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The Effects of Community Income Inequality on Health: Evidence from a Randomized Control Trial in the Bolivian Amazon

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Abstract

Research suggests that poorer people have worse health than the better-off and, more controversially, that income inequality harms health. But findings suffer from endogeneity. We addressed the gap by using a randomized control trial among a society of forager-farmers in the Amazon. Treatments included one-time unconditional income transfers to the poorest households and to all households, with untreated villages as controls. We assessed the effects of income inequality, absolute income, and spillovers within villages on self-reported health, objective indicators of health and nutrition, and adults' substance consumption. Most effects came from relative income. Targeted transfers increased the perceived stress of participants in better-off households. Evidence suggests increased work efforts among better-off households when the lot of the poor improves, possibly due to a preference for rank preservation. Our study points to paths by which inequality might affect health. We discuss the factors that may have attenuated the results and implications.

Keywords: health | economic inequality | development | social epidemiology | income transfers

JEL: C93, I14, I15, I38, Z13

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1. Introduction

Researchers from various disciplines have long shown that poorer people have worse health than richer people. But in the past two decades research has highlighted the perceived harm of income inequality on individual health (Wilkinson and Pickett 2009). Why this might happen is a debate in progress. The mechanisms that better seem to explain the relation between community income inequality and individual health are: (i) inequalities in absolute income or material living standards and (ii) psychosocial and behavioral mechanisms that affect health (Lynch, et al. 2000).

The absolute income approach focuses on the impact of material deprivation, access to healthcare, and poor nutrition and sanitation on health. Income inequality leads to an underinvestment in various areas, including infrastructure, health services, and insurance, which affect mainly the poor (Smith 1996; Lynch, et al. 2000). If so, we would expect a non-linear effect of income on health, with a decreasing effect as income increases. Material deprivation harms health and nutritional status, but the effect of income inequality on health is still unclear (Deaton 2003; 2013).

Other researchers stress the psychosocial paths by which income inequality might affect health, the relative income hypothesis. Having lived and evolved during a broad swath of history in largely egalitarian hunter-gatherer societies with reciprocity norms, significant inequities might undermine health through psychosocial stress from social comparisons (Wilkinson 2000). Psychosocial stress is partly determined by economic inequality, and researchers have identified several biological mechanisms through which stress affects health (Brunner 1997; Marmot, et al. 1999). Most of the literature on the relative income hypothesis suggests that income inequality produces psychosocial stress by the erosion of social capital and cohesion, which in turn affects individual health and nutritional status (Kawachi and Kennedy 2002; Wilkinson and Pickett 2009).

Despite great interest in the effects of income inequality on health, studies so far have relied on observational data, and thus are limited by endogeneity biases. Using a randomized control trial (RCT) among a society of forager-farmers in the Bolivian Amazon, the Tsimane', we examine the effects of absolute income and community income inequality on several indicators

of individual health. Randomization occurred at the village level, and all households in a total of 40 treated and control villages were surveyed. In addition to assessing the direct effects of the treatments, we assessed their spillovers. If targeted income transfers impact a community, overlooking spillover effects within a community would result in an underestimation of the effects of the transfers or in the unwarranted conclusion that health improvements took place from a decrease in inequality.¹

The debate about absolute and relative income effects on health matters because of its policy implications. If worse health results mainly from deprivation, improving health may require policies targeted at the poor through, for example, income transfers. If, instead, worse health results mainly from the distribution of income, then income-related policies to improve health should focus on income redistribution. Our study design has at least two advantages. First, the small scale of villages and occupational homogeneity allowed us to rule out confounders such as ethnicity, residential segregation, healthcare coverage or health investments, differential exposure to pollution, and large differences in occupation and lifestyle when examining the effects of community income inequality on health. Second, randomizing the treatment across villages allows us to both remove endogeneity biases and estimate the impact of transfers on the entire village economy.

2. The people

Tsimane' are a tightly-knit endogamic society of forager-farmers living in the tropical rain forest of the department of Beni, Bolivia, mostly along the rivers Maniqui and Apere. Recent estimates by the Tsimane' Council –the main governing body of the Tsimane'– suggest they number about 14,200 individuals, living in about 95 villages of at least eight households. A typical Tsimane' village has about 20 households (standard deviation, $SD=24$) with an average of six people per household. Despite occasional contact with Europeans since the sixteenth

¹ Recent research on conditional income transfers in Mexico suggests that treatments may have substantial spillover effects within the community (Angelucci and De Giorgi 2009; Bobonis and Finan 2009). However, to our knowledge, spillover effects have been examined only in one study for unconditional income transfers (Haushofer and Shapiro 2013), with negligible effects (in Kenya).

century, the Tsimane' remained relatively isolated until Protestant missionaries settled in the region in the 1950s and until the building of roads during the 1970s, which facilitated encroachment by cattle ranchers, logging firms, and highland farmers.

Tsimane' are economically self-sufficient, with limited market exposure. Subsistence centers on hunting, fishing, plant foraging, and slash-and-burn agriculture, with the sale of thatch palm and cash cropping of rice and plantains becoming increasingly important. In a world-wide comparative study of 15 small-scale rural societies, Tsimane' ranked next to lowest in market exposure, with about seven percent of households' food energy consumption purchased in the market (Henrich, et al. 2010). Another study (1999-2000) found that goods bought in the market accounted for less than three percent of the value of household consumption, and only 2.5 percent of goods came from outside the village (Godoy, et al. 2004). Previous studies suggest that the Tsimane' have low wealth inequality and that economic rank is relatively static (Undurraga, et al. 2010).

As is true of other native Amazonian societies, Tsimane' have norms of extensive sharing and reciprocity. Tsimane' borrow each other's assets frequently, often without asking the owner, share a home-fermented beverage (*chicha*), and work communally, particularly in smaller villages (Godoy, et al. 2004). The Tsimane' language does not include a word for stress, and a recent study suggests that Tsimane' adults have one of the lowest reported cortisol concentrations – a stress-related biomarker – in any population-based study (Nyberg 2011).

A substantial share (33-40%) of Tsimane' children are growth-stunted (Foster, et al. 2005; Godoy, et al. 2010), and have low hemoglobin levels (Lindsay, et al. 2003). However, a study by Godoy, et al. (2005) suggests that the Tsimane' diet meets daily energy and protein requirements, so child-stunting is probably explained by high infectious disease loads. Tsimane' men of higher social status have better nutritional indicators than men of lower status (Reyes-García, et al. 2008) and parental wealth is positively associated with children's nutritional status (Godoy, et al. 2006), providing partial support to the absolute income hypothesis (albeit with the usual caveats about endogeneity). Inequality may affect nutritional status through the relative ability of high social status individuals to gain preferential access to resources (Patton 2005; Reyes-García, et al. 2009). While the average Tsimane' body mass index has increased over

recent years, Tsimane' are not experiencing increased obesity as one might expect due to ongoing acculturation and increases in income (Zeng, et al. 2013a).

Recent studies of blood pressure among Tsimane' adults suggest that their blood pressure is slightly above other native Amazonian societies, but lower than blood pressure in other developing countries (Gurven, et al. 2012; Zeng, et al. 2013b). These studies have estimated that between four to six percent of Tsimane' have hypertension with minor or no differences by gender.

3. Experimental design and methods

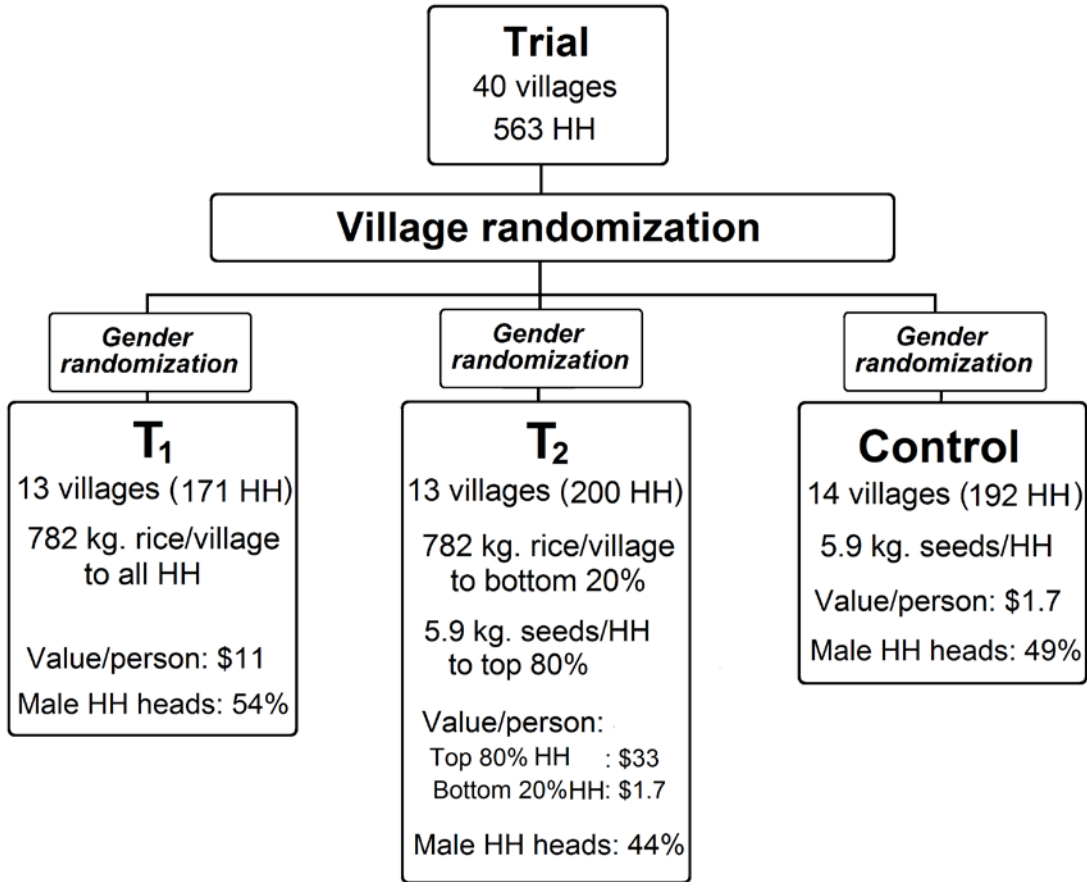
3.1 Data, sample, and treatments

We used a unique dataset from a RCT that permits assessment of the effects of a one-time unconditional in-kind income transfer on various indicators of individual well-being, including health, nutrition, income, wealth, and human capital. The trial had two treatments (Figure 1). In treatment 1 (T_1) all households in the village received the transfer and in treatment 2 (T_2) only the poorest 20% of households in a village received the transfer. Households in the top 80% of the income distribution in T_2 villages, and all households in the control villages received improved rice seeds.² Randomization was done at the village level to assess the impact of transfers on the entire local economy, rather than only on treated households.

² Public-use data from the RCT are available at <http://heller.brandeis.edu/academic/sid/tsimane/>; rgodoy@brandeis.edu.

Figure 1.

Summary of the experimental design



NOTE. – HH denotes household. All households in T₁ received rice transfers; only the households in the bottom 20% of the village income distribution in T₂ received income transfers, and the top 80% received rice seeds; all households in the control group received rice seeds. The recipient of the transfers was chosen at random between the male and female household head in all groups. The baseline sample included 3,449 individuals in 563 HH.

The trial included 40 Tsimane' villages and was informed by a panel study (2002-2010) and almost two decades of ethnographic work among the Tsimane' (Figure 2). To select the sample of villages for the trial, we eliminated villages that were participating in others studies, were too small, were too costly to reach, or contained other ethnic groups. The inclusion criteria left 65 villages of which we selected the 40 villages for the trial based on accessibility and safety (e.g.,

unsafe owing to the presence of illegal loggers, or required carrying large amounts of rice in canoes up shallow rivers).

Figure 2. Map showing the study area and the distribution of Tsimane’ villages in the panel survey (Department of Beni, Bolivia)



NOTE. – The colors of the territory denote elevation; mamsl denotes meters above mean sea level. The square symbols and letters in each town are approximately proportional in size to town population. Panel shows the 13 villages that were included in the TAPS panel study (2002-2010). RCT denotes randomized control trial; the black dots show the 40 villages that were included in the trial. Tsimane’ territory is an administrative division that does not necessarily reflect the lands inhabited by the Tsimane’.

We conducted a baseline survey from February to May 2008, gave the transfers between October 2008 and January 2009, and conducted a follow-up survey between February and May 2009. We collected demographic, anthropometric, and self-reported health data from all household members (or their parents in the case of children <16 years old), but limited collection of other data to adults (≥ 16 years old or younger if they headed a household). The sample included 3,449 individuals in 563 households. About one-fifth of the sample had left by the time of the follow-up survey. We did not track those not present due to budget limitations, but tested for attrition bias in the robustness analysis. The final sample included 494 households and 2,555 people with repeated measures.

We did not use cash transfers because of the limited use of money among the Tsimane' in isolated villages. Instead, we used edible rice as in-kind income because rice is their main cash crop (Vadez, et al. 2004), and a proxy for cash that is both fungible and consumable.

Treatment 1 (T_1): 782 kg of edible rice were allocated to each of the 13 randomly-chosen villages. The total transfer was equally divided among all households in a village (mean/household: 58 kg; median: 52 kg; SD: 23 kg; range 30-131 kg). Total rice per person varied by household size and by the total number of households in a village.

Treatment 2 (T_2): 782 kg of rice were allocated to another 13 randomly-chosen villages; however, the total transfer was equally divided only among the poorest 20% of households in the village (mean/household: 177 kg; median: 157 kg; SD: 81 kg; range 98-395 kg). Households in the top 80% of the village income distribution received 5.9 kg of improved rice seeds.

To identify the poorest 20% of households in each village, we used the area of old and fallow forest cleared by households (adjusted by household size) at baseline. Each household clears forests annually to plant crops. The total area of forest cleared is a sensible proxy for annual income because all farm output obtained from the plots is consumed, bartered, or sold; thus area of forest cleared captures total household annual consumption and monetary income from farm products. However, the measure has limitations, such as not capturing wage labor or income from the sale or consumption of forest goods.

Controls: All households in the remaining 14 villages acted as controls, and received 5.9 kg of improved rice seeds each, the same as obtained by the top 80% of households in T_2 villages.

3.2 Significance of transfers

The rice transfers were economically important. The transfers of edible rice were equivalent to about US\$11/person for people in T₁ villages, US\$33/person for people in the bottom 20% of T₂ villages, and US\$1.70/person for people in control households. The mean daily monetary income per person among the Tsimane' (wage labor + sale of farm and forest products) was about US\$0.90. Hence, transfers amounted to income earned on average over 12.4 days (T₁) or 36.5 days (T₂). The perceived value of the improved rice seeds at the time of the transfer may have been even lower, as there was no market for improved rice seeds in the region, and in focus groups following the trial, we found that Tsimane' did not like the harvested rice from improved seeds.³

The transfers also represented a substantial infusion of energy and protein to households. If we assumed a 10 percent wastage over the duration of the trial, the average rice transfer (T₁=58 kg, T₂=177 kg) would have added 1,249 kcal/day and 25 g/day of protein to average household availabilities in T₁ villages, and 3,813 kcal of energy and 75 grams of protein to average household availabilities in T₂ villages (Undurraga, et al. 2014).

We asked household heads about the actual use of the transfers during the follow up survey. Most households did not sell or barter the rice received. Households in T₁ and the bottom 20% of T₂ reported eating 76% of the edible rice, and 11% of the rice was given as gifts to others. Most of the improved rice seeds were planted (81%).

3.3 Outcome variables

We examined three types of health-related outcomes: self-reported health, objective measures of health and nutrition, and substance consumption by adults. For self-reported health, we examined self-perceived stress and health-status. Objective measures of health and nutrition included systolic and diastolic blood pressure (SBP, DBP), weight-for-height-Z-score (WHZ), and percent body fat. Last, we included two measures of traditional substance use, consumption of *chicha* and *coca*. Table 1 contains definitions and summary statistics of the outcome variables.

³ Depending on whether control households decided to plant the improved rice seeds or not, these transfers may have had a deferred benefit that is comparable to T₁ in the amount of rice produced.

Table 1. Definition and summary statistics of outcome variables used in the analysis

	Definition	2008			2009		
		Obs.	Mean	St. dev.	Obs.	Mean	St. dev.
Stress	Total episodes of the following negative emotions during the seven days before the survey: nervousness, anger, worry, sadness, inability to sleep, shame, frazzled at not having enough time to do all the subsistence and household chores needed, and envy (adults).	1,041	6.91	6.77	1,078	7.96	6.42
Health	Self-reported health status at the time of the survey: How is your health now? 1: poor or bad; 2: ok or good; 3: very good (all participants)	2,496	2.04	.40	2,468	2.03	.40
Systolic	Average of three measures of systolic blood pressure [mmHg] (adults \leq 60 yrs. old)	883	113.84	11.62	926	114.85	12.01
Diastolic	Average of three measures of diastolic blood pressure [mmHg] (adults \leq 60 yrs. old)	883	69.62	8.41	926	69.10	8.68
WHZ	Difference between weight-for-height value of Tsimane' child and median value of reference population for the same sex and age, divided by the standard deviation of the reference population (children between 2 and 16 yrs. old) ^a	966	.34	.82	895	.26	.83
Body fat [%]	Total weight of fat of the person divided by total body weight [%]. The total weight of fat is derived from the sum of 4 skinfolds using the Durnin-Womersley equations (adults \geq 18 year of age) ^b	701	22.37	8.42	755	22.19	8.38
Coca	Indicator variable. 1: participant consumed <i>coca</i> during the seven days before the day of the interview (adults)	1,081	.25	.43	1,092	.24	.43
Chicha	Indicator variable. 1: participant consumed <i>chicha</i> during the seven days before the day of the interview (adults)	1,081	.34	.47	1,092	.31	.46

NOTE. – We used 16 years of age as the cut off for adults (unless noted) because Tsimane' typically set up independent households by that age. The summary variables are limited to participants who were present during baseline (2008) and follow-up (2009). Variables used in the regressions as controls included participants' age (mean: 19.1; standard deviation: 17.89 years) and gender (50.7% males), and walking distance (hours) from the village to the nearest road or town during the dry season (mean 5.2; St. Dev.:5.6 hours). ^aWe only included children $>$ 2 years of age as Tsimane' mothers breastfeed their children for about two years, so including younger children may have increased the age-related heterogeneity regarding rice consumption by children. ^bLactating and pregnant women were excluded from body fat measurements, and we only included Tsimane' \geq 18 years of age.

Perceived *stress* captured the self-reported total number of episodes of eight negative emotions experienced by the participant during the seven days before the interview. We asked a separate question for each negative emotion, and then summed the total number of episodes. The questions for these eight emotions were adapted from the Perceived Stress Scale (Cohen, Kamarck and Mermelstein 1983). We asked children and adults about their current health status, and measured it on a Likert scale (Idler and Benyamini 1997).

SBP and DBP were defined as the average of three consecutive measures of blood pressure. Interviewers used an automatic blood pressure monitor, and took three measures of blood pressure for each adult on the upper left arm using a standard protocol (Pickering, et al. 2005). Participants rested sitting for at least five minutes before the first measure and a minimum of two minutes between each measure. We excluded adults >60 years of age from the main analysis on blood pressure to avoid the influence of older age.

We followed the protocol by Lohman, Roche and Martorell (1988) to measure height and weight. Percent body fat was estimated from the sum of four skinfolds using the Durnin-Womersley equations (Durnin and Womersley 1974). Percent body fat indicates relative fitness and WHZ captures the difference between the measured value of the Tsimane' child's WHZ and the median value of the reference population of the same sex and age (World Health Organization 2006), with low values of WHZ reflecting acute energy deficiency (i.e., recent food deprivation or illness). We did not use measures of height-for-age (HAZ, usually used as an indicator of chronic undernutrition), or weight-for-age (used as an indicator for both chronic and acute energy deficiency), because we are trying to capture short-term effects of the transfers, and most Tsimane' do not keep track of their ages.⁴

We used *coca* and *chicha* to measure traditional substance use. Though mainly a highland crop, *coca* varieties suitable to the lowlands are grown by the Tsimane'. Unlike the highlands, where *coca* leaves are consumed for work, leisure, and rituals (Mamani and Carter 1986), among Tsimane' *coca* is essentially consumed when doing hard physical work (e.g., clearing forest cover for farming). The consumption of *coca* leaves captures whether the person has had intense work activities. In contrast, *chicha* is produced by women at their homes, fermented from a

⁴ Despite these limitations, which may undermine some of the usefulness of age-standardized Z scores, we estimated the effects of the transfers on HAZ scores; results were largely consistent with WHZ.

variety of locally-grown plants, and is the cornerstone of Tsimane' social life. It is consumed in groups and is the preferred way through which Tsimane' share their experiences with others and express pro-social behavior. *Chicha* is an indicator of whether the person has had meaningful social interactions with other villagers; it proxies for traditional pro-social behavior.

Control variables included baseline (2008) measures of the health outcomes, participant's *age* and gender (*male*), and walking *distance* (hrs.) from the village to the nearest town or road during the dry season.

3.4 Identification strategy

We used the following model to analyze average treatment effects:

$$Y_{ihvt} = \alpha + \beta_1 T_{1hvt} + \beta_2 T_{2hvt} + \gamma \text{Year}_t + \delta_1 T_{1hvt} \cdot \text{Year}_t + \delta_2 T_{2hvt} \cdot \text{Year}_t + \nu X_{ihvt} + \varepsilon_{ihvt} \quad (1)$$

where the subscripts stand for individual (i), household (h), village (v), and year (t). The outcome variable, Y_{ihvt} , includes the health outcomes of interest. Year is an indicator variable for time (year=0 in 2008; year=1 in 2009), and T indicates treatment ($T_1=1$ treatment 1; $T_2=1$ treatment 2; $T_1, T_2=0$ control). X_{ihvt} is a vector with the baseline measure of the outcome variable and controls, and ε_{ihvt} is a disturbance term. δ indicates the average treatment effect (difference-in-difference estimator, DID).

We examined the effects of T_1 and T_2 versus control villages at the bottom 20% and top 80% of village income distributions, assuming that there were no spillovers to untreated households within the same T_2 village (equation 2). We added the term Bot20 to identify households at the bottom 20% of the village income distribution (Bot20=1 at the bottom 20% of income distribution at baseline in T_2 village; Bot20=0 otherwise) and a triple interaction term $T_{2hvt} \cdot \text{Year}_t \cdot \text{Bot20}$ (the coefficient is the triple difference estimator of T_2) to equation (1):

$$Y_{ihvt} = \alpha + (1 + \text{Bot20}) \cdot (\beta_1 T_{1hvt} + \beta_2 T_{2hvt} + \gamma \text{Year}_t + \delta_1 T_{1hvt} \cdot \text{Year}_t + \delta_2 T_{2hvt} \cdot \text{Year}_t) + \nu X_{ihvt} + \varepsilon_{ihvt} \quad (2)$$

Last, we used equation (1) to estimate threshold and spillover effects, by comparing the effects of income transfers on households in the bottom 20% and top 80% of the village income distribution with equivalent households from control villages. We also analyzed the treatment effects on different strata of the village income distributions, restricting the sample of households to the: (i) bottom 20%, (ii) top 80%, (iii) households right above the treatment boundary of 20% (20%-40%), and (iv) the richest households (top 40%).

4. Results

Baseline balance. We first examined the results from the randomization process (Table 2). The average health outcomes of participants in T₁ and T₂ villages were largely comparable with participants in control villages at baseline. The only exceptions were that participants in T₁ villages reported 0.3 (p=.03) fewer episodes of negative emotions (perceived *stress*) than participants in control villages, participants in T₂ had 1.96 (p=.04) times higher odds of reporting very good *health* compared with their peers in the control group, and participants in T₂ had 3.6% (p=.04) lower *DBP* than participants in the control villages at baseline.

Table 2. Baseline differences on health outcomes between participants in treatment (T₁ and T₂) and control villages

	Stress	Health	SBP	DBP	WHZ	Body fat	Coca	Chicha
<i>Specific.</i>	<i>NBR</i>	<i>OLogit^a</i>	<i>OLS</i>	<i>OLS</i>	<i>OLS</i>	<i>OLS</i>	<i>Logit</i>	<i>Logit</i>
T ₁	-.32** (.145)	1.27 (.352)	-.002 (.013)	.004 (.017)	.04 (.087)	.89 (.637)	.24 (.233)	.17 (.398)
T ₂	-.24 (.158)	1.96** (.636)	-.02 (.015)	-.04** (.017)	-.07 (.088)	-.20 (.618)	.01 (.358)	.28 (.422)
Constant	1.58*** (.131)	-2.40*** (.305)	4.68*** (0.011)	4.19*** (0.013)	.07 (.074)	26.40*** (.751)	-4.36*** (.295)	-2.27*** (.388)
N	1,344	3,288	1,137	1,137	1,198	919	1,424	1,424

NOTES. – All regressions included robust standard errors (in parentheses) adjusted for clustering at the village level and the following independent variables as controls (coefficients not shown): participant’s age and gender, and walking distance from the village to the nearest town or road. SBP denotes systolic blood pressure; DBP: diastolic blood pressure, WHZ: weight-for-height-Z-score. Baseline is a measure of the outcome variable at baseline (2008). The second row (specif.) shows the regression specification used. NBR denotes negative binomial; OLogit: ordered logit; OLS: ordinary least squares; Logit: logistic regression. The coefficients for Ologit and Logit regressions are shown as odds ratios. ^a The *constant* term in the

ordered logit regressions (health) corresponds to the first cut-point used to differentiate poor or bad health from good and very good health. The second cut-point (to differentiate bad or good health from very good health) was 2.59 (standard error: .340).

*** $p < .01$, ** $p < .05$, * $p < .10$

Average treatment effects. We assessed the average treatment effects in T_1 (absolute income effect) and T_2 (relative income effect) villages, compared with participants in control villages (Table 3). The results suggest that on average, one-time unconditional in-kind income transfers to all households in the village (T_1) increased the participants' perceived *stress* (reported number of negative emotions) and the consumption of *coca*, and decreased the probability of consuming *chicha*. Participants in villages with income transfers targeted at the poorest 20% of households (T_2) also saw an average increase in perceived stress. On average, transferring edible rice to all households (T_1) and to households in the poorest 20% of the village income distribution (T_2) increased the expected number of reported negative emotions in the seven days prior to the survey by about 30% ($\delta_1 = .28$, $e^{\delta_1} = 1.32$, $p = .04$; $\delta_2 = 0.27$, $e^{\delta_2} = 1.31$, $p = .03$). Compared with adults in control villages, adults in T_1 villages had 2.76 ($p = .03$) times larger odds of consuming *coca* and were 3.5 ($3.45 = 1/.29$; $p = .04$) times less likely to consume *chicha*.

Table 3. Average treatment effects of a one-time unconditional income transfers to all households in village (T₁) and to poorest 20% of households (T₂) on health indicators

	Stress	Health	SBP	DBP	WHZ	Body fat	Coca	Chicha
<i>Specific.</i>	<i>NBR</i>	<i>OLogit^a</i>	<i>OLS</i>	<i>OLS</i>	<i>OLS</i>	<i>OLS</i>	<i>Logit</i>	<i>Logit</i>
T ₁	-.19*** (.073)	1.14 (.225)	.09 (.385)	.16 (.429)	.02 (.027)	.15 (.110)	1.20 (.170)	1.15 (.271)
T ₂	-.13 (.081)	1.44* (.293)	-.66 (.481)	-.85* (.445)	-.02 (.029)	-.05 (.083)	1.07 (.223)	1.19 (.295)
Year	.25*** (.077)	1.38 (.683)	.21 (.705)	-1.11 (.851)	-.11** (.039)	.14 (.268)	.61* (.172)	1.26 (.527)
T ₁ ·Year	.28** (.137)	.63 (.358)	-.43 (1.347)	-.96 (1.411)	.01 (.074)	-.56 (.383)	2.76** (1.292)	.29** (.179)
T ₂ ·Year	.27** (.123)	.40 (.263)	2.14 (1.306)	2.17 (1.458)	.10 (.067)	-.05 (.498)	1.06 (.568)	.81 (.485)
Baseline	.08*** (.005)	24.64*** (3.829)	.73*** (.018)	.64*** (.020)	.70*** (.030)	.85*** (.017)	28.41*** (5.74)	21.91*** (3.675)
Constant	1.01*** (.092)	3.23*** (.314)	28.41*** (2.026)	22.43*** (1.349)	.03 (.039)	4.07*** (.447)	.02*** (.004)	.08*** (.023)
N	2,080	4,908	1,717	1,717	1,861	1,379	2,173	2,173

NOTE. – All regressions included robust standard errors (in parentheses) adjusted for clustering at the village level and the following independent variables as controls (coefficients not shown): participant’s age and gender, and walking distance from the village to the nearest town or road. SBP denotes systolic blood pressure; DBP: diastolic blood pressure, WHZ: weight-for-height-Z-score. Baseline is a measure of the outcome variable at baseline (2008). The second row (specif.) shows the regression specification used. NBR denotes negative binomial; OLogit: ordered logit; OLS: ordinary least squares; Logit: logistic regression. The coefficients for Ologit and Logit regressions are shown as odds ratios. ^a The *constant* term in the ordered logit regressions (health) corresponds to the first cut-point used to differentiate poor or bad health from good and very good health. The second cut-point (to differentiate bad or good health from very good health) was 9.39 (standard error: .555).

*** p<.01, ** p<.05, * p<.10

Threshold and spillover effects among households in bottom 20% of village income distribution. In Table 4 we refined the analysis by distinguishing the effects of the unconditional income transfers on the Tsimane' living in households at the top 80% of the village income distribution in T₁ and T₂ villages from those at the bottom 20%, by adding a triple difference term ($T_i \cdot Year \cdot Bot20$). The results largely confirm findings in Table 3, but allow some distinctions. The transfers only affected the perceived *stress* of participants living in households at the top 80% of the village income distribution in T₁ and T₂ villages: the transfers increased their expected number of reported negative emotions in the previous seven days by 35% ($\delta_1=.30$, $e^{\delta_1}=1.35$, $p=.04$) and 37% ($\delta_2=.31$, $e^{\delta_2}=1.37$, $p=.01$) in T₁ and T₂, compared with participants in the control group (T₁: LR $\chi^2=3.59$, $p=0.17$; T₂: LR $\chi^2=1.52$, $p=0.47$). Also, average increases in the odds of *coca* consumption (3.1 times more likely to consume coca than households in control villages, $p=.02$) and decreases in the odds of *chicha* consumption (3.0 times less likely to consume *chicha* than households in control villages, $p=.08$) in T₁ villages only affected those at the top 80% of the village income distribution. The Tsimane' living in households that received the income transfers (bottom 20%) in T₂ villages had .13 ($p=.04$) times lower odds of reporting very good *health* compared with their peers in the control group. Last, we found a 4% ($p=.06$) increase in *SBP* among adults in households at the bottom 20% of the village income distribution in T₂ villages (using the natural logarithm of *SBP* for ease of interpretation). Overall, the results suggest that the transfers had bigger effects on the health of adults in households at the top of the village income distribution, particularly in T₁ villages. We next analyze the impact of the treatments by relative income, limiting the sample by quintiles in the income distribution.

Table 4. Effects of one-time unconditional income transfers on health outcomes at the bottom 20% and top 80% of the village income distribution in the two arms of the treatment (T₁ and T₂), compared with control villages.

	Stress	Health	SBP	DBP	WHZ	Body fat	Coca	Chicha
<i>Specification</i>	<i>NBR</i>	<i>OLogit</i>	<i>OLS</i>	<i>OLS</i>	<i>OLS</i>	<i>OLS</i>	<i>Logit</i>	<i>Logit</i>
Bot20	-.01 (.071)	1.20 (.350)	.36 (.431)	1.24* (.730)	-.04 (.035)	-.05 (.188)	1.06 (.230)	.89 (.227)
T ₁	-.18** (.074)	1.19 (.243)	.033 (.400)	.24 (.448)	.02 (.028)	.16 (.111)	1.12 (.176)	1.14 (.274)
T ₂	-.17* (.097)	1.40 (.289)	-.44 (.495)	-.57 (.457)	-.03 (.028)	-.04 (.083)	1.02 (.273)	1.12 (.302)
T ₁ ·Bot20	-.11 (.149)	.76 (.341)	.42 (.777)	-.74 (1.198)	.03 (.048)	-.09 (.242)	1.67* (.503)	1.11 (.422)
T ₂ ·Bot20	.16 (.102)	1.05 (.366)	-1.06** (.494)	-1.84** (.825)	.08 (.052)	.00 (.199)	1.18 (.449)	1.35 (.495)
Year	.22*** (.083)	1.10 (.472)	.59 (.771)	-.85 (.899)	-.10** (.040)	.16 (.294)	.64 (.202)	1.13 (.514)
Year·Bot20	.20 (.237)	4.60** (3.055)	-3.39 (2.307)	-2.35 (2.344)	-.07 (.109)	-.17 (.704)	.60 (.504)	2.40 (1.676)
T ₁ ·Year	.30** (.144)	.75 (.402)	-.35 (1.378)	-1.14 (1.387)	.01 (.081)	-.60 (.415)	3.07** (1.431)	.33* (.209)
T ₂ ·Year	.31** (.127)	.56 (.315)	1.37 (1.398)	1.52 (1.456)	.11 (.083)	.08 (.467)	1.21 (.786)	.89 (.653)
T ₁ ·Year·Bot20	-.21 (.289)	.31 (.325)	-.21 (2.767)	1.72 (3.372)	.04 (.203)	.31 (.811)	.47 (.607)	.33 (.374)
T ₂ ·Year·Bot20	-.27 (.319)	.13** (.132)	5.02* (2.629)	4.01 (2.618)	-.03 (.164)	-.39 (.848)	.74 (.797)	.44 (.481)
Baseline	.08*** (.005)	25.11*** (3.910)	.73*** (.018)	.64*** (.020)	.70*** (.030)	.85*** (.017)	29.13*** (6.036)	22.06*** (3.697)
Constant	1.01*** (.092)	3.26*** (.319)	28.28*** (2.011)	22.25*** (1.315)	.03 (.040)	4.10*** (.464)	.02*** (.004)	.09*** (.024)
N	2,080	4,908	1,717	1,717	1,861	1,379	2,173	2,173

NOTE. – All regressions included robust standard errors (in parentheses) adjusted for clustering at the village level and the following independent variables as controls (coefficients not shown): participant’s age and gender, and walking distance from the village to the nearest town or road. SBP denotes systolic blood pressure; DBP: diastolic blood pressure, WHZ: weight-for-height-Z-score. Baseline is a measure of the outcome variable at baseline (2008). The second row (specif.) shows the regression specification used. NBR denotes negative binomial; OLogit: ordered logit; OLS: ordinary least squares; Logit: logistic regression. The coefficients for Ologit and Logit regressions are shown as odds ratios. The *constant* term in the ordered logit regressions (health) corresponds to the first cutpoint used to differentiate poor or bad health from good and

very good health. The second cutpoint (to differentiate bad or good health from very good health) was 9.48 (standard error: .570). The coefficient $T_2 \cdot Year \cdot Bot20$ is the triple difference estimate of the second treatment, assuming there are no spillover effects; $T_1 \cdot Year \cdot Bot20$ shows the effects of universal transfers on households at the bottom 20% of the village income distribution.

*** $p < .01$, ** $p < .05$, * $p < .10$.

Treatment effects by income groups. Table 5 shows the average treatment effect on households in different positions in the village income distribution (by quintiles, Q_i) in T_1 and T_2 villages, compared with equivalent households of the 14 control villages. The rows in Table 5 show the difference-in-difference coefficient, DID ($T_i \cdot year$), for the regression of the different outcomes for each sub-sample. These coefficients allowed estimating spillover effects for households in T_2 and absolute income effects for households in T_1 , compared with households in the control villages. We analyzed the treatment effects for households in each of the following income groups: (a) the bottom 20% (poorest, Q_1), (b) top 80% (Q_2 - Q_5), (c) households right next to the treatment boundary (between the bottom 20% and bottom 40%, Q_2), and (d) the richest 40% of households (Q_4 - Q_5) in each village. We first examine the results of universal unconditional income transfers (T_1), and then examine transfers targeted at the poorest households (T_2).

The results in Table 5 confirm that, on average, universal unconditional transfers (T_1) significantly increased the perceived stress of adults in households at the top 80% of the village income distribution, but not among adults in the poorest households (Q_1). Adults in households at the top 80% of the village income distribution (Q_2 - Q_5) in T_1 villages reported 1.35 ($p=.04$) times more episodes of negative emotions than their peers in control villages. The difference was more striking among households in Q_2 and Q_4 - Q_5 with 52% ($p=.04$) and 47% ($p=.03$) higher expected number of reported episodes of negative emotions compared with controls. All adults in T_1 households saw a decrease in their probability of consuming *chicha*, irrespective of their position in the village income distribution. The results also suggest that adults in households at the top 80% of the village income distribution increased their probability of consuming *coca*. However, upon further examination, we found that the observed change was mostly driven by a substantial increase in the probability of consuming *coca* of adults in Q_2 , who were 11.7 ($p<.01$) times more likely to consume coca than their peers in control villages. We ran a regression for

Q₃, and found no significant results: $T_1 \cdot \text{Year} = 1.89$, $p=.50$; regression not shown. Interestingly, this same group (Q₂) saw an average decrease of 1.2 ($p=.05$) percentage points of *body fat*, consistent with the observed increase in physical work associated with the consumption of *coca*.

Among households in T₂ villages, we found a significant increase in the perceived *stress* of adults who did not receive the unconditional income transfers, particularly among those at the top 40% of the village income distribution (Q₄-Q₅). On average, adults in T₂ villages who did not receive rice transfers (Q₂-Q₅) increased 1.37 ($p=.01$) times the expected number of reported negative emotions (1.42 times for Q₄-Q₅ households, $p=.08$) compared with their income peers in control villages. Children in households at the top 40% of the village income distribution (Q₄-Q₅) also saw an average increase of .22 SD ($p=.06$) in their *WHZ*.⁵ The Tsimane' living in households that received the income transfers (bottom 20%) had .10 ($p=.08$) times lower odds of reporting very good *health* compared with their peers in the control group, and the odds of reporting very good *health* were even lower for households in Q₂ (.04 times lower than Q₂ controls, $p<.01$) compared with controls. Adults in the bottom 20% of T₂ villages also had an average increase of 6% ($p=.02$) and 8% ($p=.06$) *SBP* and *DBP*, compared with their income peers in the control group.

⁵ In a previous analysis we found no effects of the unconditional cash transfers on child's *WHZ* indicators (Undurraga, et al. 2014); however, we only examined direct average effects.

Table 5. Effects of the unconditional income transfers on a sample of households on different positions in the village income distribution (bottom 20%, top 80%, treatment boundary 20%-40%, and richest households) in T₁ and T₂ villages, compared with equivalent households in control villages.

Quintiles	DID <i>Specific.</i>	Stress <i>NBR</i>	Health <i>OLogit</i>	SBP <i>OLS</i>	DBP <i>OLS</i>	WHZ <i>OLS</i>	Body fat <i>OLS</i>	Coca <i>Logit</i>	Chicha <i>Logit</i>
Q ₁ [Bot. 20%, poorest]	T ₁ ·Year	.10 (.267)	.27 (.311)	-.56 (2.679)	.58 (3.582)	.04 (.176)	-.24 (.745)	1.35 (1.463)	.11* (.133)
	T ₂ ·Year	.05 (.301)	.10* (.130)	6.37** (2.627)	5.53* (2.840)	.08 (.137)	-.26 (.930)	.91 (.725)	.39 (.339)
Q ₂ - Q ₅ [Top 80%]	T ₁ ·Year	.30** (.145)	.74 (.410)	-.35 (1.377)	-1.14 (1.386)	.01 (.081)	-.60 (.415)	3.21** (1.557)	.33* (.209)
	T ₂ ·Year	.31** (.127)	.55 (.313)	1.37 (1.394)	1.51 (1.453)	.12 (.083)	.08 (.467)	1.22 (.826)	.89 (.650)
Q ₂ [Treatment boundary]	T ₁ ·Year	.42** (.201)	.85 (.985)	-.58 (2.775)	-1.19 (2.211)	-.05 (.160)	-1.24* (.614)	11.72*** (9.876)	.14* (.156)
	T ₂ ·Year	.21 (.211)	.04*** (.052)	3.20 (3.217)	1.06 (3.500)	.22 (.135)	-.76 (.961)	8.82 (12.665)	.33 (.429)
Q ₄ - Q ₅ [Top 40%, richest]	T ₁ ·Year	.38** (.181)	.41 (.379)	.67 (1.990)	.03 (1.553)	.03 (.075)	-.92 (.580)	2.34 (1.413)	.19*** (.113)
	T ₂ ·Year	.35* (.197)	.89 (.885)	1.70 (1.543)	1.93 (1.577)	.22* (.117)	-.59 (.700)	.67 (.486)	.71 (.734)

NOTE. – Regressions only include the sample of households in the quintile indicated on the left column. All regressions included robust standard errors (in parentheses) adjusted for clustering at the village level and the following independent variables as controls (coefficients not shown): participant's age and gender, and walking distance from the village to the nearest town or road. Regressions included an indicator variable T₁ and T₂, year, and outcome at baseline. SBP=systolic blood pressure; DBP=diastolic blood pressure, WHZ=weight-for-height-Z-score. The second row (specif.) shows the regression specification used. NBR=negative binomial; OLogit= ordered logit; OLS=ordinary least squares; Logit=logistic regression. The coefficients for Ologit and Logit regressions are shown as odds ratios.

*** p<.01, ** p<.05, * p<.10

Attrition. To test for attrition bias, we used data from the baseline survey (2008) and regressed the health outcomes against indicator variables for T₁, T₂, attrition (1=person left at follow-up; 0=otherwise), and interaction terms between treatment and attrition (T₁·attrition; T₂·attrition) (Table 6). Most interaction terms were not significant at p<.10, which suggests that attrition was most likely random and did not introduce bias to our estimates, except for the interaction term between T₂ and perceived *stress* (p<.01). Attriters in T₂ villages had, on average, a higher expected number of reported negative emotions (perceived *stress*) than non-attriters, suggesting that our average reported estimates for *stress* in T₂ may be underestimated. The results also suggest that at baseline, attriters had marginally significant lower perceived *stress* (p=.07), and were less likely to consume *chicha* (p=.07) than participants who were present at baseline and during the follow-up (2009).

To summarize, income transfers increased the perceived *stress* of participants in households at the top 80% of the village income distribution in T₁ and T₂ villages (universal and targeted transfers) compared with control villages, by about the same amount (~30% increase in the expected number of negative emotions; Table 4). The increase was most marked among the richest 40% of households (Table 5). In T₁ villages there was an increase in the odds of consuming *coca* and a reduction in the odds of consuming *chicha* (tables 4 and 5). The biggest increase in the probability of consuming *coca* came from participants in households right above the poorest 20%, who also saw an average decrease in their body fat (Table 5). In T₂ villages, in addition to the average increase in stress of the top 80%, the transfers affected the *WHZ* of children only among the richest 40% of households. Tsimane' in the poorest 20% of households in T₂ villages saw a decrease in their odds of reporting good *health*, and an increase in blood pressure (*SBP* and *DBP*).

Table 6. Test of attrition bias

	Stress	Health	SBP	DBP	WHZ	Body fat	Coca	Chicha
<i>Specif.</i>	<i>NBR</i>	<i>OLogit</i>	<i>OLS</i>	<i>OLS</i>	<i>OLS</i>	<i>OLS</i>	<i>Logit</i>	<i>Logit</i>
T ₁	-.35** (.169)	1.27 (.333)	.003 (.012)	.01 (.016)	.07 (.093)	.97 (.725)	.23 (.238)	.34 (.387)
T ₂	-.31* (.174)	1.65 (.496)	-.02 (.016)	-.04* (.019)	-.08* (.090)	-.25 (.528)	.11 (.373)	.44 (.401)
Attrition	-.22* (.121)	.85 (.097)	.01 (.010)	-.01 (.012)	-.07 (.131)	.29 (.604)	-.48 (.378)	-.74* (.405)
T ₁ ·Att	.22 (.248)	.65 (.185)	-.02 (.015)	-.01 (.021)	-.10 (.214)	-.64 (1.116)	.34 (.505)	-.41 (.589)
T ₂ ·Att	.49*** (.160)	.82 (.209)	.004 (.015)	.01 (.016)	-.05 (.193)	-.38 (.955)	.06 (.433)	-.01 (.535)
Constant	1.66*** (.135)	-2.57*** (.267)	4.68*** (.011)	4.20*** (.014)	.10*** (.082)	26.54*** (.740)	4.23*** (.296)	-2.20*** (.393)
N	1,244	3,050	1,045	1,045	1,112	854	1,320	1,320

NOTE. – All regressions included robust standard errors (in parentheses) were adjusted for clustering at the village level and included the following independent variables as controls (coefficients not shown): participant’s age and gender, and walking distance from the village to the nearest town or road. SBP denotes systolic blood pressure; DBP= diastolic blood pressure, WHZ= weight-for-height-Z-score. Att. denotes attrition. The second row (specif.) shows the regression specification used. NBR denotes negative binomial; OLogit= ordered logit; OLS= ordinary least squares; Logit= logistic regression. The coefficients for Ologit and Logit are shown as odds ratios. The *constant* term in the ordered logit regressions (health) corresponds to the first cutpoint used to differentiate poor or bad health from good and very good health. The second cutpoint (to differentiate bad or good health from very good health) was 2.51 (standard error= .308).

*** p<.01, ** p<.05, * p<.10.

5. Discussion

Overall, the results suggest that one-time unconditional in-kind income transfers affected measures of self-reported and objective health and traditional substance consumption mostly from relative income effects, in accordance with social comparison studies in richer countries. The relative income effects were bigger for better-off households, which may be indicative of social comparisons and preference for rank preservation. We also found some evidence for absolute income effects, mostly related to *chicha* consumption. We discuss possible interpretations of the main results and limitations in the analysis.

5.1 Increase in work efforts from social comparison

Contrary to our expectations, one-time unconditional income transfers increased the perceived *stress* of the better-off in T_1 and T_2 villages compared with control villages. In villages where transfers were universal (T_1), the increase in stress came with an increase in the odds of consuming *coca*, which is usually consumed when doing intense physical work such as forest clearing, and a reduction in the odds of consuming *chicha*, an indicator of meaningful social interactions (tables 4 and 5). Adults who were right above the poorest 20% of households (Q_2) substantially increased their probability of consuming *coca*, and there is some evidence that they decreased their body fat, which is also suggestive of an increase in intense physical work (Table 5). Because the transfers were equally divided among all households in T_1 villages, they probably represented a bigger change in the well-being of the poorest households than among the better-off, due to the decreasing marginal utility of income. The evidence is suggestive of an increase in work efforts of the better-off, probably as a result of social comparisons.

In villages where transfers were targeted only to the poorest 20% (T_2), the transfers did not significantly change the odds of working harder or engaging in more social behavior, as shown through the consumption of *coca* or *chicha*; however, there is some evidence that the transfers increased children's *WHZ* among the richest 40% of households. Does this reflect an increase in energy availability for those children from additional work efforts by their parents? A recent analysis of this RCT by Saidi, et al. (2013), found a significant increase in physical assets and

Spanish fluency for better-off adults in households in T₂ villages. Because adult Tsimane' may learn Spanish through interactions with outsiders while working in logging camps, cattle ranches, or farms out of their villages, the relative increase in wealth and Spanish skills is suggestive evidence that the Tsimane' in the top 80% of households in T₂ villages also increased their work efforts.

The robustness analysis showed that income transfers produced, on average, a decrease in the probability of consuming *chicha* and an increase in the probability of consuming *coca*, but these changes were mostly driven by households at the top of the village income distribution (tables 4 and 5). We can also rule out that Tsimane' used the windfall income from the trial to buy *coca*, as we would have probably seen a substantial increase in the odds of consuming *coca* among the poorest 20% of T₂, who actually received the biggest transfers of all.

Yet another interpretation is that the increase in the total village food supply simply led to a temporary, more efficient reallocation of work, substituting farming and foraging activities with cash-income work such as described above. This effort reallocation could explain the overall increase in *coca* consumption and, if cash-income work provided less leisure hours, the decrease in *chicha* consumption in T₁ villages. However, while this may have been the case for some households, the reallocation of effort from agriculture to cash-income work would not explain the differences observed between households at the bottom 20% of the village income distribution and those at the top 80% in T₁ villages.

These results present a puzzle: why would social comparisons be so important in a tightly-knit society? It is sensible to think that an increase in income of an anonymous neighbor might trigger negative emotions and greater work effort, but in a highly endogamic society with strong rules of preferential cross-cousin marriage, why would an increase in income of one's kin trigger similar reactions?

Tsimane' social norms and settlement patterns may give some clues. Tsimane' have various norms of sharing and reciprocity; however, while households share food when stocks dwindle, they also have a less generous side. Tsimane' are more likely to share traditional assets than assets acquired in the market (e.g., metal tools), are less likely to share raw than cooked food, and may turn their backs while eating to avoid sharing (Ellis 1996). Several travelers have noted Tsimane' stinginess with food as far back as the nineteenth century (Balzan 1893; Nordenskiöld

2003 [1922]). Traditional Tsimane' communities consisted in small clusters of rarely more than five blood-related households settled next to rivers. However, since the 1980s, largely due to the influence of missionaries and the lure of schools and income-generating activities, these communities have been replaced by semi-nuclear communities of about three to eight extended families living together, commonly near a school. Each extended (marriage or blood-related) family settles around a common patio, but extended families may not necessarily have kinship bonds between them. If social comparisons occur more intensively between extended families within a village, then our findings should come as no surprise.

In sum, the evidence suggests that the income transfers increased perceived *stress* among the richest households in both scenarios, universal and targeted income transfers. The increase in *stress*, together with an increase in the consumption of *coca* and a decrease in the consumption of *chicha* among better off households in T₁ villages, and an increase in wealth and Spanish fluency among the better-off households in T₂ villages (Saidi, et al. 2013), is suggestive of an intensification of the work efforts of the richest households. These findings highlight the importance of social comparisons and relative income, in line with conclusions from previous studies (Ferrer-i-Carbonell 2005; Luttmer 2005).

5.2 Reduction in stress from transfers

Do these results suggest that the transfers had no absolute income effects on health? Probably not. If interventions increased everyone's stress in T₁ and T₂ villages, the poorest 20% of households might have seen their stress reduced by the transfers to a level that was undistinguishable from baseline. In T₂ villages transfers might have affected only adults in households at the bottom 20% of the village income distribution. Likewise, the transfers might have affected only adults in households at the bottom of the village income distribution in T₁ villages due to the decreasing marginal utility of income, which hints at the absolute income hypothesis. This interpretation of the observed changes in stress is in agreement with the results from a recent RCT in Kenya (Haushofer and Shapiro 2013) that gave much bigger (US\$404-US\$1,520) unconditional income transfers to households and, not surprisingly, found that

income transfers decreased participants' stress, with larger effects for bigger transfers (the Kenya trial also used an objective measure of stress based on the collection of stress hormone cortisol).

5.3 Other explanations and pending questions

There is also an ethnographic interpretation for the increase in perceived *stress* among the richest households in T₂ villages. If in a closely-knit and relatively egalitarian society people in the same village do not think of themselves as having more or less income, they may have interpreted the transfers as an increase rather than a decrease in inequality. However, the fact that we also found an increase in *stress* among adults in households at the top 80% and, more intensely, among adults in households at the top 40% of the village income distribution in T₁ villages, suggests that social comparisons and preferences for rank preservation are the most likely mechanism to explain the observed effects.

Surprisingly, unconditional transfers had negative absolute income effects on health. Tsimane' who received the transfers in T₂ villages (the poorest 20% of households) saw a significant decrease in their odds of reporting good *health*, and an increase in blood pressure (*SBP* and *DBP*). Recent analysis of this trial showed that these households at the bottom of the income distribution in T₂ villages saw a large increase in wealth and monetary income, but saw no increase in Spanish skills (Saidi, et al. 2013). These results, in addition to the non-significant changes we observed in the probability of consuming *coca* or *chicha* among adults in this group, suggest that the observed negative effect on *health* could have been caused by a more sedentary life and/or from changes in diet, for example, a decrease in dietary quality.

Despite the fact that households reported giving away about 11% of the edible rice received, we found no direct spillover effects of the income transfers on health (although we found significant within-village externalities). The sole exception might have been an increase in *WHZ* among the children in the richest 40% of households in T₂; however, this improvement in child nutrition most likely resulted from additional work efforts by this group, triggered by social comparison and a preference for rank conservation among Tsimane' adults. A recent randomized trial in Kenya (Haushofer and Shapiro 2013) also examined the effects of unconditional income

transfers on non-recipients and found no significant effects, except for an increase in female empowerment.

The transfers represented a substantial infusion of energy and protein, from a nutritional standpoint (Undurraga, et al. 2014). However, we saw almost no effects on anthropometric indicators of nutritional status (*WHZ, body fat*), as was found for indicators of child nutritional status (Undurraga, et al. 2014). The impact of the transfers on nutritional status may have been affected for at least three reasons. First, reciprocity may have diluted the nutritional effect of the transfers. Each Tsimane' household maintains its own food, but will cook in an open space and often eat from a communal pot, sharing cooked food with the extended family. Second, the Tsimane' have relatively good indicators of nutritional status (Foster, et al. 2005), and household analysis suggest that Tsimane' diet meets daily energy and protein requirements (Godoy, et al. 2005). Last, the income transfers may have mostly increased energy availability at the household level, but not improved nutritional quality, such as nutrient density.

5.4 Limitations and implications

Our results suggest that unconditional transfers did affect health, albeit not in the direction expected. This raises questions on whether other transfer schemes would be needed to achieve desired improvements in health, such as conditionality, transferring money rather than in-kind income, or using larger or more frequent transfers.

First, several studies suggest that conditional transfers outperform the impact of unconditional transfers on schooling outcomes (Baird, et al. 2013); we may have seen different results had we used conditionality related to health in the transfers. But understanding the effects of unconditional income transfers is important, particularly in relatively poor countries. Unconditional income transfers are less expensive, less demanding to implement, and, in most cases, less patronizing than conditional-income transfers (de Brauw and Hoddinott 2011).

A second characteristic that may have attenuated the results was the use of in-kind transfers instead of monetary income. Hidrobo, et al. (2014) compared the effects of conditional in-kind, vouchers, or income transfers in food assistance programs in Ecuador. Their study suggests that while the three conditional transfer schemes improved the quality and quantity of food consumed

among urban and peri-urban communities, food transfers resulted in larger increases in calories and vouchers lead to larger improvements in dietary diversity. But other studies in Mexico have found no differences in health and nutritional outcomes between cash and in-kind transfers to households (Skoufias, Unar and González-Cossío 2008; Cunha 2010), as one would expect from a well-functioning market. Money is of limited use among the Tsimane', particularly in more isolated villages, so despite limitations, food-transfers were the most sensible option in our study design.

A third factor that may have attenuated the results is related to the use of a one-time income transfer as opposed to a repeated or more continuous transfer. People may treat one-time windfall income differently than repeated or continuous income (Thaler 1990). If so, a one-time income transfer may have not significantly changed people's behavior or resource allocation. Further, behavior may also be affected differently by a one-time, exogenous income shock compared with an endogenous, gradual change in relative income.

In sum, our study produced several noteworthy results. First, we found suggestive evidence of psychosocial paths through which changes in income affect health indicators. The transfers increased the perceived *stress* of the richest households, which is indicative of social comparisons and preferences for rank preservation. Second, we found some support for the absolute income hypothesis. The results suggest that the transfers seemed to protect only the poorest households from perceived *stress*. We found that the biggest income transfers (to households at the bottom 20% of the village income distribution of T₂ villages) decreased the probability of reporting good health and increased blood pressure. Third, unlike previous studies in rural Mexico, we found no evidence of spillover effects from the transfers. While the debate over whether economic inequality affects health beyond absolute income is far from conclusive, our study points to paths by which inequality might affect health.

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