whose time spent in other activities such as studying might be more valuable. Overall we did not find strong support for this prediction, although out-of-school girls do work more when there are more schoolgirls in the household, suggesting they may be taking over some of the schoolgirls' chores. Schoolchildren did not work less in households with out-of-school children. This may be because household responsibilities are valued as part of a child's socialization and duties to their household, with past work among the Sukuma noting that parents believe that children should help their household in order to stop them getting 'spoiled' (Varkevisser, 1973). During our study, the majority of parents or guardians agreed that it is important and useful for children to help with household work. Work may therefore also be a way for children to gain embodied capital, in the form of skills or experience that they cannot learn in school, and so parents may perceive that household work is beneficial for all children, rather than preferring that unenrolled children substitute for schoolchildren.

Finally, we predicted that labour substitution would be gendered, given established differences in male and female work in this context (Hedges et al., 2018). Supporting our prediction, we find that the availability of girls within a household reduces the time spent by boys in household chores. There is less evidence that boys substitute for girls in farm work. This may be due to preferential fostering of boys into farming households, although we lack supporting data to test this conjecture. It may also reflect lower autonomy of girls, who may be less able to avoid being allocated work.

Why are results more consistent with labour substitution for girls than boys?

We predicted that work would be preferentially allocated to older individuals because skill and strength generally increase with age, meaning older individuals will be more efficient. For girls, this is the pattern that we observe. As our analyses are based on cross-sectional data, it is possible that this could partially reflect cohort effects such as increasing education rates or changes in children's work.

However, given that it is boys' farm work that has changed the most in recent years, rather than girls' domestic work which has remained similar, and as these results remain after adjustment for child age, we are not convinced that these age order patterns can be explained as cohort effects. In contrast to girls, boys seem to benefit in terms of school enrolment when there are more younger boys available in a household. This cannot easily be explained by younger boys substituting for older boys' work, as only in cattle-owning households is the number of younger boys associated with older boys doing less work.

This pattern is the opposite to what we predicted, as labour substitution models predict that more skilled or productive individuals should be preferred for household labour. It may instead reflect traditional practices regarding inheritance and age hierarchies within families. In traditional Sukuma law, early-born sons were favoured, inheriting more land and taking the role of household head if their father died (Varkevisser, 1973). This early-born preference is also in line with evolutionary predictions about parental investment biases. In this area, a son's marriage requires parents to pay brideprice, whereas a daughter's marriage brings cattle or money into the household. Parents may therefore delay certain sons' marriages in order to afford the brideprice, whereas daughters' marriages are less restricted. As earlier-born boys can marry earlier, prioritizing their marriage and reproduction gives the greatest return to investment in the long-term. A similar pattern was observed among Gabbra pastoralists in Kenya, where older sons had much higher reproductive success than younger sons, but daughters' reproduction wasn't much influenced by birth order (Mace, 1996). This preference for earlier-born sons may also manifest in the allocation of work to younger sons where possible, to free older sons' time for other activities, or just to relieve them from the discomforts of tasks such as cattle herding. This tradition of a family age hierarchy appears to continue into the present day, with parents preferring to invest in earlier-born boys' education.

A lack of strong labour substitution effects overall for boys echoes findings from our previous study, which showed minimal trade-offs between work and school for boys not involved in herding work (Hedges et al., 2018). In the local area, livelihoods have shifted away from subsistence agriculture, and landholdings and herd sizes have decreased, reducing the demand for boys' work (Wijsen &

Tanner, 2002). This appears to make boys' everyday work quite compatible with school, eliminating the need for substitution between boys not in cattle-owning households.

Girls' labour substitution fits better with predictions from embodied capital models. Household chores such as food processing and cooking may be more sensitive to the gains in efficiency associated with gains in skill. Additionally, chores are frequently combined with being responsible for any other children present. In this case, it is beneficial to have the most senior girl available to do this, as she will have the most experience and authority. The value of older girls' work was also seen in our previous study, in which the trade-off in time allocation between work and school was much greater among older than younger girls, suggesting that the opportunity costs of girls' work increase with age (Hedges et al., 2018).

Birth order, education, and modernization

Labour substitution effects may help to explain some of the varied results regarding differential investment by birth order reviewed in our introduction. Where children are still producers, their work contributions are likely to influence decisions about investment in education, favouring children whose work is less important to the household. However, as livelihoods shift away from subsistence agriculture towards market integration or formal work, and children's contributions become less important to their households, parents may invest more in earlier-born children. This may explain why early-born biases in education are more evident in industrialized countries, where children are primarily consumers and make negligible work contributions to their households (e.g. Price, 2008; Steelman, Powell, Werum, & Carter, 2002). Studies in lower-income settings have found that age order biases in education are more evident in wealthier households (Gibson & Lawson, 2011; Gibson & Sear, 2010; Hedges et al., 2016). This may be because wealthier households are less reliant on children's work, being more able to hire outside help or because they are less reliant on subsistence farming.

This may also help to explain the differing effects of family size on education during the course of the demographic transition. Economic theory predicts a quantity-quality trade-off between family size and educational investment, such that in larger families, there are fewer resources available per child, and so children are less likely to be educated (Becker, 1960). However, in many pre-transition societies children are producers as well as consumers, alleviating the trade-off between quantity and quality of

children (Kramer, 2011). Across Africa, many studies actually report a positive effect of the number of siblings or co-resident children on schooling, perhaps because children have a lower individual burden of work (Al-Samarrai & Peasgood, 1998; Chernichovsky, 1985; Cornwell, Inder, Maitra, & Rammohan, 2005; Gomes, 1984; Lloyd & Blanc, 1996; Roth, 1991). However this effect appears to reduce then reverse as modernization and fertility decline occur (Eloundou-Enyegue & Williams, 2006; Marteleto, 2010). In pre-transition settings the payoffs to education are frequently uncertain due to poor quality schools and high youth unemployment, meaning parents may benefit more by pursuing a 'bet-hedging' strategy, or by using older children's work to reduce the opportunity costs of younger children's schooling (Liddell et al., 2003). Both wealth and modernization improve the payoffs to education and reduce the value of children's work, as households become less reliant on subsistence farming, and no longer have to fetch water and fuel. As modernization occurs, it may therefore become more beneficial to parents to bias investment towards earlier-born children, and ultimately to limit fertility.

Limitations

Data on household composition were collected through a household roster, with all individuals in the household linked to the household head. This means it is difficult to subsequently relate other individuals within the household to one another. We can link biological children of the household head together as siblings, but we do not know whether they are half or full siblings, and for other children, it is difficult to reconstruct relationships other than that with the household head. This is a common limitation of demographic data, but one which has not often been questioned (Madhavan, Myroniuk, Kuhn, & Collinson, 2017; Randall, Coast, & Leone, 2011). An additional limitation of the household roster approach is that it assumes that household members have equal access to household resources, when in fact there may be within-household differences in food security or access to assets, and involvement in household decision-making (Randall, Coast, & Leone, 2011).

This study is also limited by its cross-sectional nature, introducing the possibility that age differences may partially be explained through cohort effects, for example due to rising education rates or changes in children's work. While we do not think that this is the case for reasons discussed above, longitudinal data would allow these trends to be more thoroughly investigated, and enable changes over a household's lifetime to be investigated, for example whether it is the timing or overall level of

investment that differs by age order. If work tasks change considerably with age (rather than just skill or productivity in tasks) it might be expected that labour substitution would predominantly occur between children of similar ages, while those of different ages might specialize in different work. We do not have enough data on specific work tasks at different ages to investigate this here, but future work could further expand on age profiles of children's work and the effects of household age configurations, for example comparing households with a wide age range of children with households with a narrower age range.

Finally, we examine only one measure of educational investment, school enrolment. Progression through school or academic attainment may show different associations with household composition.

Conclusion and Implications

Embodied capital theory frames education as a form of parental investment in children's embodied capital, while also recognizing the role of work in children's skill acquisition and socialization. Research in this vein has focused primarily on the long-term benefits of educational investment and less on the short-term implications for children's time allocation in contexts where children's work remains valuable. By contrast, economic models of labor substitution have placed greater focus on the short-term costs and benefits of children's time allocation. Bringing together literature from both these fields, we frame both work and education as forms of embodied capital, and consider how parental investment biases, alongside short-term economic considerations, affect children's time allocation. We demonstrate that the presence and characteristics of other co-resident children have important implications for children's work and education. Work by relatively older girls enables younger girls' to allocate more time to attend school, and out-of-school girls alleviate the burden of household chores for schoolgirls. For boys, traditional age hierarchies appear to favour older boys in education access, while a gendered allocation of household work is seen, with girls substituting for boys' household chores. This study highlights the complexities of decision-making regarding educational investment and children's time allocation in transitioning contexts, indicating that multiple factors influence these decisions, from the availability of substitute workers, the relative value of a child's work contributions according to their age and gender, to traditional gender and family norms. We reinforce the importance of including

562 work in studies of children's education in modernizing contexts, particularly recognizing the value of
563 children's work and its role in influencing education decisions within households.

564

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Tables and Figures

Table 1: Descriptive statistics about household characteristics		
Household composition	Mean (SD)	Range
Household size	7.6 (3.1)	2 – 19
Children aged 7-19	3.1 (1.7)	1 – 10
Household characteristics (% households)		
Residence		
Village	52.3%	
Town	47.7%	
Household farms		
No	26.6%	
Yes	73.4%	
Household keeps cattle		
No	73.9%	
Yes	26.1%	
Household assets		
Higher value	21.4%	
Intermediate	59.2%	
Basic	19.4%	
Household is food insecure		
No	50.3%	
Yes	49.7%	
N	441	

Table 2: Descriptive statistics on child characteristics by gender			
	Male	**Female**	**Total**
N	632	641	1,273
Currently enrolled in education			
No	20.6%	17.5%	19.0%
Yes	79.4%	82.5%	81.0%
Age order within household			
Only child	5.5%	8.3%	6.9%
Oldest	26.3%	22.8%	24.5%
Middle child	41.5%	40.9%	41.2%
Youngest	26.7%	28.1%	27.4%
Child lives with			
Parent(s)	76.1%	72.4%	74.2%
Close kin	18.1%	18.9%	18.5%
Distant kin	5.9%	8.7%	7.3%
Types of siblings			
No siblings	3.2%	3.0%	3.1%
Only half-siblings	10.0%	13.1%	11.5%
Only full siblings	35.8%	32.0%	33.9%
Full siblings and maternal half-siblings	15.3%	14.8%	15.1%
Full siblings and paternal half-siblings	26.1%	25.6%	25.8%
Full siblings and both maternal and paternal half-siblings	9.7%	11.5%	10.6%

Table 3: Models testing prediction 1, that increasing age order (i.e. living with more older children) will be associated with higher odds of school enrolment. Models were run separately for boys and girls and adjust for (1) number of younger and older children, and (2) number of younger and older children of the same gender.

	Boys	Boys	Girls	Girls
	(1)	(2)	(1)	(2)
Number of younger children	1.38**		1.08	
	[1.11,1.72]		[0.87,1.33]	
Number of older children	0.9		1.58*	
	[0.70,1.16]		[1.08,2.31]	
Number of younger boys / girls		1.45**		0.91
		[1.12,1.88]		[0.69,1.22]
Number of older boys / girls		0.84		1.62†
		[0.61,1.16]		[0.95,2.75]
Child lives with (reference = parent(s))				
Close kin	0.82	0.75	2.06	2.06
	[0.41,1.63]	[0.38,1.48]	[0.81,5.24]	[0.82,5.17]
Distant kin	0.5	0.53	0.44†	0.46†
	[0.18,1.38]	[0.19,1.51]	[0.18,1.08]	[0.19,1.12]
Household food security	1.04†	1.04†	1.04	1.04
	[0.99,1.09]	[0.99,1.09]	[0.99,1.10]	[0.99,1.10]
Household assets (reference = basic)				
Higher value	2.87*	3.11*	1.52	1.8
	[1.01,8.17]	[1.10,8.82]	[0.48,4.84]	[0.57,5.67]
Intermediate value	1.81†	1.94†	1.62	1.83
	[0.91,3.58]	[0.99,3.82]	[0.69,3.81]	[0.78,4.28]
Town (reference = village)	5.40***	5.04***	2.53*	2.39*
	[2.73,10.67]	[2.60,9.75]	[1.23,5.19]	[1.17,4.87]
Age (years)	0.56***	0.58***	0.53***	0.53***
	[0.49,0.64]	[0.52,0.65]	[0.45,0.62]	[0.45,0.61]
N	590	590	578	578

Data shown are odds ratios (exponentiated coefficients) from logistic regression models; 95% confidence intervals in brackets

† p<0.10, * p<0.05, ** p<0.01, *** p<0.001

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Table 4: Models testing prediction 1, that increasing age order (i.e. living with more older children) will be associated with less time spent in work, and more time spent in leisure. Models were run separately for boys and girls and adjust for (1) number of younger and older children, and (2) number of younger and older children of the same gender.

	Boys		Girls		Boys		Girls	
	Total work	**Leisure**	**Chores**	**Leisure**	**Total work**	**Leisure**	**Chores**	**Leisure**
			(1)				**(2)**	
Number of younger children	1.04 [0.97,1.12]	1.02 [0.96,1.09]	0.99 [0.94,1.04]	0.98 [0.91,1.06]				
Number of older children	0.98 [0.92,1.05]	1.01 [0.96,1.07]	0.99 [0.94,1.03]	1.07† [1.00,1.14]				
Number of younger boys / girls					1.04 [0.94,1.14]	0.97 [0.89,1.05]	1.02 [0.95,1.09]	0.98 [0.87,1.09]
Number of older boys / girls					0.99 [0.90,1.09]	1 [0.93,1.08]	0.92* [0.86,0.99]	1.12* [1.01,1.23]
Child lives with (reference = parent(s))								
Close kin	1.02 [0.81,1.27]	0.94 [0.78,1.14]	1 [0.86,1.18]	1.04 [0.83,1.31]	1.01 [0.81,1.27]	0.96 [0.79,1.17]	1 [0.86,1.18]	1.05 [0.83,1.31]
Distant kin	1.14 [0.81,1.61]	1.19 [0.89,1.60]	1.07 [0.87,1.33]	1.51* [1.10,2.08]	1.14 [0.81,1.60]	1.2 [0.90,1.61]	1.08 [0.87,1.33]	1.50* [1.09,2.06]
Enrolled (reference = no)	0.34*** [0.27,0.43]	0.45*** [0.37,0.56]	0.58*** [0.49,0.70]	0.24*** [0.18,0.33]	0.34*** [0.27,0.43]	0.46*** [0.38,0.57]	0.58*** [0.49,0.69]	0.24*** [0.18,0.32]
Household food security	1.01 [0.99,1.02]	0.99 [0.98,1.00]	1 [0.99,1.01]	1.02† [1.00,1.03]	1 [0.99,1.02]	0.99 [0.98,1.00]	1 [0.99,1.01]	1.02* [1.00,1.03]
Household assets (reference = basic)								
Higher value	0.91 [0.65,1.26]	1.11 [0.84,1.47]	0.81† [0.64,1.03]	1.08 [0.76,1.53]	0.91 [0.66,1.27]	1.14 [0.86,1.50]	0.82 [0.65,1.04]	1.09 [0.77,1.55]
Intermediate value	0.95 [0.75,1.20]	1.09 [0.89,1.34]	0.94 [0.80,1.12]	0.92 [0.72,1.19]	0.95 [0.75,1.20]	1.12 [0.91,1.37]	0.94 [0.79,1.11]	0.94 [0.73,1.21]
Town (reference = village)	0.71**	1.07	0.98	0.98	0.71***	1.05	0.99	0.97

	[0.58,0.87]	[0.90,1.26]	[0.85,1.13]	[0.80,1.20]	[0.57,0.87]	[0.88,1.24]	[0.86,1.13]	[0.79,1.20]
Monday interview	0.92	1	1.01	0.94	0.91	1	1.02	0.93
(reference = other day)	[0.73,1.15]	[0.82,1.21]	[0.87,1.18]	[0.75,1.18]	[0.72,1.14]	[0.82,1.21]	[0.88,1.19]	[0.74,1.17]
Age (years)	0.98	0.94***	1.05**	0.88***	0.99	0.95***	1.03*	0.87***
	[0.95,1.03]	[0.90,0.97]	[1.02,1.08]	[0.84,0.92]	[0.96,1.03]	[0.92,0.97]	[1.01,1.06]	[0.84,0.91]
N	590	590	578	578	590	590	578	578

Data shown are incident rate ratios from negative binomial regression models; 95% confidence intervals in brackets

† p<0.10, * p<0.05, ** p<0.01, *** p<0.001

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Table 5: Models further exploring prediction 1, that the number of younger boys will be associated with higher odds of school enrolment in cattle-owning households, and in cattle-herding households, with less time spent herding. Models were run for boys only.

	Enrolment (odds ratios)[a]	**Time spent herding (incident rate ratios)[b]**
Number of younger boys	1.37†	0.75*
	[0.98,1.91]	[0.57,0.99]
Cattle-owning household (reference = no cattle)	0.7	
	[0.33,1.49]	
Cattle-owning household # number of younger boys interaction	1.12	
	[0.72,1.76]	
Number of older boys	0.86	0.92
	[0.62,1.18]	[0.57,1.49]
Child lives with (reference = parent(s))		
Close kin	0.75	0.98
	[0.38,1.50]	[0.33,2.90]
Distant kin	0.54	0.71
	[0.19,1.52]	[0.11,4.56]
Household food security	1.04†	1.08†
	[0.99,1.09]	[1.00,1.17]
Household assets (reference = basic)		
Higher value	3.38*	0.06**
	[1.16,9.85]	[0.01,0.50]
Intermediate value	2.03*	0.68
	[1.01,4.06]	[0.19,2.49]
Town (reference = village)	4.40***	0.28
	[2.11,9.15]	[0.04,2.13]
Age (years)	0.58***	0.82*

	[0.52,0.65]	[0.71,0.96]
Enrolled (reference = no)		0.27*
		[0.09,0.79]
Monday interview (reference = other day)		0.96
		[0.37,2.52]
N	590	220

[a] From logistic regression models [b] From negative binomial regression models
95% confidence intervals in brackets

† p<0.10, * p<0.05, ** p<0.01, *** p<0.001

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Table 6: Models testing prediction 2, that out-of-school children will work more when co-resident with more schoolchildren. Models were run separately for out-of-school boys and out-of-school girls, and adjust for (1) number of schoolboys, and (2) number of schoolgirls.

	Out-of-school boys		Out-of-school girls	
	(1)	**(2)**	**(1)**	**(2)**
Number of schoolboys	1.04		0.87†	
	[0.93,1.17]		[0.75,1.01]	
Number of schoolgirls		0.97		1.23**
		[0.85,1.11]		[1.06,1.43]
Number of school-age children	1.01	1.03	0.98	0.86**
	[0.91,1.11]	[0.95,1.12]	[0.89,1.08]	[0.78,0.95]
Household food security	1	1	1	1
	[0.98,1.02]	[0.98,1.02]	[0.98,1.02]	[0.97,1.02]
Household assets (reference = basic)				
Higher value	1.52	1.54	0.9	0.88
	[0.88,2.62]	[0.88,2.69]	[0.58,1.40]	[0.57,1.35]
Intermediate value	1.07	1.08	1.07	1.02
	[0.81,1.43]	[0.81,1.44]	[0.76,1.51]	[0.73,1.43]
Town (reference = village)	0.52***	0.51***	1.32*	1.28†
	[0.37,0.73]	[0.36,0.73]	[1.01,1.73]	[0.99,1.67]
Monday interview (reference = other day)	1.01	1.01	1.13	1.12
	[0.71,1.43]	[0.71,1.43]	[0.82,1.56]	[0.82,1.54]
Age (years)	1.02	1.02	1.04	1.04
	[0.98,1.05]	[0.98,1.06]	[0.98,1.11]	[0.98,1.10]
N	124	124	103	103

Data shown are incident rate ratios; 95% confidence intervals in brackets

† p<0.10, * p<0.05, ** p<0.01, *** p<0.001

Fig. 1: Time allocation diagram

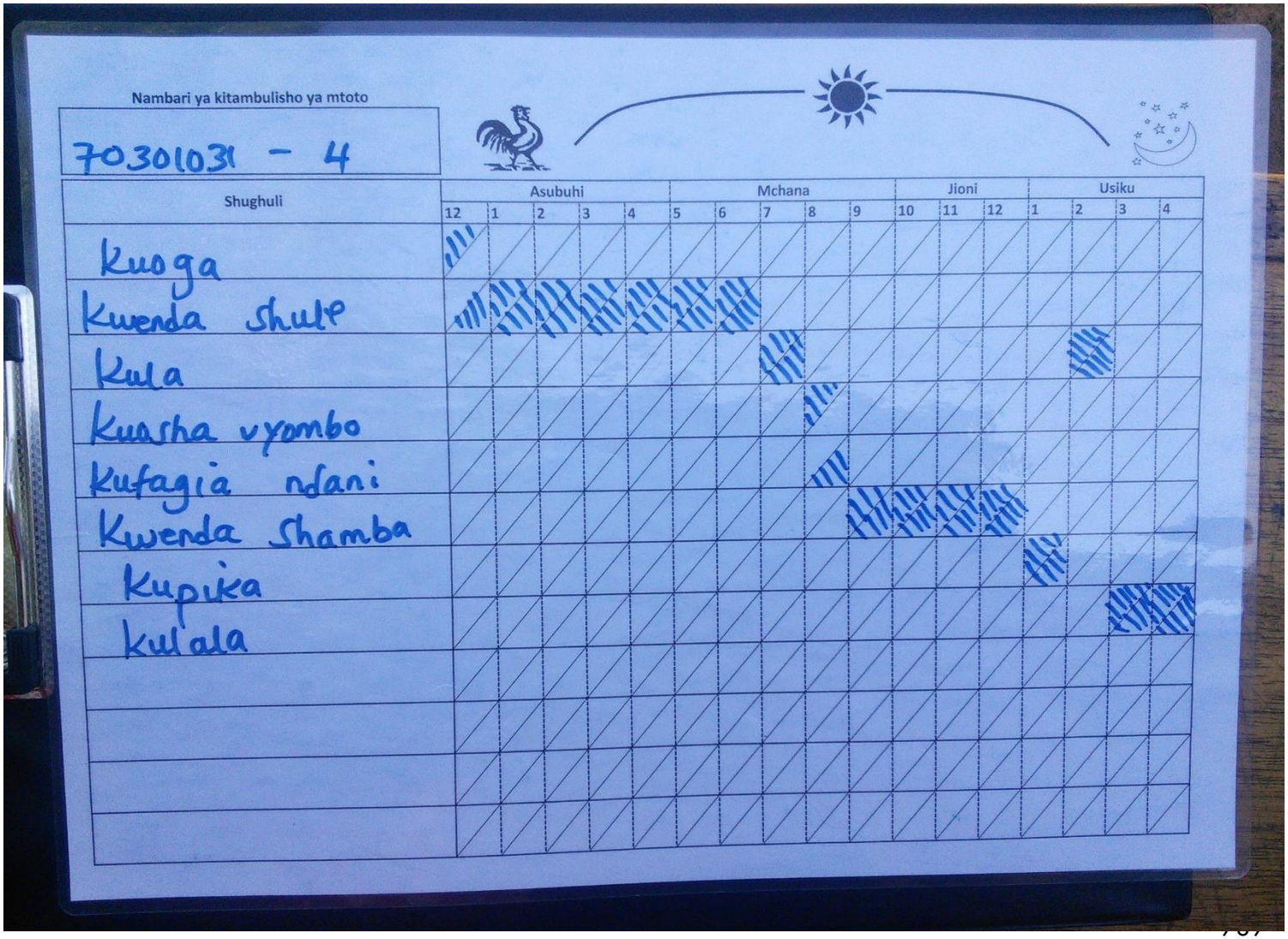


Fig. 2: Results from models testing prediction 1, that increasing age order will be associated with higher odds of school enrolment, less time spent in work, and more time spent in leisure. Models were run separately for boys and girls. School enrolment models show predicted probability of school enrolment from logistic regression models. Work and leisure models show predicted hours from negative binomial regression models. (95% confidence intervals shown)

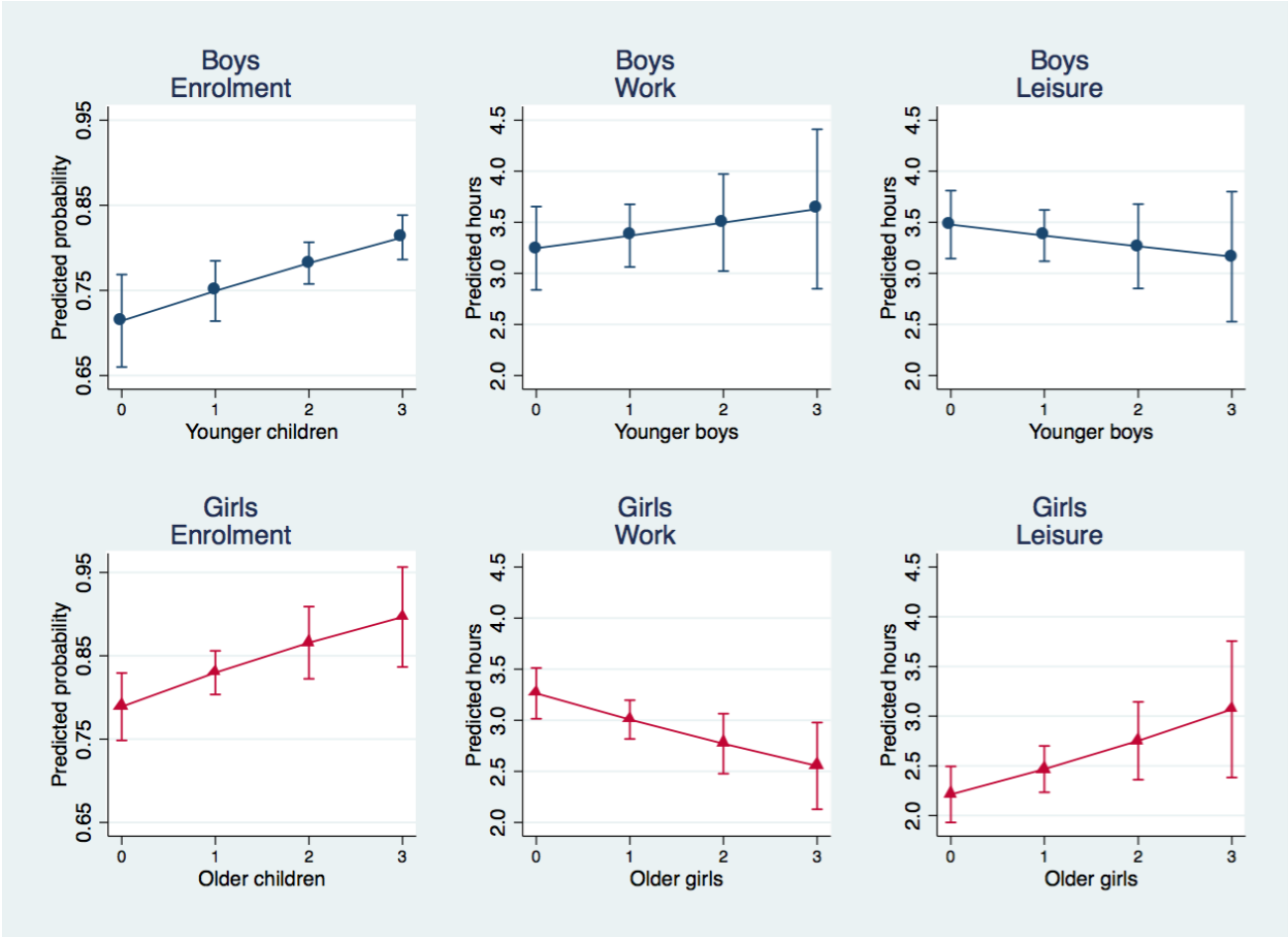
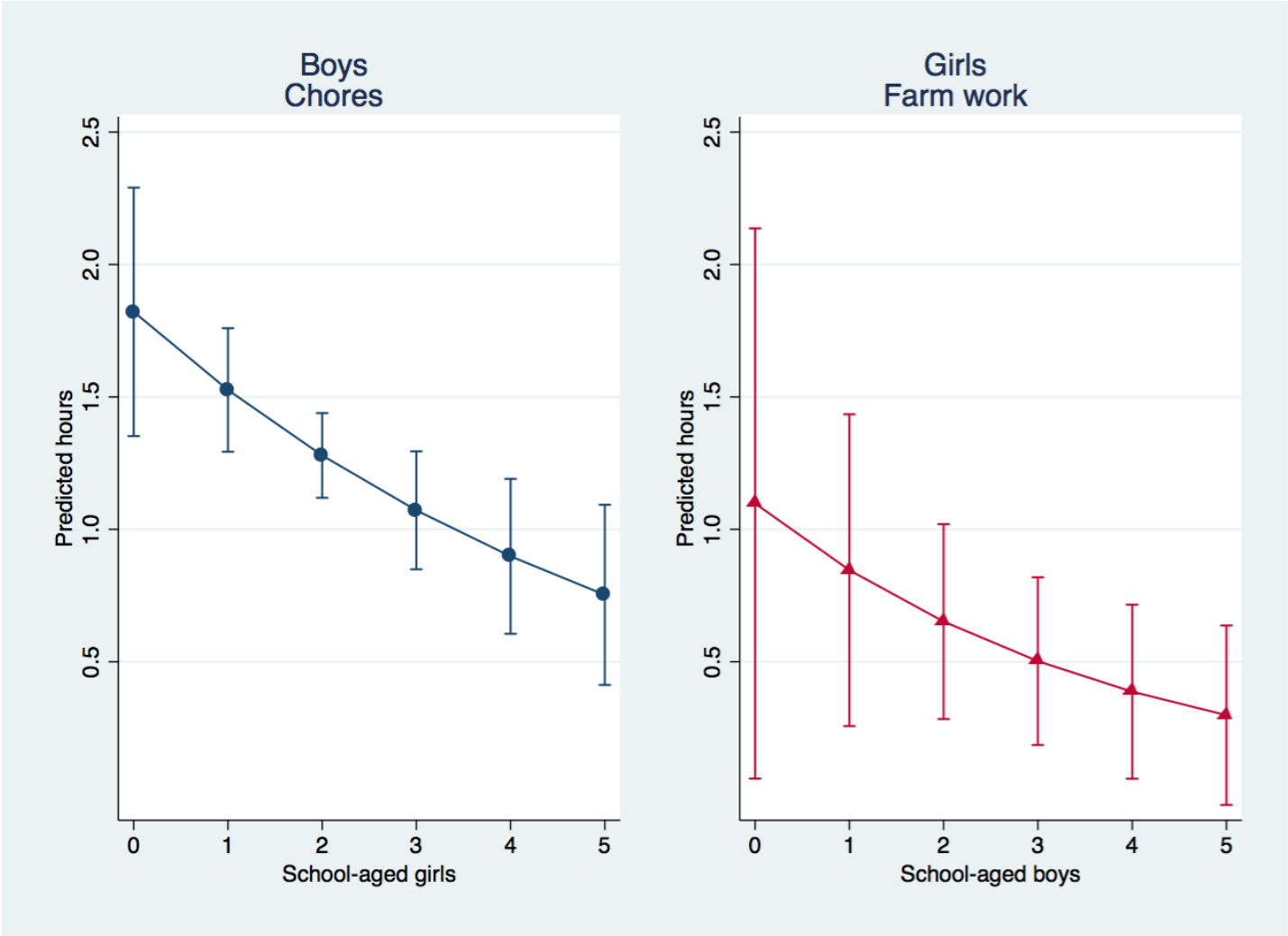


Fig. 3: Results from models testing prediction 3, that the number of co-resident opposite gender children will reduce time spent in gender-inappropriate work. Models were run separately for boys and girls and show predicted hours of work from negative binomial regression models. (95% confidence intervals shown)



803 **Supplementary Material**

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Table S1: Association between being the only child in the household and enrolment, work time, and leisure time

	Enrolment (odds ratios)		Time spent in activity (incidence rate ratios)			
	Boys	**Girls**	**Boys (overall work)**	**Boys (leisure)**	**Girls (chores)**	**Girls (leisure)**
Only child (reference = no)	2.62	1.31	0.93	1.02	1.26*	0.97
	[0.73,9.39]	[0.37,4.70]	[0.64,1.37]	[0.73,1.43]	[1.00,1.59]	[0.69,1.37]
Child lives with (reference = parent(s))						
Close kin	0.78	2.10†	1.03	0.94	1	1.05
	[0.40,1.51]	[0.88,5.02]	[0.83,1.27]	[0.78,1.14]	[0.86,1.17]	[0.84,1.30]
Distant kin	0.54	0.42*	1.13	1.19	1.08	1.43*
	[0.20,1.48]	[0.19,0.96]	[0.81,1.59]	[0.89,1.60]	[0.88,1.32]	[1.06,1.93]
Number of school-age children	1.19*	1.18†	1.01	1.02	0.99	1.03
	[1.01,1.39]	[0.98,1.42]	[0.96,1.06]	[0.98,1.06]	[0.95,1.02]	[0.98,1.08]
Household food security	1.04	1.04	1	0.99	1	1.01†
	[0.99,1.09]	[0.99,1.09]	[0.99,1.02]	[0.98,1.00]	[0.98,1.01]	[1.00,1.03]
Household assets (reference = basic)						
Higher value	2.33†	1.83	0.94	1.14	0.82†	1.12
	[0.85,6.40]	[0.63,5.34]	[0.68,1.29]	[0.86,1.50]	[0.65,1.03]	[0.81,1.56]
Intermediate value	1.74	1.76	0.97	1.07	0.97	0.98
	[0.89,3.39]	[0.79,3.91]	[0.77,1.22]	[0.88,1.31]	[0.82,1.14]	[0.77,1.25]
Town (reference = village)	5.01***	2.86**	0.72**	1.03	0.96	1
	[2.63,9.55]	[1.45,5.65]	[0.59,0.87]	[0.87,1.21]	[0.84,1.10]	[0.82,1.21]
Age (years)	0.62***	0.52***	1	0.94***	1.05***	0.86***
	[0.57,0.68]	[0.46,0.59]	[0.98,1.03]	[0.92,0.96]	[1.03,1.07]	[0.83,0.89]
Enrolled (reference = no)			0.34***	0.46***	0.58***	0.25***
			[0.27,0.42]	[0.38,0.57]	[0.49,0.69]	[0.19,0.32]
Monday interview (reference = other day)			0.93	0.97	1.01	0.95
			[0.75,1.16]	[0.80,1.18]	[0.88,1.17]	[0.76,1.18]
N	624	631	624	624	631	631

† p<0.10, * p<0.05, ** p<0.01, *** p<0.001

Data shown are odds ratios / incidence rate ratios; 95% confidence intervals in brackets

Table S2: Multi-level models testing prediction 1, that increasing age order (i.e. living with more older children) will be associated with higher odds of school enrolment. Models were run separately for boys and girls and adjust for (1) number of younger and older children, and (2) number of younger and older children of the same gender. Models include a household random effect.

	Boys	Boys	Girls	Girls
	(1)	(2)	(1)	(2)
Number of younger children	1.34*		1.02	
	[1.07,1.67]		[0.79,1.31]	
Number of older children	0.84		1.84*	
	[0.63,1.11]		[1.15,2.96]	
Number of younger boys / girls		1.48*		0.85
		[1.10,1.99]		[0.58,1.24]
Number of older boys / girls		0.77		2.06*
		[0.53,1.11]		[1.03,4.08]
Child lives with (reference = parent(s))				
Close kin	0.82	0.74	2.33	2.33
	[0.39,1.71]	[0.35,1.58]	[0.77,7.04]	[0.74,7.34]
Distant kin	0.52	0.54	0.29*	0.26*
	[0.17,1.60]	[0.17,1.73]	[0.09,0.99]	[0.07,0.97]
Household food security	1.04	1.04	1.04	1.04
	[0.98,1.09]	[0.98,1.09]	[0.97,1.11]	[0.97,1.12]
Household assets (reference = basic)				
Higher value	2.56	2.81†	2.12	2.94
	[0.80,8.17]	[0.85,9.26]	[0.47,9.51]	[0.59,14.59]
Intermediate value	1.87	2.00†	1.94	2.39
	[0.87,4.01]	[0.91,4.37]	[0.67,5.61]	[0.78,7.36]
Town (reference = village)	6.95***	6.91***	3.77**	3.56*
	[3.07,15.74]	[2.99,15.93]	[1.44,9.88]	[1.31,9.62]
Age (years)	0.53***	0.54***	0.50***	0.48***
	[0.44,0.63]	[0.46,0.63]	[0.39,0.66]	[0.37,0.63]
Household random effect	0.59	0.77	1.78	2.33
	[0.09,4.12]	[0.14,4.22]	[0.27,11.56]	[0.44,12.4]
Likelihood ratio test versus logistic model	1.57	2.21	2.76†	4.12*
N	624	624	631	631

Exponentiated coefficients; 95% confidence intervals in brackets

† p<0.10, * p<0.05, ** p<0.01, *** p<0.001

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Table S3: Association between (1) continuous age order and enrolment and (2) categorical age order and enrolment, for boys and girls, from logistic regression models 806

	Boys	Boys	Girls	Girls
	(1)	(2)	(1)	(2)
Age order (continuous)	0.61**		1.47†	
	[0.43,0.86]		[0.97,2.23]	
Age order (reference = youngest)				
Middle child		0.75		1.48
		[0.39,1.42]		[0.71,3.07]
Youngest		0.38*		3.23†
		[0.15,1.00]		[0.83,12.53]
Number of children	1.43**	1.18†	1.08	1.18
	[1.15,1.79]	[0.99,1.41]	[0.87,1.34]	[0.95,1.48]
Child lives with (reference = parent(s))				
Close kin	0.8	0.83	2.04	2.08
	[0.40,1.59]	[0.41,1.65]	[0.80,5.18]	[0.80,5.37]
Distant kin	0.44	0.48	0.42†	0.45†
	[0.15,1.22]	[0.17,1.36]	[0.17,1.03]	[0.19,1.10]
Household food security	1.04†	1.04†	1.04	1.04
	[0.99,1.09]	[1.00,1.09]	[0.99,1.10]	[0.99,1.10]
Household assets (reference = basic)				
Higher value	2.99*	2.63†	1.49	1.55
	[1.04,8.54]	[0.93,7.39]	[0.47,4.77]	[0.48,4.97]
Intermediate value	1.83†	1.77	1.64	1.63
	[0.92,3.64]	[0.90,3.49]	[0.70,3.88]	[0.68,3.91]
Town (reference = village)	5.58***	5.07***	2.55*	2.54*
	[2.81,11.07]	[2.61,9.84]	[1.24,5.24]	[1.24,5.22]
Age (years)	0.54***	0.59***	0.53***	0.52***
	[0.47,0.62]	[0.52,0.66]	[0.46,0.63]	[0.45,0.61]
N	590	590	578	578

Data shown are odds ratios (exponentiated coefficients); 95% confidence intervals in brackets
† p<0.10, * p<0.05, ** p<0.01, *** p<0.001

Table S4: Association between (1) age order and (2) age order by gender, and time spent in work and leisure for boys and girls, from negative binomial regression models

	Boys				Girls			
	Work	**Leisure**	**Work**	**Leisure**	**Chores**	**Leisure**	**Chores**	**Leisure**
	(1)	**(1)**	**(2)**	**(2)**	**(1)**	**(1)**	**(2)**	**(2)**
Age order	0.92	0.98			1.01	1.08		
	[0.83,1.02]	[0.90,1.07]			[0.94,1.08]	[0.97,1.21]		
Age order by gender			0.96	0.99			0.91*	1.1
			[0.85,1.07]	[0.90,1.08]			[0.84,0.98]	[0.98,1.23]
Enrolled (reference = no)	0.33***	0.45***	0.34***	0.45***	0.58***	0.24***	0.58***	0.24***
	[0.26,0.42]	[0.36,0.56]	[0.27,0.43]	[0.37,0.56]	[0.49,0.70]	[0.18,0.32]	[0.48,0.69]	[0.18,0.32]
Number of school-age children	1.06	1.03	1.02	1.02	0.98	0.98	1.01	1.01
	[0.98,1.13]	[0.96,1.09]	[0.97,1.08]	[0.97,1.07]	[0.93,1.04]	[0.90,1.07]	[0.97,1.05]	[0.95,1.07]
Child lives with (reference = parent(s))								
Close kin	1.02	0.94	1.02	0.94	1	1.05	1.02	1.04
	[0.81,1.27]	[0.77,1.14]	[0.81,1.27]	[0.77,1.14]	[0.86,1.18]	[0.83,1.32]	[0.87,1.19]	[0.83,1.31]
Distant kin	1.14	1.19	1.13	1.19	1.07	1.52*	1.07	1.50*
	[0.81,1.61]	[0.89,1.59]	[0.80,1.60]	[0.89,1.60]	[0.87,1.33]	[1.10,2.09]	[0.87,1.33]	[1.09,2.07]
Household food security	1.01	0.99	1	0.99	1	1.02†	1	1.02*
	[0.99,1.02]	[0.98,1.00]	[0.99,1.02]	[0.98,1.00]	[0.99,1.01]	[1.00,1.03]	[0.99,1.01]	[1.00,1.03]
Household assets (reference = basic)								
Higher value	0.91	1.11	0.91	1.11	0.81†	1.09	0.83	1.07
	[0.65,1.26]	[0.84,1.47]	[0.65,1.27]	[0.84,1.47]	[0.64,1.03]	[0.77,1.54]	[0.65,1.05]	[0.76,1.52]
Intermediate value	0.95	1.09	0.95	1.09	0.94	0.93	0.94	0.93
	[0.75,1.21]	[0.89,1.34]	[0.75,1.20]	[0.89,1.34]	[0.80,1.12]	[0.72,1.20]	[0.80,1.12]	[0.72,1.19]
Town (reference = village)	0.71**	1.07	0.70***	1.06	0.98	0.98	0.97	0.99
	[0.58,0.87]	[0.90,1.26]	[0.57,0.87]	[0.90,1.26]	[0.85,1.12]	[0.80,1.20]	[0.85,1.12]	[0.81,1.22]
Monday interview (reference = other day)	0.92	1	0.92	1	1.01	0.94	1.02	0.93
	[0.73,1.15]	[0.82,1.21]	[0.73,1.15]	[0.82,1.21]	[0.87,1.18]	[0.75,1.18]	[0.88,1.19]	[0.74,1.16]
Age (years)	0.98	0.94***	0.99	0.94***	1.05***	0.88***	1.04**	0.87***
	[0.94,1.02]	[0.90,0.97]	[0.96,1.03]	[0.91,0.96]	[1.02,1.08]	[0.84,0.92]	[1.01,1.06]	[0.84,0.90]
N	590	590	590	590	578	578	578	578

Data shown are incident rate ratios; 95% confidence intervals in brackets; † p<0.10, * p<0.05, ** p<0.01, *** p<0.001

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Table S5: Associations between (1) number of younger and older children, and (2) number of younger and older children of the same gender, and school enrolment, for non-fostered children only

	Boys	Boys	Girls	Girls
	(1)	(2)	(1)	(2)
Number of younger children	1.47**		1.1	
	[1.14,1.90]		[0.85,1.43]	
Number of older children	0.8		2.08**	
	[0.59,1.08]		[1.29,3.33]	
Number of younger boys / girls		1.67**		0.86
		[1.23,2.27]		[0.62,1.18]
Number of older boys / girls		0.75		1.61
		[0.52,1.10]		[0.90,2.91]
Household food security	1.02	1.02	1.03	1.04
	[0.96,1.08]	[0.97,1.08]	[0.97,1.10]	[0.98,1.11]
Household assets (reference = basic)				
Higher value	4.03*	4.24*	1.25	1.44
	[1.14,14.22]	[1.20,14.96]	[0.32,4.82]	[0.38,5.42]
Intermediate value	1.96	1.99†	2.07	2.32†
	[0.88,4.39]	[0.89,4.47]	[0.79,5.37]	[0.91,5.94]
Town (reference = village)	4.45***	4.22***	2.74*	2.54*
	[2.05,9.67]	[2.00,8.91]	[1.16,6.46]	[1.10,5.84]
Age (years)	0.53***	0.56***	0.56***	0.55***
	[0.45,0.62]	[0.49,0.64]	[0.47,0.67]	[0.46,0.64]
N	453	453	425	425

Data shown are odds ratios (exponentiated coefficients); 95% confidence intervals in brackets

† p<0.10, * p<0.05, ** p<0.01, *** p<0.001

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Table S6: Associations between (1) number of younger and older children, and (2) number of younger and older children of the same gender, and time spent in work and leisure for boys and girls, for non-fostered children only

	Boys		Girls		Boys		Girls	
	Total work	**Leisure**	**Chores**	**Leisure**	**Total work**	**Leisure**	**Chores**	**Leisure**
	(1)				**(2)**			
Number of younger children	1.05 [0.97,1.14]	1.04 [0.96,1.12]	0.96 [0.90,1.02]	1.03 [0.93,1.15]				
Number of older children	1.01 [0.93,1.09]	1 [0.94,1.07]	1 [0.94,1.05]	1.07 [0.98,1.17]				
Number of younger boys / girls					1.05 [0.94,1.17]	0.95 [0.86,1.05]	1 [0.93,1.08]	1.01 [0.88,1.15]
Number of older boys / girls					1.01 [0.90,1.14]	1 [0.91,1.09]	0.92* [0.85,0.99]	1.11† [0.99,1.25]
Enrolled (reference = no)	0.35*** [0.27,0.46]	0.41*** [0.32,0.52]	0.55*** [0.45,0.67]	0.23*** [0.16,0.33]	0.35*** [0.27,0.46]	0.43*** [0.34,0.55]	0.55*** [0.45,0.66]	0.23*** [0.17,0.33]
Household food security	1 [0.99,1.02]	0.99 [0.97,1.00]	1 [0.99,1.02]	1.01 [0.99,1.03]	1 [0.99,1.02]	0.99 [0.97,1.00]	1 [0.99,1.02]	1.01 [0.99,1.03]
Household assets (reference = basic)								
Higher value	0.94 [0.64,1.37]	1.1 [0.79,1.53]	0.77† [0.59,1.01]	1.21 [0.80,1.84]	0.96 [0.66,1.39]	1.12 [0.81,1.56]	0.80† [0.61,1.04]	1.22 [0.80,1.85]
Intermediate value	1.08 [0.82,1.43]	1.1 [0.87,1.41]	1.02 [0.85,1.23]	0.96 [0.71,1.29]	1.09 [0.83,1.44]	1.13 [0.89,1.45]	1.02 [0.85,1.23]	0.98 [0.73,1.31]
Town (reference = village)	0.71** [0.56,0.89]	1.06 [0.88,1.29]	0.98 [0.84,1.14]	1.11 [0.87,1.41]	0.70** [0.56,0.88]	1.04 [0.86,1.26]	0.99 [0.85,1.15]	1.09 [0.85,1.39]
Monday interview (reference = other day)	0.87 [0.67,1.13]	0.93 [0.74,1.18]	1.02 [0.86,1.20]	1.03 [0.79,1.35]	0.85 [0.65,1.11]	0.93 [0.74,1.17]	1.03 [0.87,1.21]	1.02 [0.78,1.33]
Age (years)	0.98 [0.94,1.03]	0.93*** [0.89,0.97]	1.06*** [1.02,1.09]	0.85*** [0.81,0.90]	0.99 [0.96,1.03]	0.95** [0.92,0.98]	1.03* [1.01,1.06]	0.86*** [0.82,0.90]
N	453	453	425	425	453	453	425	425

Data shown are incident rate ratios; 95% confidence intervals in brackets † p<0.10, * p<0.05, ** p<0.01, *** p<0.001

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Table S7: Association between (1) number of out-of-school boys and time spent in work and (2) number of out-of-school girls and time spent in work, for schoolboys and schoolgirls

	Schoolboys		Schoolgirls	
	(1)	**(2)**	**(1)**	**(2)**
Number of out-of-school boys	1.03		1.08	
	[0.85,1.23]		[0.97,1.20]	
Number of out-of-school girls		0.91		0.99
		[0.74,1.11]		[0.88,1.12]
Number of school-age children	1.01	1.02	0.99	1
	[0.95,1.07]	[0.96,1.08]	[0.95,1.03]	[0.96,1.04]
Household food security	1.01	1.01	1	1
	[0.99,1.03]	[0.99,1.02]	[0.98,1.01]	[0.98,1.01]
Household assets (reference = basic)				
Higher value	0.82	0.82	0.83	0.83
	[0.55,1.22]	[0.55,1.22]	[0.63,1.10]	[0.63,1.09]
Intermediate value	0.89	0.9	0.92	0.92
	[0.65,1.20]	[0.66,1.22]	[0.76,1.11]	[0.76,1.11]
Town (reference = village)	0.76*	0.75*	0.91	0.89
	[0.59,0.98]	[0.59,0.96]	[0.77,1.07]	[0.76,1.05]
Monday interview (reference = other day)	0.9	0.91	0.98	0.98
	[0.68,1.19]	[0.69,1.20]	[0.83,1.16]	[0.83,1.16]
Age (years)	0.99	0.99	1.05***	1.05***
	[0.96,1.03]	[0.96,1.03]	[1.03,1.08]	[1.03,1.08]
N	466	466	475	475

Data shown are incident rate ratios; 95% confidence intervals in brackets; † p<0.10, * p<0.05, ** p<0.01, *** p<0.001

Table S8: Association between number of co-resident girls and boys' time spent in household chores, and number of co-resident boys and girls' time spent in farm work

	Boys	Girls
Number of co-resident girls	0.84** [0.73,0.96]	
Number of co-resident boys		0.77 [0.54,1.09]
Number of school-age children	1.09 [0.98,1.20]	1.19 [0.90,1.55]
Enrolled (reference = no)	0.70* [0.49,0.99]	0.10*** [0.04,0.26]
Household food security	1 [0.98,1.02]	0.99 [0.93,1.04]
Household assets (reference = basic)		
Higher value	1.08 [0.68,1.72]	0.19* [0.05,0.73]
Intermediate value	1.07 [0.77,1.48]	1.1 [0.47,2.58]
Town (reference = village)	1.73*** [1.31,2.29]	0.08*** [0.04,0.18]
Monday interview (reference = other day)	0.79 [0.57,1.11]	1.03 [0.50,2.13]
Age (years)	0.99 [0.95,1.03]	1.05 [0.93,1.19]
N	625	631

Data shown are incident rate ratios; 95% confidence intervals in brackets
† p<0.10, * p<0.05, ** p<0.01, *** p<0.001

Figure S1: Association between categorical age order by gender and time spent in work and leisure for boys and girls (95% confidence intervals shown)

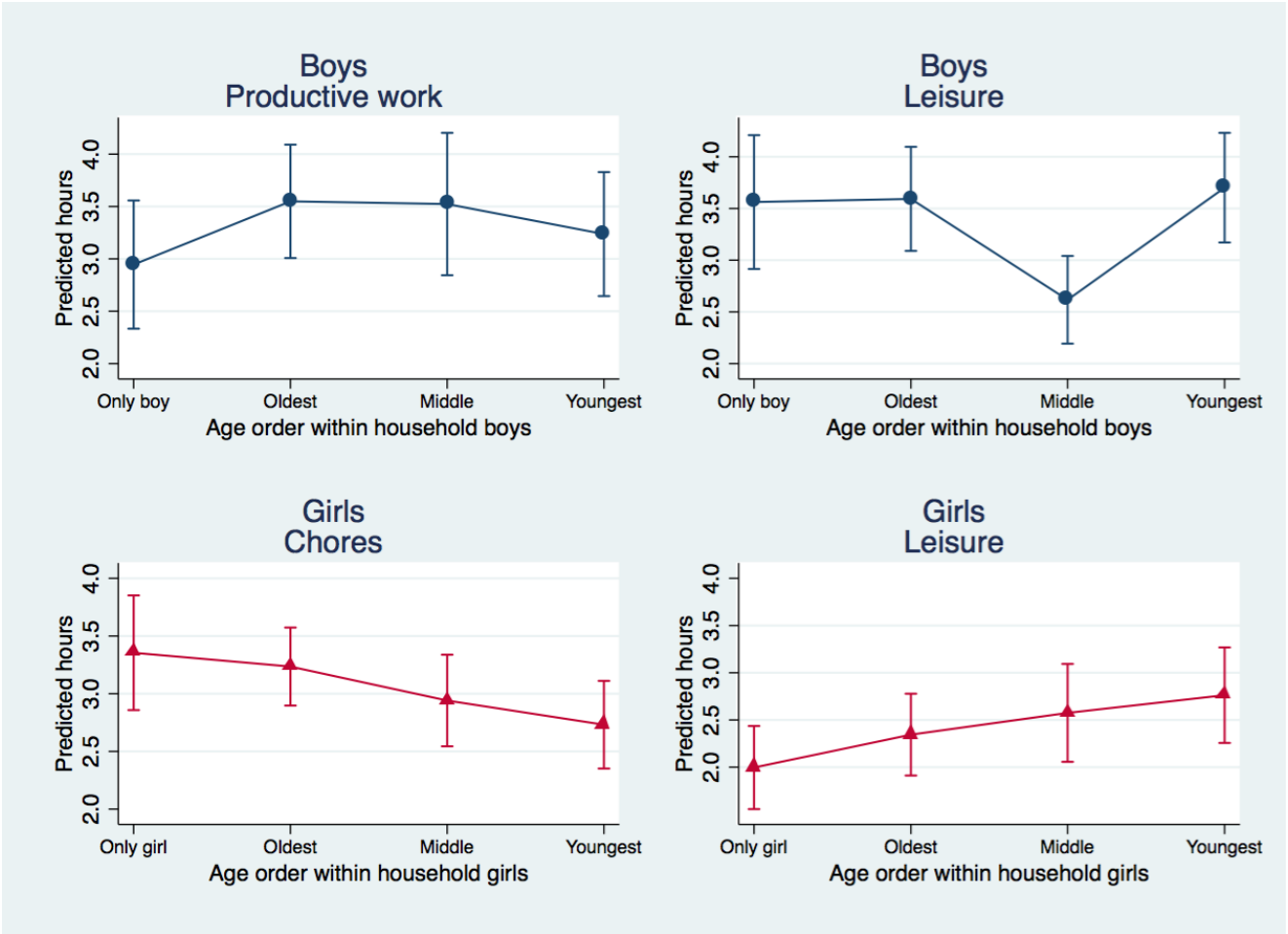

Table S2: Association between younger children and boys' enrolment, work time and leisure time, and older children and girls' enrolment, chore time and leisure time, for non-fostered children only