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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 causal interpretations suffer from endogeneity. We addressed the gap by using a randomized control trial among a society of forager-farmers in the Bolivian Amazon. Treatments included one-time unconditional income transfers (T_1) to all households and (T_2) only to the poorest 20% of households, with other 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 improved, possibly due to a preference for rank preservation. The study points to new paths by which inequality might affect health.

Keywords

Health; Economic inequality; Development; Income transfers; Randomized control trial

1. Introduction

Research suggests that poorer people have worst health than richer people. But mounting evidence suggests that income inequality may harm health beyond the social gradient

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Appendix A. Supplementary data

Supplementary data related to this article can be found at <http://dx.doi.org/10.1016/j.socscimed.2015.12.003>.

(Deaton, 2013; Kawachi and Subramaniam, 2014; Pickett and Wilkinson, 2015). Why this might happen is a debate in progress. The relation between income inequality and health is largely explained by (i) absolute income or material living standards and (ii) psychosocial and behavioral mechanisms (Lynch et al., 2000), but previous studies have relied on observational data and are limited by endogeneity bias.

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 areas such as infrastructure and health services which affect mainly the poor (Lynch et al., 2000; Stiglitz, 2012). If so, we would expect a decreasing effect as income increases. Material deprivation harms health and nutritional status, but the effect of income inequality on health remains unclear (Deaton, 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). These comparisons erode social capital and cohesion, and fuel psychosocial stress that may affect health through various biological mechanisms (Brunner, 1997; McEwen, 2012).

Using a randomized control trial (RCT) among a society of forager-farmers in the Bolivian Amazon, the Tsimane', we examined the effects of absolute income and community income inequality on indicators of individual health. We gave income transfers in the form of edible rice (Tsimane' main cash crop) to all households in 13 villages to estimate absolute income effects (T_1), only to households at the bottom 20% of the village income distribution in another 13 villages to reduce village income inequality (T_2), and included 14 villages as controls. Households in control villages and those at the top 80% of the village income distribution in T_2 villages received a much smaller amount of rice seeds as a consolation price. Besides assessing the direct effects of the income transfers, we examined spillover effects. To our knowledge, two RCTs have assessed spillover effects of income transfers. A conditional income transfer program in Mexico found spillover effects within the community (Angelucci and De Giorgi, 2009; Bobonis and Finan, 2009), but an unconditional income transfer program in Kenya found negligible effects (Haushofer and Shapiro, 2013). Overlooking spillover effects within a community might result in an underestimation of the effects of income transfers or in the unwarranted conclusion that health improvements took place from a decrease in inequality.

The debate about the role of income and income inequality on health matters. If worse health results mainly from deprivation, improving health would require policies targeted at the poor through, for example, income transfers. If, instead, worse health results mainly from unequal distribution of income, then improving health would require policies to reduce income disparities. Our study design has at least two advantages. First, the small scale of villages and occupational homogeneity allowed us to rule out many confounders that plague studies in industrial nations (e.g., ethnicity, residential segregation, healthcare coverage).

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 native Amazonian society of forager-farmers in Bolivia (Fig. 1). Recent estimates 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 century, the Tsimane' remained relatively isolated until Protestant missionaries and road-building projects arrived to the area in the 1950s and 1970s.

Tsimane' are economically self-sufficient. Subsistence centers on 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 <3% the value of household consumption, and only 2.5% of goods came from outside the village (Godoy et al., 2004). Tsimane' have low wealth inequality and mobility in economic rank (Undurraga et al., 2010).

As is true of other native Amazonian societies, Tsimane' have norms of extensive sharing and reciprocity (Godoy et al., 2004). The Tsimane' language does not have a word for stress. In population-based studies, the Tsimane' have one of the lowest reported cortisol concentrations, a stress-related biomarker (Nyberg, 2012). Adult blood pressure is slightly above other native Amazonian societies, with 4–6% having hypertension (Gurven et al., 2012; Zeng et al., 2013b).

About 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, the Tsimane' diet meets daily energy and protein requirements, so child-stunting is probably explained by high infectious disease burden (Godoy et al., 2005). 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 some support to the absolute income hypothesis. 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 (Zeng et al., 2013a). (See supplementary material for further background on the Tsimane').

3. Experimental design and methods

3.1. Data, sample, and treatments

The RCT had two treatments (Fig. 2). In treatment 1 (T_1) all households in the village received the income transfer, hence increasing the available household income while

maintaining the same village income distribution. In treatment 2 (T_2) only the poorest 20% of households in a village received the transfer, maintaining the same overall impact in the village economy as in T_1 , but decreasing the village income inequality. Households in the top 80% of the income distribution in T_2 villages, and all households in the control villages received improved rice seeds. Randomization was done at the village level to assess the impact of transfers on the entire local economy, rather than only on treated households. We also randomized the assignment of income transfers to female versus male heads in each household in both treatments and in control villages, to assess whether income in the hands of female household heads benefits children more than income in the hands of men (preliminary results are shown in Undurraga et al., 2014a; see supplementary material).

The trial included 40 Tsimane' villages and was informed by an annual panel study (2002–2010) and almost two decades of ethnographic work among the Tsimane' (Fig. 1) (Leonard et al., 2015). We excluded from our sample villages that were participating in other studies, were too small, were too costly to reach, or contained other ethnic groups. This left 65 villages of which we selected the 40 villages for the trial based on accessibility and safety.

We did the baseline survey during February–May 2008, transferred income during October 2008–January 2009, and did the follow-up survey during February–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 baseline sample included 3449 individuals in 563 households; about 20% of the sample had left by the time of the follow-up survey. We did not track attriters due to budgetary limitations, but we test for attrition bias in the robustness analysis. The final sample included 494 households and 2555 people.

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 between 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; the total transfer was equally divided only between the poorest 20% of households in the village (mean/household = 177 kg; median = 157 kg; SD: 81 kg; range 98–395 kg). Each household in the top 80% of the village income distribution received 5.9 kg of improved rice seeds.

To identify the poorest 20% of households, we used the baseline household per capita area of forest cleared for farming. 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 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, because it does not capture wage labor or income from the sale or consumption of forest goods.

Controls—All households in the remaining 14 villages were treated as controls, and received 5.9 kg of improved rice seeds each, the same as obtained by the top 80% of households in T₂ villages. The treatments and controls we used in the trial were defined with and approved by the governing body of the Tsimane' (supplementary material).

3.2. Significance of transfers

The rice transfers were economically important for the recipients in T₁ and T₂; they amounted to about US\$11/person in T₁ villages and US\$33/person for people at the bottom 20% of the income distribution in T₂ villages, but only US\$1.70/person in control households. The mean daily monetary income per person among the Tsimane' (wage labor + sale of farm and forest products) was about US\$.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 was low because there was no market for improved rice seeds in the region.

The transfers also represented a substantial infusion of energy and protein to households. Assuming a 10% wastage over the duration of the trial, the average rice transfer (T₁ = 58 kg, T₂ = 177 kg) would have added 1249 kcal/day and 25 g/day of protein to average household availabilities in T₁ villages, and 3813 kcal of energy and 75 g of protein to average household availabilities in T₂ villages (Undurraga et al., 2014a).

Most households did not sell or barter the rice received. Households in T₁ villages and the bottom 20% of T₂ villages 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 health-related outcomes: self-reported health, objective measures of health and nutrition, and substance consumption. 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).

Further details of how we measured outcome variables are shown in the supplementary material. However, two variables deserve brief mention here. We used coca and chicha to measure traditional substance use. Unlike the highlands, where coca leaves are consumed for work, leisure, and rituals (Mamani and Carter, 1986), among Tsimane' coca is consumed when doing hard physical work (e.g., clearing forest cover). In contrast, chicha is produced by women at their homes, fermented from a variety of local plants, and is the cornerstone of Tsimane' social life. Consumed in groups, coca is the preferred way through which Tsimane' share their experiences with others and express pro-social behavior.

3.4. Identification strategy

We used the following model to analyze average treatment effects:

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

where the subscripts stand for individual (i), household (h), village (v), and year (t). Y_{ihvt} includes the health outcomes of interest, year indicates 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 covariates, to control for potential differences between groups, 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 $T_{2hvt} \bullet \text{Year}_t \bullet \text{Bot20}$ (the coefficient is the triple difference-in-difference estimator of T_2) to equation (1):

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

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

At baseline, the average health outcomes of participants in T_1 and T_2 villages were similar to the health outcomes of participants in control villages (regression results shown in supplementary material, Table S1).

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 2). The results suggest that 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. 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 by about 30% ($\delta_1 = .28$, $e^{\delta_1} = 1.32$, p

$= .04$; $\delta_2 = .27$, $e^{\delta_2} = 1.31$, $p = .03$). 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.

Threshold and spillover effects among households in the bottom 20% of the village income distribution

In Table 3 we add a triple difference term ($T_1 \cdot \text{Year} \cdot \text{Bot}20$) to distinguish the effects of the income transfers on people living in households at the top 80% of the village income distribution in T_1 and T_2 villages from those at the bottom 20%. The results confirm findings from Table 2, 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 T_1 and T_2 villages: compared with participants in control villages (T_1 : LR $\chi^2 = 3.59$, $p = .17$; T_2 : LR $\chi^2 = 1.52$, $p = .47$), the transfers increased the number of negative emotions by 35% and 37% in T_1 and T_2 ($\delta_1 = .30$, $e^{\delta_1} = 1.35$, $p = .04$; $\delta_2 = .31$, $e^{\delta_2} = 1.37$, $p = .01$). In T_1 villages, only people at the top 80% of the income distribution increased coca consumption and decreased chicha consumption; these people were about three times more likely consume coca ($p = .02$) and three times less likely to consume chicha ($p = .08$). People in treated households (bottom 20%) of T_2 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 T_2 villages. 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 T_1 villages. We next analyze the impact of the treatments by relative income for different quintiles (Q_i) of the income distribution.

Treatment effects by income groups

Table 4 shows the average treatment effect on households in different quintiles in the village income distribution in T_1 and T_2 villages, compared with equivalent households of the 14 control villages. The rows in Table 4 show the difference-in-difference coefficient, DID ($T_1 \cdot \text{year}$), 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 at: (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 unconditional income transfers on all households (T_1), and then examine transfers targeted at the poorest households (T_2).

The results in Table 4 suggest that universal 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.

Irrespective of their position in the village income distribution, all adults in T₁ villages saw a decrease in their probability of consuming chicha. The results also suggest that adults in households at the top 80% of the village income distribution increased their probability of consuming coca. The change was mostly driven by a substantial increase in the probability of consuming coca of adults in Q₂, 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: T₁·Year = 1.89, $p = .50$; regression not shown. Interestingly, people in Q₂ saw a 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 income transfers, particularly among those at the top 40% of the village income distribution (Q₄-Q₅). 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 WHZ. People in treated households in T₂ villages (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. Compared with their income peers in the control group, adults in the bottom 20% of income distribution in T₂ villages also had an average increase of 6% ($p = .02$) and 8% ($p = .06$) SBP and DBP..

Attrition

To test for attrition bias, we used 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) (supplementary material, Table S.2). Most interaction terms were not significant at $p < .10$, suggesting that attrition was most likely random.

To summarize, income transfers increased by about 30% the perceived stress of participants in households at the top 80% of the village income distribution in T₁ and T₂ villages (Table 3). The increase was most marked among the richest 40% of households (Table 4). In T₁ villages there was an increase in the odds of consuming coca and a reduction in the odds of consuming chicha (Tables 3 and 4). 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 4). In T₂ villages, the transfers also increased the WHZ of children in 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 SBP and DBP. Overall, the results suggest that transfers affected measures of self-reported and objective health and traditional substance consumption mostly from relative income effects. The relative income effects were bigger for better-off households.

5. Discussion

Interventions in T_1 and T_2 villages were designed to test absolute and relative income effects respectively. With both an increase in available income (T_1) and a decrease in village inequality (T_2), we expected improvements in individual health; however, the results differed from our expectations. We begin the discussion with our study hypotheses for clarity, and follow with spillovers, attenuating factors, and limitations of the trial.

5.1. Absolute income (T_1 villages)

In villages where all households received transfers (T_1), we found an increase in stress among adults in the better off-households, along with indications of increased work efforts. This was suggested by an increased consumption of coca (consumed when doing intense physical work) and a reduction in the consumption of chicha (an indicator of meaningful social interactions). The evidence for increases in physical work was stronger among adults in households right above the bottom 20% of the village income distribution (Q_2), who substantially increased their probability of consuming coca and decreased their body fat. Because of the decreasing marginal utility of income, income transfers in T_1 villages probably represented a bigger change in the well-being of people in the poorest households than among the better-off.

The increase in the total village food supply may have also led to a temporary, more efficient reallocation of work, substituting farming and foraging activities with cash-income work. 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 T_1 villages. However, 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%. We can also rule out that Tsimane' used the windfall income from the trial to buy coca, as we would have seen a substantial increase in the odds of consuming coca among the poorest 20% of T_2 .

Do these results suggest that the transfers had no absolute income effects on health? Probably not. If interventions increased everyone's stress in T_1 and T_2 villages, the poorest 20% of households might have seen their stress reduced by the transfers to a level that was undistinguishable from baseline. In T_2 villages transfers were given only to households at the bottom 20% of the village income distribution. Likewise, the transfers might have affected households at the bottom of the village income distribution in T_1 villages due to the decreasing marginal utility of income. This interpretation is in agreement with the results from a recent RCT in Kenya (Haushofer and Shapiro, 2013) that gave much bigger (US \$404-US\$1520) unconditional income transfers to households and found a decrease in participants' stress, with larger effects for bigger transfers (the trial measured perceived and objective stress, based on cortisol levels).

5.2. Relative income (T_2)

We also saw an increase in stress among adults in better-off households in T_2 villages. While we did not observe significant changes in the consumption of coca or chicha, 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 wealth and Spanish fluency for adults in the better-off households in T₂ villages. Because adult Tsimane' mostly 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 of increased work efforts among adults in better-off households.

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, Tsimane' may have interpreted the transfers in T₂ villages 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% of the 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, transfers in T₂ villages also had negative absolute income effects on health. Tsimane' who received the transfers (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 saw a large increase in wealth but no increase in Spanish skills (Saidi et al., 2013). Considering that we observed no changes in the consumption of coca or chicha among adults in this group, the observed negative effect on health may have been caused by less physical activity and changes in diet, for example, a decrease in dietary quality.

Why would social comparisons be important in a tightly-knit society? Traditional Tsimane' communities consisted of 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, 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. Also, Tsimane' have various norms of sharing and reciprocity; while households share food when stocks dwindle, Tsimane' also have a less generous side. Tsimane' are more likely to share traditional assets than assets acquired in the market, are less likely to share raw than cooked food, and may turn their backs while eating to avoid sharing (Ellis, 1996, Undurraga et al. 2014b). If sharing occurs mostly within extended families and social comparisons occur more intensively between extended families within a village, our findings should come as no surprise.

5.3. Spillovers and attenuating factors

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. A 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, but we saw almost no effects on anthropometric indicators of nutritional status (WHZ, body fat). The impact of the transfers on nutritional status may have been limited 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.

Our results suggest that unconditional transfers affected health, albeit not in the direction expected. This raises questions on whether other transfer schemes would have achieved desired improvements in health, such as conditionality, transferring money rather than in-kind income, or using larger or more frequent transfers. Conditional transfers apparently 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. Unconditional transfers are less expensive, less demanding to implement, and less patronizing than conditional-income transfers (de Brauw and Hoddinott, 2011).

The use of in-kind transfers instead of monetary income may have also attenuated the results. Hidrobo et al. (2014) compared the effects of conditional in-kind, vouchers, or income transfers in food assistance programs in Ecuador. While the three transfer schemes improved the quality and quantity of food consumed, food transfers resulted in larger increases in calories and vouchers led to larger improvements in dietary diversity. Voucher schemes to improve health outcomes have also shown promising results in developing countries (Bellows et al., 2011). However, studies in Mexico have found no differences in health and nutritional outcomes between cash and in-kind transfers to households (Cunha, 2010; Skoufias et al., 2008), as one would expect in 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 relates to the use of a one-time income transfer as opposed to a repeated or 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.

5.4. Limitations

Our study has some limitations. The resource constraints in this pilot study limited the number of communities and the transfers to one-time transfers rather than repeated changes

in income. The requirement of the Tsimane' Council for participating in the study that all households received something means that the estimated treatment effects are underestimates of the true treatment effects because they refer to the difference between the treated and the controls, and the latter also received small transfers. 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 T_1 in the amount of rice produced. Also, we only measured short-term effects of the income transfers. Because the effect of inequalities are likely to build-up over time, we may have seen different results with a longer follow-up. The conditions of the Tsimane', while reducing possibly important cofounders, may also limit external validity. Despite these limitations the definite strengths due to randomization of absolute and relative income at community levels leads to definite contributions to the literature that previously had relied on observational data.

6. Conclusions

Our study produced several noteworthy results. We found suggestive evidence of psychosocial paths through which changes in income affect health indicators. The income transfers increased perceived stress among the better-off. This 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 T_1 villages, and an increase in wealth and Spanish fluency among the better-off households in T_2 villages (Saidi et al., 2013), is suggestive of increased work efforts among households at the top of the income distribution. These findings highlight the importance of social comparisons and preferences for rank preservation, even in a relatively egalitarian society, in line with conclusions from previous studies (Ferrer-i-Carbonell, 2005; Luttmer, 2005). We found some support for the absolute income hypothesis. The transfers may have protected only the poorest households from perceived stress. We also found that the biggest income transfers (to households at the bottom 20% of the village income distribution in T_2 villages) decreased the probability of reporting good health and increased blood pressure, possibly due to changes in diet from increased wealth. Last, 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 status preservation as a possible path by which inequality affects health.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Fig. 1.

Map showing the study area and the distribution of Tsimane' villages in the panel survey (Department of Beni, Bolivia). **NOTES.** – The shading of the territory denotes 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 location of the 13 villages in the TAPS panel study (2002–2010). RCT denotes randomized control trial; black dots show the approximate location of the 40 villages included in the trial. Tsimane' territory is an administrative division that does not necessarily reflect the lands inhabited by the Tsimane'.

Fig. 2.

Summary of the experimental design. *NOTES.* – 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 (see supplementary material).

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	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).	1041	6.91	6.77	1078	7.96	6.42
Health	Self-reported health status: How is your health now? 1: poor or bad; 2: ok or good; 3: very good (all participants).	2496	2.04	.40	2468	2.03	.40
Systolic	Average of three measures of systolic blood pressure [mmHg] (adults 60 yrs old).	883	113.84	11.62	926	114.85	12.01
Diastolic	Average of three measures of diastolic blood pressure [mmHg] (adults 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 [%]. Total weight of fat derived from the sum of 4 skinfolds using the Durnin–Womersley equations (adults 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)	1081	.25	.43	1092	.24	.43
Chicha	Indicator variable, 1: participant consumed <i>chicha</i> during the seven days before the day of the interview (adults)	1081	.34	.47	1092	.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). Covariates included participants' age (mean: 19.1; standard deviation: 17.9 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 h).

^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. The number of observations vary between variables because they include different age groups.

Table 2

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

<i>Specific.</i>	<u>Stress</u>	<u>Health</u>	<u>SBP</u>	<u>DBP</u>	<u>WHZ</u>	<u>Body fat</u>	<u>Coca</u>	<u>Chicha</u>
	<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	2080	4908	1717	1717	1861	1379	2173	2173

Notes

All regressions included robust standard errors (in parentheses) adjusted for clustering at the village level and the following covariates 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 (spec.) 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.

p < .01

**
p < .05

*
p < .10.

^aThe *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: .55).

Table 3

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.

Specification	<u>Stress</u>	<u>Health</u>	<u>SBP</u>	<u>DBP</u>	<u>WHZ</u>	<u>Body fat</u>	<u>Coca</u>	<u>Chicha</u>
	<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	2080	4908	1717	1717	1861	1379	2173	2173

Notes

Same notes as in Table 2, except: 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 *T₂-Year-Bot20* is the triple difference estimate of the second treatment, assuming there are no spillover effects; *T₁-Year-Bot20* shows the effects of universal transfers on households at the bottom 20% of the village income distribution.

p < .01

**
*p < .05

*
p < .10.

Table 4

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	Stress	Health	SBP	DBP	WHZ	Body fat	Coca	Chicha
	<i>Specific.</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>
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)

Notes

Same notes as in Table 2, except constant term in ordered logit regressions. Regressions only include the sample of households in the quintile indicated on the left column.

p < .01

**
p < .05

*
p < .10.