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Mother's income and child nutritional status:

Results from a randomized control trial in the Bolivian Amazon[1]

Running title: Mother's income and child nutrition

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Abstract

Observational studies suggest that income in the hands of women benefits young children more than income in men's hands, apparently because women are more likely to shift marginal resources to their children. These studies have influenced policies such as conditional cash transfers, which typically target women. However, these studies have been unable to control for unobserved heterogeneity in child endowments and parental preferences. We report the results of a randomized control trial that allocated one-time in-kind income transfers in the form of edible rice (the main staple and cash crop in the study area) or rice seeds to the female or male household head, randomly. The trial took place in a native Amazonian society of forager-farmers in Bolivia. Outcomes included four anthropometric indicators of short-run nutritional status of 848 children from 40 villages. We found no effects of the transfers on child nutritional status, nor any differential effects by the parent who received them. These null results probably relate to the pooling of food resources, shared preferences, and relatively equal bargaining power between women and men. The results suggest that gender targeting in cash transfer programs might not increase investments in children in societies where women are already empowered.

Keywords: Cash transfer, nutrition, empowerment, native Amazonians, child growth, Bolivia, randomized control trial

JEL code: D13, H31, I20

We saw the Amazons in front of all the Indian men as women captains, fighting so courageously that the Indians did not dare turn their backs, and if they did the women clubbed them to death before our very eyes.

Friar Gaspar de Carvajal, 1541-1542, Relación del nuevo descubrimiento

1. Introduction

There is a belief that income in women's hands benefits young children more than income in men's hands (Behrman and Skoufias 2006, Deaton 2010), presumably from the socialization of women and from a biological pre-disposition of women to care and to shift marginal resources more toward young children (Gettler 2010, Trevathan 2010). The belief finds support in observational studies (Thomas 1990, Kennedy and Peters 1992, Haddad, Hoddinott, and Alderman 1996, Handa 1996, Rogers 1996, Behrman 1997, Phipps and Burton 1998, Pfeiffer, Gloyd, and Li 2001, Smith et al. 2003, Qian 2008), but such studies do not permit firm conclusions about causality owing to endogeneity biases (Behrman 1988). Despite the uncertainty of the estimates, the belief and observational studies have influenced the design of social policies such as conditional cash transfer programs, which typically transfer income to women (Fiszbein and Schady 2009). The belief is so common that it has taken the center stage of anti-poverty programs, including Mexico's *PROGRESA* (*Oportunidades*) program and Brazil's *Bolsa Familia*. To our knowledge there is no published empirical evidence with exogenous allocation of resources between women and men to support the claim that the well-being of young children improves more when women rather than men receive income (Yoong, Rabinovich, and Diepeveen 2012).

Recent experimental studies provide *indirect* evidence that the conclusion might need reappraisal. Chattopadhyay and Duflo (2004) used an experiment by the Indian Government that assigned leadership positions to women in communities selected at random. They estimated the effects of having women leaders on public investments, and found that communities with women leaders invested more in water (which might improve child health) but some of these communities invested less in education (which might erode child health). The study hints at the idea that empowering women might have ambiguous effects on child well-being. Braido et al. (2012) and Morris et al. (2004) treat data from a conditional cash transfer program in Brazil as a natural experiment to examine the effect of the transfer on women's bargaining power and child nutrition. The government meant to transfer income to all eligible poor households, but it accidentally (and quasi randomly) excluded some households, which it nonetheless surveyed. The authors treat the data as a natural experiment, using the excluded households as a control. Braido et al. (2012) found that women in households with a male partner who received income had similar expenditures patterns as did their peers in control households and Morris et al. ((2004) found that children <3 year of age of women who received transfers had lower rates of weight gain than their peers in control households. A recent evaluation of the *PROGRESA* (*Oportunidades*) program in Mexico found no difference in women's use of conditional and earned income (Handa et al. 2009). Another recent evaluation of a conditional cash transfer program in Nicaragua found that transfers targeted at women increased child school enrollment, but the effects declined if a women's bargaining power far exceeded that of her male partner (Gitter and Barham 2008).

Taken together, the studies from Latin America suggest that exogenous improvements in women's income might not change consumption or improve child outcomes (or do so only under special conditions), but they do not allow to assess the comparative effects of gender-targeted income transfers on child well-being because all the programs transferred income only to women. Furthermore, most studies pay little attention to social norms that shape bargaining power, which may be driving the observed results.

Here we present the results of a randomized control trial (RCT) in which we randomized the female or the male household head to receive a one-time, *unconditional* in-kind transfer of income in the form of edible rice. The trial took place in a foraging-farming society of native Amazonians in Bolivia, the Tsimane' (Behrman et al. 2011, Saidi et al. 2011). Rice is their most important staple and cash crop (Vadez et al. 2004, Vadez et al. 2008), and thus provides a useful tool for assessing the impact of transfers to women on children's nutritional status, offering a proxy for cash that is both fungible and consumable. The trial built on continual ethnographic studies since 1995 and on a panel study (2002-2010) among the Tsimane' of a nearby area (Leonard and Godoy 2008).[i] We assessed the impact of the transfers on four anthropometric indicators of short-run nutritional status of children 2-9 years of age about five months after the transfer. We found no direct effects of the cash transfers on child nutrition. Given the substantial emphasis in the literature on the importance of transfers to women versus men in improving child outcomes, our focus was to examine whether the lack of aggregate effects might simply mask significant effect differences by the recipients' gender. We found no differences in child nutritional status when women rather than men received the transfer. The absence of differential effects probably relates to intra-household pooling of food, shared preferences, and relatively equal bargaining power between household heads, as in many traditional native Amazonian societies. The results highlight the probable importance of social norms that shape intra-household resource allocation, and suggest that gender targeting of cash transfer programs might not increase investments in children in societies where women are already empowered.

2. Context and Study Design

2.1 The Tsimane'

Recent studies contain descriptions of the history, geography, culture, and economy of the Tsimane' (Huanca 2008, Ringhofer 2010, Vallvé 2010) so here we focus on selected aspects of their economy and society to better understand the statistical results of this study.

Tsimane' live mostly along the Maniqui and the Apere rivers in the department of Beni, Bolivia. They were in sporadic contact with Europeans since the 17th century, avoiding permanent contact by retreating farther into the hinterlands. Continual exposure to Europeans dates to the early 1950s when the first Protestant missionaries arrived in the area to convert the Tsimane' (Godoy et al. 2005a). The opening of roads through the Tsimane' territory during the 1970s eased encroachment by highland colonist farmers, cattle ranchers, and logging firms.

Although missionaries and colonists brought market goods and employment opportunities, many Tsimane' still maintain a lifestyle primarily based on forest exploitation, fishing, hunting, gathering, and horticulture. In a recent comparative study of pro-social behavior in 15 small-scale foraging and horticultural societies (Henrich et al. 2010), the Tsimane' ranked next to the lowest in market exposure. About 40% of the sample of adults (≥ 16 years) in our panel study (2002-2007) had earned no monetary income during the two months before the interview, suggesting Tsimane' are almost economically self-sufficient. Tsimane' earn some monetary income through the continual sale of plantains, the seasonal sale of rice and palm roofing, and occasional wage labor in logging camps or cattle ranches.

Many Tsimane' children are growth stunted, meaning they are two standard deviations or more below median height values of their age-specific and sex-specific peers from reference values (Jebb et al. 1993). Depending on the age bracket, between 33% and 40% of Tsimane' children are growth stunted, similar to rates found in other native Amazonian societies (Orr, Dufour, and Patton 2001, Foster et al. 2005, Godoy et al. 2005b, McDade et al. 2005, Godoy et al. 2010). Household-level analyses of food-use patterns suggest that the Tsimane' diet is sufficient to meet daily energy and protein requirements (Godoy et al. 2005b). Consequently, the high levels of stunting observed among Tsimane' children most likely reflects the interaction between high infectious disease loads and marginal dietary quality (e.g., micronutrient deficiencies) rather than limited availability of food or energy. Other anthropometric measures besides height also suggest that Tsimane' children are not experiencing observable protein-energy malnutrition. Specifically, weight-for-height, body fatness, and indices of muscularity in Tsimane' children all more closely approximate age-specific and sex-specific reference values than height-for-age (Foster et al. 2005). For instance, in our sample the average girl or boy was 0.33 standard deviations above their age-specific and sex-specific peers in the USA in weight-for-height measures, and only 1.20% of the sample was "wasted" or below two standard deviations of the median values of their age and sex-peers.

Owing to the relative low income of Tsimane' and to some of the poor anthropometric indicators of nutritional status of children we expect income transfers to produce improvements in average anthropometric indicators of short-run nutritional status by allowing for increased consumption of goods (e.g., foods, shoes) and services (e.g., health care) related to nutritional status. However, this expectation must be qualified *(i)* by the low income elasticities of nutrient consumption estimated for other low-income societies (Behrman and Deolalikar 1987, Behrman and Deolalikar 1989, Bouis and Haddad 1992, Bouis 1994) and *(ii)* by the fact that in some of the anthropometric indicators of nutritional status we measured Tsimane' children were already doing well. Furthermore, *(iii)* another factor that may be at play here is the inability of the transfers to improve nutritional *quality.* Research on the dietary correlates of early childhood growth in the developing world has shown that measures of dietary quality (i.e., nutrient density of diets), such as percent of dietary energy/protein from animal foods, and amount of animal protein consumed are stronger predictors of physical growth patterns than overall intakes of energy or protein (Allen et al. 1992, Allen 1993, Leonard et al. 2000, Allen 2003). Indeed, the results from the Nutrition Collaborative Research Support Program (Nutrition CRSP) research in Kenya, Egypt, and Mexico have shown that the strongest correlates of child growth and other dimensions of human health were measures of dietary quality, such as animal food sources (Allen 1993, 1994, 2003). Research among South American populations has produced similar results. Among rural farming populations of highland and coastal Ecuador, better rates of child growth were most strongly correlated with greater consumption of animal foods (Leonard et al. 1995, 2000). Consequently, even though the transfers likely increased total energy availability at the household level, that they may not have directly increased dietary quality (raise animal food consumption) may have limited the potential impact on physical growth of Tsimane' children. These three qualifications might explain why we found no significant direct effects,[ii] but would not explain differential effects on child nutritional status by the parent receiving the transfer.

Two additional aspects of Tsimane' culture deserve brief mention: pro-social behavior and female empowerment. First, the impact of the transfers on the nutritional status of the children in the household might be attenuated by leakages of the transfers through gifts or reciprocal exchanges to other households. We found that households gave away 11.1% of the edible rice received, while control households gave away 2.8% of the rice seeds received. There is informal sharing of rice that our surveys did not capture. Tsimane' households often share a kitchen, practicing post-marital matrilocal residence. Households maintain their own food stocks, but will cook and eat from communal pots. Tsimane' are less likely to share uncooked food, except at the end of the rainy season (January to April) when stocks of rice dwindle and the new crop has yet to be harvested. At this point those with extra rice might share it with their neighbors or extended family, but others might rely primarily on plantains or those with higher monetary income might buy food in towns.

Second, Tsimane' women have considerable empowerment, although this does not seem obvious from standard economic and human capital indicators. Women have lagged behind men in standard economic indicators, such as monetary income, monetary value of modern physical assets owned, and also in formal schooling, academic skills, and fluency speaking Spanish, Bolivia's national language (Godoy et al. 2006a). In the baseline survey of this study we found that the value of modern assets (e.g., metal tools) and monetary earnings of male household heads was 2.5 times larger than the value of modern assets or monetary earnings of female household heads. Female household heads had 1.30 fewer years of schooling, a 30 percentage-point lower probability of speaking fluent Spanish, and scored one point lower in a test of formal math skills (range: 0-4) compared with male households heads of the same age.

However, these disadvantages are partially offset by other indicators that relate to life away from the market. Observational data suggests that women maintain social status equal to men within community and home life. For example, female and male household heads did not differ in the value of physical assets made from local materials (e.g., canoes) or in the value of their stock of domesticated animals (e.g., chickens, pigs). Additionally, female household heads in this and in a previous study (Godoy et al. 2006a) had better average nutritional indicators, such as higher age and sex-standardized Z-scores of muscle area, skinfolds, and weight-for-age than their male counterparts.

Although women and men own and keep physical assets separately, they pool resources in farming, and often literally eat from a common pot, using a spoon or shell to serve themselves food from a pot, or each picking at a piece of cooked meat over the fire. Particularly in communities far from market towns, men buy durable and consumption goods for their spouse. Furthermore, like other native Amazonian societies, Tsimane' practice preferential bilateral cross-cousin marriage, meaning that men tend to marry only their mother's brother's daughter (matrilateral cross-cousin marriage), or their father's sister's daughter (patrilateral cross-cousin marriage) (Gurven et al. 2009, Saidi 2011). In a 2006 study among 93 married adults in two villages of the panel study we found that 75% of respondents had married their cross cousin (Patel et al. 2007), and in an unpublished study with 606 adults ≥ 16 years of age from the panel study we found that 65% of respondents thought it important to follow the rule of cross-cousin marriage. Adherence to the cultural rule of preferential bilateral cross-cousin marriage plus matrilocal post-marital residence means that adult women live in villages with close kin to provide informal support in times of need. The social support of close kin contributes to a perceived sense of empowerment among women. In a study on perceived empowerment done in 2006 we found that female household heads perceived themselves as being the major decision makers -and tie breakers when disputes arose with their spouses in many economic domains of the household economy (Godoy et al. 2006a).

Many other examples exist of cultural attitudes, divisions of labor and responsibilities that build a case for other manifestations of gender equality and empowerment in running the household. For example, both women and men pool labor resources for agricultural production.

Additionally, while commonly a man hunts and thus provides high-protein and lipid foods, his wife gathers plant-derived products such as fruits and roots, thereby providing micronutrients, and produces locally-fermented beer (*chicha)*, an important part of the social fabric of Tsimane' society. Each thus plays an important role in food production and consumption of the household (Gurven et al. 2009). Last, Tsimane' women historically shared roles in spiritual power, acting as medicinal authorities and shamans in their own capacity (Huanca 2008).

2.2 Experimental Design

2.2.1 The Trial

The Great Tsimane' Council, the governing body of the Tsimane', estimated that the Tsimane' numbered ~15,000 and lived in ~100 villages of at least eight households each at the time of the study. To select the sample of villages for the trial, we eliminated villages that were being studied for other ends (e.g., our panel study), too costly to reach, too small or unsafe, or that contained other ethnic groups. This left 65 villages of which we selected the final sample of 40, based on accessibility. Only 4% of households were single-headed, so randomizing the transfer between the female or the male household head yielded similar numbers of female (n=88, 46%) and male recipients (n=103, 54%).

The random assignment of income transfers to female versus male household heads was part of a larger trial to estimate the effects of lowering village income inequality and raising household income on adult and child health in 40 Tsimane' villages. The larger trial had two treatment groups that received edible rice (described below) and a control group that received improved rice seeds. We randomly allocated the transfers of rice or rice seeds between female and male household heads. The baseline survey happened during February-May, 2008, the transfers happened during October 2008-January 2009, and the follow-up survey happened during February-May 2009.

Treatment 1 (T_1): Each of the 13 villages in T_1 received a total of 782 kg of edible rice, which we divided equally among all households of the village on the day of the transfer. Transferring the same amount of edible rice to each village ensured that each village received the same aggregate positive income shock, but the amount of rice received per person varied within and across villages for two reasons. First, since villages differed in the number of households, the amount of edible rice received by each household was inversely related to the number of households in a village. The mean and median amounts of edible rice received by households in T_1 were 58 kg and 52 kg (standard deviation [SD] = 23 kg; range: 30-131 kg). Second, intra-village differences in household sizes meant that the amount of rice per person varied further by household size (inversely).

Treatment 2 (T_2): The total amount of edible rice received by each of the 13 villages in T_2 was the same (782 kg) as in T_1. We used the area of forest cleared by households at baseline to identify the poorest 20% of households in a village (Behrman et al. 2011). Since transfers of edible rice in T_2 went only to households in the bottom 20% of the village income distribution, households received a bigger amount of edible rice in T_2 than in T_1. The mean and median quantities of edible rice received by all the poorest 20% of households (n=48) in villages receiving T_2 were 177 kg and 157 kg (SD=81 kg; range: 98-395 kg), about three times larger than the quantity of edible rice received by households in T_1. The quantities of rice were not five times larger than those for T_1because the village population distribution of the two treatments was not identical, which is not surprising because of the limited sample number (n=40) of villages for the trial.

Controls: The controls included 158 households in the 14 villages that did not receive T_1 or T_2. Controls also included households in the top 80% of the village income distribution of villages receiving T_2. Each household serving as a control received 5.9 kg of improved rice seeds.

Random gender-targeting in the delivery of transfers: Among households in the treatment groups, 62% of the female or the male household heads selected were present during the transfers to directly receive the edible rice from us, but only 52% of the household heads selected in the control group were present to receive the improved rice seeds from us (χ^2= 4.5, p=0.03). If the household head selected (female or male) was missing at the time of the transfer, we gave the edible rice or the improved rice seeds to a third party, such as the other spouse, another adult of the household who was not a spouse, or to a village authority (e.g., teacher). We told the third party to give the edible rice or the rice seeds to the absent household head who had won when that head returned. We found only partial compliance to our request.[iii] For this reason, we later restrict the analysis to households that directly received the transfers from us.

2.2.2 Economic significance of the transfers

We used rice rather than money because of the limited use of money in remote villages and because of the importance of rice as a staple and as a cash crop (Vadez et al. 2004). Rice consumption bore a positive though small correlation with monetary income (r=0.05, p<0.01). Total monetary expenditures in all foods did not change from the rice transfers, suggesting that the transfers did not displace other foods.

The transfers of rice were economically significant. The transfers of edible rice amounted to ~US$11/person for people in villages receiving T_1 and to ~US$ 33/person for people in the bottom 20% of the income distribution in villages receiving T_2. In 2009, mean daily monetary income per person among Tsimane', including trade, reached US$0.90 (SD=2.1), slightly above the threshold of extreme poverty used by the Bolivian Government (US$0.62/person) (World Bank 2005). For a typical Tsimane' household, the transfers would amount to income earned over 12.4 days (T_1) or 36.5 days (T_2). Expressed in terms of rice consumption and assuming a household has six people (the average for the sample), a person in a household receiving rice in either T_1 or T_2 would have had enough rice for 10 weeks (T_1) or 30 weeks (T_1).[iv]

The monetary value of 5.9 kg of rice seeds given to households serving as control was US$ 1.7/person, much lower than the per capita monetary value of edible rice given to households in T_1 (US$ 11) or in T_2 (US$ 33). The perceived value of the improved rice seeds at delivery time may have been lower than US$ 1.7/person for two reasons. First, there is no market for improved rice seeds in the study area. Tsimane' buy local seeds in local towns. For example, 12% of the 303 households surveyed annually during 2004-2007 as part of the panel study of 13 villages reported buying rice seeds. However, the rice seeds transferred to households in the control groups were new to them because they were an improved, high-yielding variety procured in the Department of Santa Cruz. Being unfamiliar with the improved seeds, Tsimane' may not have valued them as much as traditional seeds. Second, through focus groups and open-ended ethnographic interviews after the study ended (February 2011), we found that Tsimane' did not like the harvested rice from improved seeds.[v]

One dimension of the consolation prize that works in our favor by justifying using the transfer of seeds as another type of treatment has to do with the delayed value of the rice seeds. The value of the seeds just noted refers to the value of the seeds at the moment of the transfer. The farm-gate net value of the 5.9 kg of seeds five months later, when they were harvested, was ~US$7/person. Given the spotty data on interest rates, we did not attempt to compute the present value of the delayed reward embodied in the seeds, but it gives one a flavor of the future value of the consolation prize. The value of US$7/person captures adjustments for production costs and for losses from pests and diseases. Since 81% of households in the control group reported having planted the rice seeds received, many of these households were likely consuming their consolation prize by the time of the follow-up survey. In sum, the values per person of the transfers were US$33 ($T_2$), US$11 (T_1), and US$7 (controls).

2.2.3 Nutritional significance of the transfers

The rice transfers also represented a substantial infusion of energy and protein to the treatment households. As shown in Table 1, 58 kg of rice contains 208,220 kcal of energy and 4,118 grams of total protein, whereas 177 kg contains 635,430 additional kcal and 12,567 grams of protein. Assuming 10% wastage over five months (150 days), the 58 kg transfers would have added 1,249 kcal/day and 25 g/day of protein to average household availabilities. For the 177 kg transfers, the daily increases would have been 3,813 kcal of energy and 75 grams of protein.

INSERT TABLE 1 ABOUT HERE

Based on the World Health Organization's most recent energy and protein requirements (FAO/WHO/UNU 2004, WHO 2007a), nutritional needs are 1,281 kcal/day and 15g/day protein for a 5.5 year-old Tsimane' boy with average activity levels, and 1,165 kcal/day and 14 g/day protein for a Tsimane' girl of the same age (Table 1). Considering these estimates, even a small allocation of the household rice allotment would have important nutritional implications for Tsimane' children. Indeed, for the 58 kg rice transfers, a 10% allocation to a five-year old child would meet ~10% of the child's daily energy requirements and 16-17% of daily protein needs. For the large rice transfers (177 kg) of T_2, a 10% allocation accounts for ~30% of the energy requirements and half of the protein needs of a 5.5 year old Tsimane' child. By way of comparison, the WHO recommends that an increase of ~3-4% in dietary energy consumption is necessary for 'catch up' growth in body weight for a child of this age (FAO/WHO/UNU 2004, 32). Consequently, if these transfers were used primarily for home consumption, we would expect to see improvements in the anthropometric measures of nutritional status used in this article (e.g., Z-scores of weight-for-height, arm muscle area).

2.3 Anthropometric data and analysis

2.3.1 Methods to collect anthropometric data

We followed the protocol of Lohman et al. (1988) to collect children's anthropometric data. Linear growth (stature/length) was measured to the nearest millimeter using a portable stadiometer. Body weight was measured to the nearest 0.2 kg using a standing scale. We measured mid upper-arm circumference (MUAC) to the nearest millimeter using a plastic tape measure and triceps skinfold thickness (TST) to the nearest 0.5 mm using Lange skinfold calipers.

From these raw anthropometric measures, we calculated two additional indices: weight-for-height Z-score (WHZ) and arm muscle area (AMA). WHZ values were calculated relative to the WHO reference values (WHO 1995, 2006, Onyango et al. 2007) using WHO AnthroPlus software (WHO 2007b). We followed the procedure of Frisancho (1990) to calculate AMA (cm^2) from MUAC and TST measures.

2.3.2 Assessment of physical nutritional status

The anthropometric indices just discussed reflect short-term nutritional status and risk of acute energy stress. The rationale for the inclusion of each index is discussed next.

Weight-for-Height Z-score (WHZ). We used WHZ to assess wasting and mortality risk. Given that the growth velocities of children in both weight and stature depend on age (Baumgartner, Roche, and Himes 1986), changes in weight-for-height were assessed as Z-scores, rather than as changes in the raw measurements. Z-scores capture the difference between the measured value of the Tsimane' child's weight-for-height and the median value of the reference population for weight-for-height and same sex and age, divided by the standard deviation of the reference population for that nutritional indicator. Low values of WHZ reflect acute energy deficiency; children with WHZ scores ≤–2.0 are classified as 'wasted'.

Mid-Upper Arm Circumference (MUAC). MUAC measures the diameter of the upper arm and assesses both fat storage (source of energy) and muscle mass (source of protein or amino acids) in the body. MUAC can predict mortality among young children independent of WHZ and other weight-based or height-based measures (Briend et al. 1989, Van den Broeck, Eeckels, and Hokken-Koelega 1998, Berkley et al. 2005, Akinbami et al. 2010). MUAC captures muscularity and fatness, both of which represent tissues that are energy reserves for supporting vital functions during infection. MUAC is a stronger predictor of early childhood mortality than either height-based or weight-based anthropometric indices (Trowbridge and Sommer 1981, deOnis, Yip, and Mei 1997).

Arm-Muscle Area (AMA). AMA was calculated following Frisancho (1990). AMA provides a measure of muscular development and protein reserve (Saito et al. 2010). Consequently, as with low WHZ, low AMA is indicative of protein-energy malnutrition.

Triceps Skinfold Thickness (TST). TST measures the thickness of subcutaneous adipose tissue and captures total body fat and energy reserves (Frisancho 1990, Jebb et al. 1993, Pecoraro et al. 2003). High fat content is associated with high calorie intake or low energy expenditure (Frisancho 1990). Fat assessment has an added advantage because fat remains stable among children 1-7 years of age (Gurney 1969). The use of muscle and fat measures was of primary interest because these dimensions are affected by nutritional disorders and can change in the short run (Holliday 1978, Briend et al. 1989).

We did not use height-for-age in the main analysis. This measure captures children's long-term growth and nutritional status, but does not take into account body muscle mass and body fatness.

Anthropometric measures contained rounding errors around the digits zero and five. For instance, the shares of all measures ending in the digit five were 14.85% for height (n=1,812), 17.19% for weight (n=1082), 28.90% for MUAC (n=1384), and 24.18% for TST (n=1778) instead of the expected 10%. The amount of digit heaping for measures of height or TST did not vary between the two years of the study, but declined considerably for measures of weight and MUAC, suggesting improved precision for weight and MUAC in the end-line survey. For instance, during 2008 the share of weight measures ending in the digits zero or five were 51.72% and 47.78%, but during 2009 the shares dropped to 11.83% and 10.13% (χ^2= 428, p=0.001), which is what one would have expected from this relatively large sample of children (n=848) . Random measurement errors should increase the noise-to-signal ratio in the outcome variables and weaken the explanatory power and therefore the statistical significance of regression results using height or TST as outcomes, but should not affect as much regression results using weight or MUAC as outcome variables. We transformed MUAC, AMA, and TST into natural logarithms to ease the interpretation of results.

2.3.3 Sample and analysis strategy

We limited the analysis to children between two and nine years of age. We set the upper age bracket to ensure puberty did not affect estimates of growth rates, particularly in height. In previous studies we found that children may enter pre-pubertal growth spurt as early as 10-12 years of age (Byron 2003, Godoy et al. 2010). Tsimane' mothers breastfeed their children until about two years of age so including children younger than two years of age would have increased age-related heterogeneity regarding the possible consumption by children of the allocated rice. This said, in the robustness analysis we include them to check our main results. The sample with complete data for analysis includes 40 villages, 191 households, and 848 children (girls=407, boys=441) between two and nine years of age (Table 2).

INSERT TABLE 2 ABOUT HERE

Child attrition from the sample was low (4.69%). The total baseline sample contained 959 children (girls=473; boys=486); this number included children present at baseline even if they had a missing value for one or more of the outcomes. By the time of the follow-up survey, 24 girls (5.07% of the baseline sample of girls) and 21 boys (4.32% of the baseline sample of boys) had left, producing a total attrition of only 45 children or a 4.69% loss of the baseline sample. Owing to budgetary limitations we did not track attriters.

For the analysis we split the sample into four groups and for each group we assess whether the sex of the household head who received the transfer affected the nutritional status of the children in the household. The four groups include: *(1)* all households in the 13 villages receiving edible rice as part of T_1, *(2)* all households in the 14 control villages receiving rice seeds, *(3)* households in the bottom 20% of the village income distribution in the 13 villages receiving edible rice as part of T_2, and *(4)* households in the top 80% of the village income distribution in the 13 villages receiving rice seeds as part of T_2. Splitting the sample into four groups takes into account the fact that we transferred two different resources (rice and seeds) and that the effects of the treatments in households in villages of T_2 might vary by the position of the household in the village income distribution (Saidi et al. 2011).

We estimated the effect of the income transfers to female or male household heads on child nutritional status using a double-difference estimator. We used the following general model for a particular child-level anthropometric outcome (Y_{ai}) for each of the four groups:

$$Y_{aihvt} = \beta_0 + \beta_1 \textit{Male-Winner}_{hvt} + \beta_2 \textit{After}_{ihvt} + \beta_3 \textit{Male-Winner*After}_{ihvt} + \mu_{aihvt} \quad (1)$$

The subscripts stand for anthropometric indicators (a), individual or child (i), household (h), village (v), and time or year (t). The explanatory variables include a dummy variable for the treatment (*Male-winner*) which takes the value of 1 if the winner (of rice or seeds transfer) was a man, and zero if the winner was a woman; a dummy variable for time (*After*=0 for year 2008 or baseline; *After*=1 for year 2009 or follow up), an interaction term of the two variables, *Male-winner*After*, and a disturbance term μ for random events. The coefficient β_3 of interaction term *Male-winner*After* is the difference-in-difference (DID) estimate for the effect of gender-targeting of the transfer. We estimate expression [1] for each of the four groups separately, and cluster by village because individual-level and household-level outcomes are correlated with one another within villages. To gain statistical power, in some regressions we also pool the four groups, but add dummy variables for T_1 and T_2.

3. Results

3.1 Main results

We show the main regression results in Tables 3-4. Table 3 contains the parameter estimates for equation [1] and Table 4 shows the same regressions, but controlling for the outcome at baseline.

INSERT TABLES 3-4 ABOUT HERE

The most striking finding of Table 3 is the absence of almost any statistically significant result, whether we did the analysis with the four separate groups or pooled all groups (columns 17-20) while controlling for T_1 and T_2. The coefficient for the difference-in-difference variable, *Male-winner *After,* was only significant in one of the 20 regressions, what would have been expected by chance using a 5% significance level. Children in households in the top 80% of the income distribution in villages receiving high-yielding rice seeds (top 80% of T_2 villages; column 9) saw their WHZ score increase by 0.24 standard deviations (SE=0.11, p=0.05) more when male household heads received the seeds than when female household heads received the seeds. Nevertheless, the result became statistically non-significant after controlling for the baseline measure of WHZ (Table 4; column 9).

3.2 Extensions

First, to increase the sample size, we re-estimated the regressions of Table 3 by raising the upper age bracket from nine years of age to include children ≤16 years of age (Table 5). Changing the age bracket did not produce any significant results. Second, we assessed whether the treatment might have had a stronger effect on children 2-5 years of age since mothers might be particularly important for the nutrition of pre-school age children (Navia et al. 2003, Ovaskainen et al. 2009). We created a dummy variable for this age bracket (*child*), and interacted it with all variables from equation [1]. To assess whether the triple difference-in-difference estimate (*Male-winner*After*child*) was significant, we ran the regression for the pooled sample with all these interaction variables and found no significant effect for any group (regressions not shown). Third, we re-ran the regressions of Table 4 using instead the natural logarithm of height, weight, and BMI separately as outcome variables. We found no significant results. Fourth, we assessed whether mothers and fathers skewed investments differently between daughters and sons, as some have suggested (Thomas 1994, Godoy et al. 2006b). Using the pooled sample, we interacted the child sex variable (*boy*) with all the variables of Table 4, and assessed whether the triple interaction, *Male-winner*After*boy* was significant (Table 6). We found no significant results. Fifth, we limited the analysis to households that directly received the transfer from us rather than from third parties (Table 7). To avoid a reduction in sample size, we used the pooled sample with additional dummy variables for T_1 and T_2, and again found no significant results.

INSERT TABLES 6-7 ABOUT HERE

3.3 Randomness of transfers between female and male household heads

We ran separate regressions using treatment (*Male-winner*) as the outcome variable and the child's age, sex, and anthropometric indicator as independent variables, for each of the four groups and anthropometric indicators, considering only the baseline year. In all but one of the regressions all the individual coefficients and the overall F statistic were not significant at the 95% confidence interval or higher, suggesting that the assignment of the treatments between female and male household heads was well randomized (regressions not shown).

3.4 Attrition bias

Although the rate of child attrition was low (4.7%), we did a formal test of attrition bias to rule out the possibility that attrition could drive the results. We regressed the raw anthropometric measures (outcome variables) against *Male-winner*, a child's sex and age, dummy variables for T_1 and T_2, a discrete dummy variable for attrition, and a vector of interaction variables of the attrition dummy variable with all the above explanatory variables. F tests for the joint significance of the interaction of the attrition variable with all the explanatory variables were never significant at the 95% confidence interval or higher (regressions not shown).

4. Discussion and Conclusions

Our results showed no effects of one-time, in-kind income transfers on child nutritional status, and no differential effect by whether the women or men head of the household received the transfers. Intra-household resource allocation depends on the specific social norms of a community. We focus on three possible explanations for the absence of differential effects on child nutritional status by the sex of the parent receiving the transfer: *(i)* resource pooling within the household and common household decision-making, *(ii)* shared preferences, *(iii)* and equal bargaining power between female and male household heads. We then discuss some implications of our findings.

4.1 Resource pooling and common decision-making within households

Unlike physical assets, over which Tsimane' have defined private property rights, with food resources Tsimane' have an open-access policy of allowing any person in the household to consume the food. Tsimane' slash-and-burn farming requires cooperation between women and men. Men cut the large trees for farming, but thereafter women and men work jointly clearing the underbrush, burning, planting, weeding, and harvesting. Both have equal rights to the farm plots and equal say on the end uses of the harvest, including bartering or selling crops. There is no gendered division in food products, and no restrictions on access to food (except for food taboos during specific periods in the life cycle, such as pregnancy). Wildlife and harvested crops are pooled and food crops are stored in the house as a type of family bank, open for use to any person in the household. Wildlife, meat from domesticated animals, and fish can be sun-dried or smoked-dried and preserved for a few days, and is also shared. Children as young as five years of age feel free to take plantains stored in the house and cook them on their own in the open fire. Furthermore, although women or older un-married daughters in the household take primary responsibilities for cooking, the cooked food is placed in an open pot for all people to eat directly, or else is dished out, with people serving themselves second portions. Thus, there would be no difference in child nutritional status in relation to the parent who received the transfer because the food would have been accessible for all to eat. This would have been particularly true with our transfers, which took place from the end of the dry season through the rainy season, a time when many households are often short on rice and food, and would have been most likely to consume the rice.

4.2 Shared preferences

Because of strong endogamic marriage rules, and because of the small size of the society, it is not surprising that Tsimane' parents would share preferences about food consumption and child rearing. We have no direct measures on this point, but indirect evidence suggests that Tsimane' share many traits. For example, we have found that they widely share ethno-botanical knowledge (Reyes-Garcia et al. 2003), and that they practice positive assortative mating for age, ethno-botanical knowledge, schooling, body size and type, and psychological traits (Godoy et al.

2008). As part of this trial, we asked recipients of the rice transfer about the end uses of the transfer. We found almost no significant gender differences in the amount of rice allocated to barter, sale, gifts to others, or that they had in storage at the time of the follow-up survey, suggesting shared preferences in the use of the transfers. However, women reported allocating 25% more rice to direct consumption than men (t=4.15; p=0.001), most likely because women cook and keep closer tabs on rice stocks.

4.3 Equal bargaining power between women and men household heads

Many observers going back to the 16th century have commented on the strength and power of Amazonian women, as noted in the epigraph to this article (referred to the Amazons myth).We might have observed no differential impact on child nutritional status if women were equally empowered than men (Smith et al. 2003, Basu 2006, Gitter and Barham 2008).

In 2004, as part of the panel study in 13 villages we asked separately both the female and the male head of all households (n=231) who was the major decision maker in 10 areas of the household economy, such as decisions about buying or selling goods, child schooling, or cooking, and we also asked who broke the ties when spouses could not reach agreement (Godoy et al. 2006a). Women and men each viewed themselves as the major decision maker and tie breaker in most areas. Only with decisions about wage labor and the purchase of commercial alcoholic beverages did both agree that men were the main decision makers. The study also suggested that both women and men had a thick tangle of kin available for social support – 36% of women and 39% of men lived in their village of birth. The reasons for female empowerment remain unclear, but probably can be traced to equality in the ownership of traditional wealth and stocks of domesticated animals, and from a wide and deep social support system derived from a tightly knit endogamic society in which most people in a village have blood or marriage ties with each other. While bargaining power is defined by many factors, a person's fall-back position (alternative scenarios if cooperation failed) is thought to play a major role (McElroy and Horney 1981, McElroy 1990, Agarwal 1997, Behrman and Rosenzweig 2006).

4.4 Implications and conclusion

Our results have at least one possible policy implication for cash transfer programs. If other societies resemble the Tsimane' in resource pooling, sharing of preferences, and female empowerment, then targeting transfers to women might not have impact on investments in children. Gender targeting not only has equity implications but may also raise implementation costs or generate negative side effects, like gender-based conflicts as suggested by research in Ecuador (Hidrobo and Fernald 2012). However, the absence of large effects on child nutritional status in the context studied raises the questions of whether larger transfers, more frequent transfers, or conditionality would be required to have measureable impact on child nutritional status.

The results shown also raise concerns about the potential limits of standard economic and modern human capital indicators to infer intra-household bargaining and female empowerment. Researchers typically estimate the gap or ratio in earnings, asset wealth, or human capital between female and male household heads to make inferences about the degree of female empowerment (Gitter and Barham 2008). If applied to the Tsimane', the approach would lead one to the conclusion that adult women lacked bargaining power compared with men. What we find, instead, is that female empowerment seems to reflect not only access to some material resources, but also harder-to-measure social norms and representations (Agarwal 1997).

To conclude, in this low-income, highly autarkic and endogamous, relatively egalitarian society, large one-time in-kind income transfers to female versus male household heads produced no discernible impact on anthropometric indicators of short-run nutritional status of children in the household. We used an experimental design, and evaluated the differential effect on four different income-transfer scenarios. The trial did not allow us to identify the mechanisms for the null finding, but ethnographic research and panel data from a nearby area of the same ethnic group suggested that pooling of resources, shared preferences, and female empowerment might be plausible explanations. The null findings are in accord with the predictions of a unitary household model with common preferences and constraints (Becker 1991, Behrman 1997). However, more importantly, our results highlight the probable importance of social norms in determining household decision-making and resource allocation, and question the belief that income in the hands of women benefits young children more than income in men's hands.

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End Notes

[i] The complete data sets and publications from the panel study and the data for the trial reported in this article are available at the following web site: www.tsimane.org.

[ii] Random measurement error of some outcome variables (e.g., height, TS) could explain the weak statistical results in some of our estimates, but the likely noise-to-signal ratio is not in itself so large to explain the weak results in some of our better-measured variables, such as weight or MUAC.

[iii] We know that third parties did not always deliver the transfers because some winners complained to us in the follow-up survey about not having received their prize. Some third parties kept the entire transfer, but others apparently kept only a portion of the transfer.

[iv] Annual panel data (2002-2007, inclusive) from ~280 households in 13 Tsimane' villages that were not part of this study (Leonard and Godoy 2008) suggest that mean weekly rice consumption per person was ~1 kilogram. Since the average household has six people, the mean transfer of rice/household in T_1 (58 kg of rice/household) implies each person would have received ~10 kg of rice.

[v] Tsimane' had the following complains about the rice they harvested from the improved rice seeds: ***(a)*** the husk did not separate easily from the grain, ***(b)*** the grains were hard and broke into pieces when separating the husk from the grain, ***(c)*** broken grains fetch a lower price in the market, ***(d)*** the color of the rice was darker and not valued as highly in the market towns, ***(e)***

because edible rice from the improved seeds was harder, it took longer to cook and consumed more firewood, and ***(f)*** the rice from improved seeds did not taste as good as edible rice from traditional rice seeds.

7. Tables

Table 1. Nutritional significance of 58 kg and 177 kg rice transfers for household energy and protein availability

	58 kg Rice Transfer		177 kg Rice Transfer	
	Energy (kcal)	Protein (g)	Energy (kcal)	Protein (g)
Total infusion	208,220	4,118	635,430	12,567
Daily increase (household/day)[a]	1,249	25	3,813	75
Boy's daily needs[b]	1,281	15	1,281	15
Percent of needs from a 10% rice allocation	9.8%	17.0%	29.8%	50.0%
Girl's daily needs[c]	1,165	14	1,165	14
Percent of needs from a 10% rice allocation	10.7%	17.9%	32.7%	53.6%

Notes:

[a] Daily increase calculated over 150 days of consumption, assuming 10% wastage.

[b] Tsimane' boy of 5.5 years, weighing 17.2 kg

[c] Tsimane' girl of 5.5 years, weighing 16.3 kg

Table 2. Descriptive statistics at baseline for children 2-9 years of age measured during the two survey rounds (2008 and 2009)

	Treatment 1 (T_1)	Treatment 2 (T_2)		Control	Sub-totals		Total
		Bottom 20%	Top 80%		T1+Bottom 20%	Control+Top 80%	
	(Rice)	(Rice)	(Seeds)	(Seeds)	T_2 (Rice)	T_2 (Seeds)	(Both)
Children							
Girls (N)	132	42	94	139	174	233	407
%	51.56	48.28	46.53	45.87	50.73	46.14	48.00
Boys (N)	124	45	108	164	169	272	441
%	48.44	51.72	53.47	54.13	49.27	53.86	52.00
Household winner$^{\chi}$							
Women (N)	23	14	23	28	37	51	88
%	37.70	66.67	50.00	44.44	45.12	46.79	46.07
Men (N)	38	7	23	35	45	58	103
%	62.30	33.33	50.00	55.56	54.88	53.21	53.93
Villages	13		13	14	NA	NA	40

Child attributes: mean (standard deviation)							
Age	5.47 (2.24)	5.26 (2.16)	5.28 (2.26)	5.47 (2.24)	5.42 (2.22)	5.39 (2.25)	5.40 (2.24)
WHZ	0.44 (0.81)	0.29 (0.74)	0.24 (0.88)	0.30 (0.73)	0.40 (0.80)	0.28 (0.79)	0.33 (0.80)
AMA	16.10 (3.62)	15.17 (4.18)	15.94 (4.21)	16.39 (4.13)	15.86 (3.78)	16.21 (4.17)	16.07 (4.02)
MUAC	16.43 (1.66)	15.97 (1.82)	16.30 (1.83)	16.41 (1.69)	16.31 (1.71)	16.37 (1.75)	16.34 (1.73)
TST	7.32 (2.34)	7.32 (2.75)	7.23 (2.45)	6.89 (1.91)	7.32 (2.44)	7.03 (2.15)	7.15 (2.28)

Notes: NA=Not applicable.

ᵡ Household winner refers to which household head received the transfer, and only considers participating households with children 2-9 years of age (total households include households with or without children).

Table 3. Difference-in-difference estimate of the effects of transfers to female versus male household heads on child anthropometric indicators of nutritional status: Results of OLS regressions

Explanatory variables:	Treatment 1 (T_1)				Treatment 2 (T_2) - Bottom 20%				Treatment 2 (T_2) -Top 80%			
	WHZ	MUAC	AMA	TSF	WHZ	MUAC	AMA	TSF	WHZ	MUAC	AMA	TSF
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]
DID	0.058	0.007	0.027	-0.040	0.056	0.038	0.062	0.049	0.243*	-0.011	-0.026	-0.007
	(0.113)	(0.017)	(0.045)	(0.063)	(0.130)	(0.027)	(0.062)	(0.042)	(0.112)	(0.020)	(0.049)	(0.050)
After	-0.143	-0.005	-0.021	0.029	-0.136	-0.026	-0.038	-0.029	-0.196	-0.027*	-0.038	-0.030
	(0.073)	(0.015)	(0.036)	(0.038)	(0.119)	(0.017)	(0.056)	(0.079)	(0.160)	(0.009)	(0.023)	(0.051)
Male-winner (household head)	-0.054	-0.000	-0.014	0.042	-0.077	-0.042	-0.076	-0.067	-0.366*	-0.020	-0.028	-0.038
	(0.131)	(0.015)	(0.035)	(0.031)	(0.149)	(0.023)	(0.046)	(0.081)	(0.145)	(0.016)	(0.027)	(0.066)
Boy (child sex)	0.139	-0.008	0.010	-0.088*	-0.175	-0.013	0.010	-0.131**	-0.183	-0.024*	-0.024	-0.110**
	(0.083)	(0.008)	(0.015)	(0.031)	(0.129)	(0.016)	(0.035)	(0.033)	(0.088)	(0.010)	(0.029)	(0.035)
Age (child age)	0.068**	0.027**	0.072**	- 0.027**	0.091**	0.034**	0.086**	-0.024	0.047	0.031**	0.078**	-0.023
	(0.018)	(0.003)	(0.004)	(0.008)	(0.023)	(0.003)	(0.007)	(0.013)	(0.023)	(0.002)	(0.003)	(0.011)

Constant	0.038	2.651**	2.360**	2.114**	-0.063	2.609**	2.254**	2.152**	0.256	2.641**	2.344**	2.122**
	(0.139)	(0.017)	(0.025)	(0.066)	(0.245)	(0.023)	(0.066)	(0.107)	(0.183)	(0.014)	(0.030)	(0.052)
Observations	477	477	475	475	163	162	162	162	399	397	393	393
R^2	0.044	0.309	0.414	0.059	0.075	0.446	0.451	0.071	0.041	0.306	0.362	0.071

Table 3 (continued). Difference-in-difference estimate of the effects of transfers to female versus male household heads on child anthropometric indicators of nutritional status: Results of OLS regressions

	Control villages				Pooled			
Explanatory variables:	WHZ	MUAC	AMA	TSF	WHZ	MUAC	AMA	TSF
	[13]	[14]	[15]	[16]	[17]	[18]	[19]	[20]
DID	0.050	-0.000	-0.022	0.056	0.097	0.004	0.002	0.010
	(0.122)	(0.010)	(0.029)	(0.032)	(0.060)	(0.008)	(0.022)	(0.026)
After (0=2008; 1=2009)	-0.166	-0.022	-0.046	-0.007	-0.160**	-0.018**	-0.035*	-0.005
	(0.078)	(0.011)	(0.026)	(0.029)	(0.049)	(0.006)	(0.017)	(0.022)
Male-winner (household head)	-0.070	-0.013	-0.023	-0.027	-0.135	-0.014	-0.027	-0.013
	(0.105)	(0.010)	(0.027)	(0.031)	(0.067)	(0.007)	(0.016)	(0.022)
Boy (child sex)	0.141	0.006	0.033*	-0.078**	0.028	-0.007	0.010	-0.094**
	(0.089)	(0.006)	(0.014)	(0.017)	(0.055)	(0.005)	(0.011)	(0.015)
Age (child age)	0.071**	0.031**	0.080**	-0.022**	0.064**	0.030**	0.077**	-0.024**

	(0.013)	(0.002)	(0.005)	(0.005)	(0.010)	(0.001)	(0.002)	(0.004)
Treatment 1	NA	NA	NA	NA	0.164	0.010	0.008	0.037
	NA	NA	NA	NA	(0.107)	(0.012)	(0.024)	(0.031)
Treatment 2	NA	NA	NA	NA	-0.019	-0.011	-0.028	0.001
	NA	NA	NA	NA	(0.100)	(0.011)	(0.025)	(0.039)
Constant	-0.124	2.624**	2.324**	2.075**	-0.006	2.637**	2.341**	2.096**
	(0.109)	(0.016)	(0.037)	(0.040)	(0.104)	(0.012)	(0.026)	(0.034)
Observations	553	555	552	552	1592	1591	1582	1582
R^2	0.055	0.452	0.498	0.058	0.045	0.358	0.425	0.061

Notes: DID=*Male-winner*After*. NA=Not applicable. Robust standard errors are in parentheses. ** p<0.01, * p<0.05. MUAC, AMA, and TSF are in natural logarithms. The excluded category when using Treatment 1-2 in columns 17-20 are the 14 control villages.

Table 4. Difference-in-difference estimate of the effects of transfers to female versus male household heads on child anthropometric indicators of nutritional status: Results of OLS regressions controlling for outcome at baseline

	Treatment 1 (T_1)				Treatment 2 (T_2) – Bottom 20%				Treatment 2 (T_2) – Top 80%			
Explanatory variables:	WHZ	MUAC	AMA	TSF	WHZ	MUAC	AMA	TSF	WHZ	MUAC	AMA	TSF
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]
DID	-0.023	0.003	0.029	-0.064	-0.044	0.040	0.064	0.070	0.123	-0.016	-0.038	0.012
	(0.124)	(0.011)	(0.030)	(0.058)	(0.120)	(0.025)	(0.058)	(0.039)	(0.151)	(0.022)	(0.054)	(0.048)
After	-0.073	0.013	0.016	0.027	-0.021	-0.003	0.017	-0.054	-0.088	0.002	0.022	-0.044
	(0.094)	(0.010)	(0.023)	(0.038)	(0.120)	(0.017)	(0.056)	(0.076)	(0.133)	(0.011)	(0.029)	(0.050)
Male-winner (household head)	-0.017	-0.000	-0.005	0.010	-0.028	-0.014	-0.029	-0.020	-0.105	-0.007	-0.012	-0.014
	(0.033)	(0.003)	(0.012)	(0.009)	(0.054)	(0.008)	(0.017)	(0.022)	(0.056)	(0.006)	(0.012)	(0.023)
Boy (child sex)	-0.056	-0.007	-0.011	-0.021	0.002	-0.022*	-0.043	-0.017	0.017	-0.012	-0.018	-0.042
	(0.036)	(0.004)	(0.012)	(0.015)	(0.095)	(0.010)	(0.024)	(0.015)	(0.062)	(0.008)	(0.014)	(0.025)
Age (child age)	0.021	0.007*	0.023**	-0.004	0.024	0.012**	0.034**	-0.012	-0.007	0.009*	0.029**	-0.008
	(0.014)	(0.002)	(0.007)	(0.004)	(0.014)	(0.002)	(0.005)	(0.008)	(0.018)	(0.004)	(0.006)	(0.004)

Base log (WHZ)	0.775**				0.654**				0.662**			
	(0.054)				(0.114)				(0.054)			
Base log (MUAC)		0.765**				0.664**				0.678**		
		(0.101)				(0.043)				(0.073)		
Base log (AMA)			0.689**				0.626**				0.608**	
			(0.102)				(0.035)				(0.056)	
Base log (TSF)				0.745**				0.725**				0.654**
				(0.027)				(0.030)				(0.029)
Constant	0.024	0.623*	0.737*	0.522**	-0.014	0.884**	0.858**	0.610**	0.156	0.857**	0.932**	0.736**
	(0.070)	(0.271)	(0.247)	(0.063)	(0.105)	(0.118)	(0.090)	(0.063)	(0.125)	(0.192)	(0.136)	(0.079)
Observations	477	477	475	475	163	162	162	162	399	397	393	393
R^2	0.642	0.772	0.735	0.602	0.458	0.737	0.712	0.633	0.471	0.510	0.538	0.571

Table 4 (continued). Difference-in-difference estimate of the effects of transfers to female versus male household heads on child anthropometric indicators of nutritional status: Results of OLS regressions controlling for outcome at baseline

	Control villages				Pooled			
Explanatory variables:	WHZ	MUAC	AMA	TSF	WHZ	MUAC	AMA	TSF
	[13]	[14]	[15]	[16]	[17]	[18]	[19]	[20]
DID	0.087	-0.001	-0.023	0.058	0.046	0.001	-0.003	0.012
	(0.132)	(0.010)	(0.032)	(0.034)	(0.069)	(0.007)	(0.021)	(0.026)
After	-0.150	0.003	0.009	-0.009	-0.096	0.005	0.016	-0.014
	(0.080)	(0.012)	(0.028)	(0.027)	(0.049)	(0.006)	(0.017)	(0.023)
Male-winner (household head)	-0.017	-0.004	-0.007	-0.009	-0.037	-0.004	-0.010	-0.004
	(0.028)	(0.003)	(0.009)	(0.010)	(0.021)	(0.002)	(0.006)	(0.007)
Boy (child sex)	0.013	0.001	0.010	-0.030*	0.000	-0.007*	-0.008	-0.029**
	(0.049)	(0.002)	(0.009)	(0.014)	(0.030)	(0.003)	(0.007)	(0.009)
Age (child age)	0.028	0.009**	0.029**	-0.011**	0.016	0.009**	0.028**	-0.008**
	(0.019)	(0.002)	(0.005)	(0.003)	(0.009)	(0.001)	(0.003)	(0.002)
Base WHZ	0.735**				0.714**			

	(0.058)				(0.028)			
Base log MUAC		0.725**				0.722**		
		(0.041)				(0.042)		
Base log AMA			0.671**				0.654**	
			(0.046)				(0.039)	
Base log TSF				0.670**				0.692**
				(0.033)				(0.017)
Treatment 1					0.050	0.005	0.010	0.002
					(0.042)	(0.005)	(0.012)	(0.018)
Treatment 2					0.025	-0.003	-0.003	-0.017
					(0.044)	(0.006)	(0.014)	(0.014)
Constant	-0.072	0.718**	0.748**	0.706**	0.002	0.735**	0.807**	0.660**
	(0.087)	(0.106)	(0.108)	(0.068)	(0.059)	(0.111)	(0.093)	(0.042)
Observations	553	555	552	552	1592	1591	1582	1582
R^2	0.565	0.743	0.732	0.515	0.547	0.670	0.668	0.568

Same notes as in Table 3

Table 5. Difference-in-difference estimate of the effects of transfers to female versus male household heads on child anthropometric indicators of nutritional status: Results of OLS regressions including children ≤age 16

	Treatment 1 (T_1)				Treatment 2 (T_2) – Bottom 20%				Treatment 2 (T_2) – Top 80%			
Explanatory variables:	WHZ	MUAC	AMA	TSF	WHZ	MUAC	AMA	TSF	WHZ	MUAC	AMA	TSF
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]
DID	0.097	0.020	0.048	-0.001	0.021	0.024	0.047	0.050	0.200	-0.002	-0.019	0.032
	(0.134)	(0.022)	(0.041)	(0.055)	(0.154)	(0.020)	(0.037)	(0.051)	(0.109)	(0.013)	(0.040)	(0.042)
After	-0.255*	-0.013	-0.024	-0.029	-0.210	-0.023	-0.026	-0.079	-0.182	-0.022*	-0.021	-0.050
	(0.084)	(0.020)	(0.031)	(0.055)	(0.151)	(0.015)	(0.047)	(0.054)	(0.112)	(0.010)	(0.029)	(0.052)
Male-winner	-0.077	-0.023	-0.050	-0.020	0.065	-0.025	-0.047	-0.065	-0.307*	-0.014	-0.010	-0.066
(household head)	(0.134)	(0.014)	(0.029)	(0.037)	(0.253)	(0.018)	(0.029)	(0.100)	(0.118)	(0.011)	(0.021)	(0.070)
Boy (child sex)	0.101	-0.018*	0.006	-0.176**	-0.215	-0.007	0.038	-0.181**	-0.153	-0.029*	-0.006	-0.232**
	(0.077)	(0.008)	(0.018)	(0.027)	(0.156)	(0.011)	(0.025)	(0.033)	(0.092)	(0.012)	(0.029)	(0.054)
Age (child age)	0.013	0.033**	0.075**	0.007	0.083*	0.037**	0.086**	-0.000	0.035	0.039**	0.084**	0.009*
	(0.011)	(0.002)	(0.003)	(0.004)	(0.030)	(0.002)	(0.004)	(0.005)	(0.020)	(0.001)	(0.003)	(0.004)
Constant	0.446**	2.635**	2.353**	2.053**	-0.040	2.582**	2.216**	2.093**	0.309	2.604**	2.286**	2.052**

	(0.121)	(0.018)	(0.027)	(0.041)	(0.246)	(0.022)	(0.069)	(0.073)	(0.161)	(0.014)	(0.029)	(0.068)
Observations	605	785	774	774	193	233	232	232	504	618	607	607
R-squared	0.017	0.587	0.626	0.075	0.071	0.705	0.705	0.087	0.024	0.653	0.664	0.115

Table 5 (continued). Difference-in-difference estimate of the effects of transfers to female versus male household heads on child anthropometric indicators of nutritional status: Results of OLS regressions including children ≤age 16

	Control villages				Pooled			
Explanatory variables:	WHZ	MUAC	AMA	TSF	WHZ	MUAC	AMA	TSF
	[13]	[14]	[15]	[16]	[17]	[18]	[19]	[20]
DID	0.044	0.001	-0.003	0.031	0.088	0.009	0.015	0.022
	(0.125)	(0.011)	(0.028)	(0.027)	(0.069)	(0.008)	(0.019)	(0.021)
After	-0.264**	-0.017	-0.029	-0.018	-0.229**	-0.017*	-0.024	-0.035
	(0.079)	(0.012)	(0.027)	(0.035)	(0.049)	(0.008)	(0.017)	(0.024)
Male-winner (household head)	-0.058	-0.011	-0.026	-0.025	-0.105	-0.016*	-0.029*	-0.035
	(0.072)	(0.007)	(0.020)	(0.030)	(0.061)	(0.006)	(0.013)	(0.024)
Boy (child sex)	0.091	-0.011	0.028	-0.189**	0.005	-0.018**	0.013	-0.195**
	(0.068)	(0.006)	(0.016)	(0.016)	(0.049)	(0.005)	(0.011)	(0.018)
Age (child age)	0.027*	0.038**	0.080**	0.020**	0.029**	0.037**	0.080**	0.011**
	(0.011)	(0.001)	(0.002)	(0.003)	(0.008)	(0.001)	(0.002)	(0.002)
Treatment 1					0.137	-0.004	-0.012	0.015

					(0.097)	(0.013)	(0.028)	(0.031)
Treatment 2					-0.078	-0.013	-0.023	-0.024
					(0.097)	(0.011)	(0.025)	(0.039)
Constant	0.249*	2.602**	2.317**	1.941**	0.278**	2.616**	2.322**	2.020**
	(0.106)	(0.017)	(0.041)	(0.035)	(0.089)	(0.012)	(0.028)	(0.030)
Observations	679	892	875	875	1981	2528	2488	2488
R-squared	0.025	0.707	0.683	0.133	0.025	0.655	0.661	0.101

Same notes as in Table 3.

Table 6. Triple difference-in-difference estimate estimate of the differential effects of transfers to female versus male household heads on anthropometric indicators of nutritional status of boys versus girls: Results of OLS regressions controlling for baseline conditions for the pooled sample

Explanatory variables:	WHZ	MUAC	AMA	TSF
DID	0.079	0.003	0.004	0.033
	(.077)	(0.008)	(0.025)	(0.033)
After	-0.107	0.010	0.032	-0.029
	(.056)	(0.006)	(0.018)	(0.027)
Male-winner (household head)	-0.065*	-0.006 *	-0.016 *	-0.004
	(.025)	(0.002)	(0.007)	(0.009)
Age (child age)	0.011	0.010 **	0.030 *	-0.003
	(.009)	(0.001)	(0.003)	(0.003)
Boy (child sex)	-0.049	0.026	0.001	0.014
	(.091)	(0.224)	(0.160)	(0.078)
Base outcome	0.730 **	0.719**	0.644**	0.684**
	(0.047)	(0.037)	(0.028)	(0.024)
Treatment 1	0.078	0.009	0.020	0.001
	(0.047)	(0.005)	(0.013)	(0.020)
Treatment 2	0.017	0.005	0.016	-0.014
	(0.051)	(0.005)	(0.012)	(0.016)
DID*boy	-0.066	-0.005	-0.015	-0.041
	(0.133)	(0.0148)	(0.033)	(0.044)
After*boy	0.022	-0.010	-0.030	0.027

	(0.096)	(0.009)	(0.021)	(0.029)
Male-winner*boy	0.055	0.003	0.012	0.002
	(0.032)	(0.004)	(0.010)	(0.012)
Age *boy	0.009	-0.002	-0.003	-0.010 *
	(.015)	(0.003)	(0.007)	(0.005)
Base outcome*boy	-0.026	-0.004	0.014	0.005
	(0.052)	(0.085)	(0.067)	(0.036)
Treatment 1*boy	-0.054	-0.008	-0.020	0.002
	(0.067)	(0.005)	(0.015)	(0.022)
Treatment 2*boy	0.011	-0.015*	-0.034*	-0.006
	(.077)	(0.006)	(0.015)	(0.022)
Constant	0.029	0.728**	0.807**	0.645**
	(0.057)	(0.097)	(0.066)	(0.050)
Observations	1592	1591	1582	1582
R-squared	0.542	0.671	0.669	0.570

Notes: *DID*boy=Male-winner*After*boy* Same notes as in Table 3

Table 7. Difference-in-difference estimate of the effects of transfers to female versus male household heads on child anthropometric indicators of nutritional status: Results of OLS regressions restricted to households that directly received the transfer from researchers for the pooled sample

Explanatory variables:	WHZ	MUAC	AMA	TSF
DID	0.129	-0.010	-0.027	-0.000
	(0.081)	(0.010)	(0.027)	(0.038)
After	-0.151*	-0.015	-0.025	-0.006
	(0.058)	(0.009)	(0.024)	(0.033)
Male-winner (household head)	-0.239**	-0.018	-0.032	-0.031
	(0.083)	(0.010)	(0.024)	(0.031)
Boy (child sex)	-0.025	-0.018*	-0.009	-0.116**
	(0.080)	(0.008)	(0.017)	(0.019)
Age (child age)	0.067**	0.030**	0.077**	-0.021**
	(0.013)	(0.002)	(0.003)	(0.004)
Treatment 1	0.272*	0.010	0.008	0.028
	(0.127)	(0.015)	(0.030)	(0.039)
Treatment 2	0.099	-0.011	-0.034	0.014
	(0.137)	(0.012)	(0.028)	(0.049)
Constant	-0.067	2.638**	2.346**	2.096**
	(0.131)	(0.015)	(0.034)	(0.041)
Observations	940	943	936	936
R-squared	0.059	0.348	0.401	0.061

Notes: Same notes as in Table 3