Inter-generational correlations of "wealth" measures among Tsimane Amerindians of Bolivia

1. Background

Tsimane are mostly a subsistence-based society of forager-horticulturalists with fairly minimal market interactions with the cash economy. In general, there is very little accumulated "wealth" among Tsimane. Nonetheless, exploratory examinations of wealth (as defined by imputed annual rice production, income, household possession of traditional and modern assets) in 511 households from 59 villages did reveal Gini coefficients ranging from 0.28 for household wealth to 0.54 for income (Godoy et al. 2004). No consistent, robust associations were found to show that wealthier communities located closer to the market saw more inequality.

Traditionally, horticultural fields of plantains, rice, corn and manioc are fairly small and are left to fallow after several years, with new fields created based on availability, and then ownership is based on usufruct. In acculturated villages, fields are usually larger because rice is sold as a cash crop. Mobility was more common a generation ago, and with high fertility (TFR=10), extended families are often spread across numerous communities (62% of 729 adults ranging from 17-80 years old were born in different communities than where they were living when interviewed 2002-2005). Other items of value include shotguns and rifles, axes, radios, watches, bicycles and dugout canoes. After death a person's belongings are usually burnt or buried with the person, although expensive durable items, like shotguns are passed down to a relative (usually a son). Another source of wealth includes domesticated animals such as chickens, ducks, and in some rare cases, pigs and cows. Poultry are used for consumption, and sometimes for trade. Pigs and cows are used for barter and also for consumption during festivals.

For most traditional Tsimane, wealth is somatic. It is food stored in human bodies, channeled into growth, reproduction and immune function (the Tsimane are non-contracepting). A wealthy Tsimane is healthy, well-fed and fertile. Below, I outline wealth variables in several macro-domains: somatic, household wealth and skills. Overall, I expect the intergenerational correlations to be fairly small, especially for fertility. Fertility and body size correlations across generations may be undermined by the number of siblings competing over the same food resources that affect body size and fertility. Future analyses will attempt to control for these effects.

2. The sample

There are over 8,000 Tsimane living in over 50 villages. Our sample covers a census population of over 2,500 individuals living in 18 villages. The sample includes three large acculturated communities located close to market (San Miguel, Tacuaral, La Cruz), where a greater percentage of individuals speak Spanish, have received formal education and trade agricultural products in town. The other communities are smaller and located in more remote regions along a major river and in interior territory near small tributaries (RIVERINE: Cachuela, Cosincho, Munday, Anachere, Donoy, Catumare, Emeya, Boreyo, Fatima; FOREST: Aperecito, Uishiricansi, Campana, Nuevo Mundo, Moseruna, Jamanchi 1). For this initial investigation, we do not stratify our sample by geographical region.

3. Description of Dataset

All analyses were done using SAS v. 9.1 with REG procedure. Using SURVEYREG procedure we were able to control for parent "clusters". These only increased the standard errors a small amount, and did not change any of the qualitative conclusions (or quantitative beta estimates). For brevity, these additional analyses that take into account the non-independence of offspring from the same parent are left out of this memo. For this amended memo, all regressions have the following format: $w = \beta*\log w_p + a_1*age_p + a_2*age_p^2 + a_3*age + a_4*age^2 + a_5*\log w_p*(age\text{-}ref)$, where ref is the mean age of offspring in the respective sample. [NOTE: so far, this has only been applied to the fertility analyses]

4. Somatic "Wealth"

4.1. ***Body size****:*

We use some simple measures of body size, **height** (in cm) and **weight** (in kgs), as well as **BMI** (wt/ht^2). Future work will focus on anthropometric measures (sum of subscapular, suprailiac, tricep, biceps) to examine body fat. These data are routinely collected on over 2,500 individuals at least once per year since 2002 (coverage is usually about 80% of a community during each visit). Where multiple measurements exist for the same individuals, we choose the most recent measurement. We attempt two types of comparisons for intergenerational correlations: 1) between same-sex adults (defined as older than 18) and 2) between same-sex parent-offspring dyads where offspring body size measurements are z-scores based on age-sex controlled comparisons based on WHO international standards from Epi Info software (offspring defined as ages 10-18). (understandably parental and offspring wealth measures are no longer in the same units…) In order to take the logarithm of z-scores≤0, the value of 6 was added to each z-score. For increased comparability we also ran a regression on log parent and offspring values, controlling for parental and offspring age and age2 terms, sex, and a sex*age interaction term. The β from this regression is reported in the summary table at the end of the memo.

SAME SEX ADULTS

4.1.1. Descriptive statistics

Fathers & Adult Sons (22+) Anthropometry

Variable	Label	N	Mean	Std Dev	Minimum	Maximum
Altura	Altura	117	163.1452991	5.4160759	148.6000000	177.8000000
Peso	Peso	117	61.4452991	6.6624720	44.3000000	80.4000000
PadreAltura	PadreAltura	117	160.2683761	4.6474066	145.0000000	170.1000000
PadrePeso	PadrePeso	117	59.0914530	7.6566916	41.3000000	81.3000000

4.1.2. Father-son adult dyads Regressions

Father-son height correlation LOGGED, r^2=0.040, n=117

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	1	3.92936	0.53015	7.41	<.0001
lPadreAltura	1	0.22944	0.10443	2.20	0.0300

Father-son weight correlation LOGGED, r^2=0.055, n=117

<table>
<tr><th>Variable</th><th>DF</th><th>Parameter Estimate</th><th>Standard Error</th><th>t Value</th><th>Pr > |t|</th></tr>
<tr><td>Intercept</td><td>1</td><td>3.33120</td><td>0.30356</td><td>10.97</td><td><.0001</td></tr>
<tr><td>lPadrePeso</td><td>1</td><td>0.19189</td><td>0.07454</td><td>2.57</td><td>0.0113</td></tr>
</table>

4.1.3. Descriptive statistics

Mothers & Adult Daughters (22+) Raw Anthropometry

Variable	Label	N	Mean	Std Dev	Minimum	Maximum
Altura	Altura	155	150.5787097	4.2758000	139.0000000	160.0000000
Peso	Peso	155	53.4903226	8.0961573	37.0000000	88.7000000
MadreAltura	MadreAltura	155	149.7516129	4.5545376	138.6000000	161.2000000
MadrePeso	MadrePeso	155	50.6741935	7.9608934	35.5000000	75.4000000

4.1.4. Regressions

Mother-daughter height correlation LOGGED, r^2=0.053, n=155

<table>
<tr><th>Variable</th><th>DF</th><th>Parameter Estimate</th><th>Standard Error</th><th>t Value</th><th>Pr > |t|</th></tr>
<tr><td>Intercept</td><td>1</td><td>3.94347</td><td>0.36787</td><td>10.72</td><td><.0001</td></tr>
<tr><td>lMadreAltura</td><td>1</td><td>0.21376</td><td>0.07345</td><td>2.91</td><td>0.0041</td></tr>
</table>

Mother-daughter weight correlation LOGGED, r^2=0.083 (no pregnant women included), n=155

<table>
<tr><th>Variable</th><th>DF</th><th>Parameter Estimate</th><th>Standard Error</th><th>t Value</th><th>Pr > |t|</th></tr>
<tr><td>Intercept</td><td>1</td><td>2.92254</td><td>0.28101</td><td>10.40</td><td><.0001</td></tr>
<tr><td>lMadrePeso</td><td>1</td><td>0.26742</td><td>0.07175</td><td>3.73</td><td>0.0003</td></tr>
</table>

SAME SEX adult-teen (age 10-18) dyads

4.1.5. Descriptive Statistics

Fathers (Raw) & Juvenile Children (Z-Scores, 10-18)
All cases >5, <-5 z-score omitted.

Variable	Label	N	Mean	Std Dev	Minimum	Maximum
HtForAge	HtForage	369	-1.9058266	0.9943632	-4.4200001	1.1300000
WtForAge	WtForAge	369	-1.0948781	1.0843025	-4.5900002	1.6200000
PadreAltura	PadreAltura	369	163.1073171	5.8011127	145.0000000	177.8000000
PadrePeso	PadrePeso	369	63.8501355	8.3361938	42.5000000	93.2000000

4.1.6. Regressions

Father-son dyads for height correlation, LOGGED, r^2=0.0548, p=0.0001, n=369

<table>
<tr><th>Variable</th><th>Parameter DF</th><th>Standard Estimate</th><th>Error</th><th>t Value</th><th>Pr > |t|</th></tr>
<tr><td>Intercept</td><td>1</td><td>-7.23404</td><td>1.86154</td><td>-3.89</td><td>0.0001</td></tr>
<tr><td>lPadreAltura</td><td>1</td><td>1.69047</td><td>0.36544</td><td>4.63</td><td><.0001</td></tr>
</table>

Father-son dyads for weight correlation, LOGGED, r^2=0.0489, p=0.0001, n=359

<table>
<tr><th>Variable</th><th>DF</th><th>Parameter Estimate</th><th>Standard Error</th><th>t Value</th><th>Pr > |t|</th></tr>
</table>

Intercept	1	-0.18433	0.40255	-0.46	0.6473
lPadrePeso	1	0.42115	0.09699	4.34	<.0001

4.1.7. Descriptive Statistics

Mothers (Raw) & Juvenile Children (Z-Scores, 10-18)

Variable	Label	N	Mean	Std Dev	Minimum	Maximum
HtForAge	HtForage	400	-1.8620500	0.9900112	-4.4200001	1.3000000
WtForAge	WtForAge	400	-1.0515250	1.0815256	-4.5900002	1.7900000
MadreAltura	MadreAltura	400	150.8030000	4.4236425	135.0000000	165.5000000
MadrePeso	MadrePeso	400	53.7517500	9.1253151	35.8000000	89.3000000

4.1.8. Regressions

Mother-daughter dyads for height correlation, LOGGED, r^2=0.0298, p=0.0001, n=400

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	1	-6.11019	2.14121	-2.85	0.0045
lMadreAltura	1	1.49538	0.42691	3.50	0.0005

Mother-daughter dyads for weight correlation, LOGGED, r^2=0.028, p=0.0007, n=400

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	1	0.56286	0.29688	1.90	0.0587
lMadrePeso	1	0.25416	0.07470	3.40	0.0007

*4.2. Parent-teen regression controlling for age, age^2, age*sex interaction*

a. Father-teen height

R Squared = .657 (Adjusted R Squared = .652)

Parameter	B	Std. Error	t	Sig.	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
Intercept	2.016	.419	4.811	.000	1.192	2.841
[Sexo=0]	.161	.032	5.030	.000	.098	.225
[Sexo=1]	0(a)	.	.	.	.	.
AnthropomEdad	.138	.014	9.705	.000	.110	.166
AnthropomAge2	-.004	.001	-7.168	.000	-.005	-.003
lPadreAltura	.350	.079	4.436	.000	.195	.506
[Sexo=0] * AnthropomEdad	-.013	.002	-5.248	.000	-.017	-.008
[Sexo=1] * AnthropomEdad	0(a)	.	.	.	.	.

4.3. Summary

All same-sex adult β coefficients for height and weight hover in the range of 0.20-0.25, with same-sex parental height explaining less than 8% of the variance in adult height of offspring. (see summary table at end of document). The β's relating parental body size and z-scores of ht-for-age and wt-for-age in teen offspring are not comparable in magnitude due to the different units for parent and offspring generation. Therefore, the β's from multiple regressions that control for age, age^2, sex and age*sex interaction

4.4. ***Fertility:***

Based on reproductive histories of over 800 adults that include total numbers of pregnancies, live births and surviving offspring for ego, parents and siblings, I create intergenerational correlations for a) **total number of live births (#tot)** and b) **total number of children who survived to age 5 (#surv)**. (Mortality rates are much lower after age 5 and restricting to age 5, instead of 15, will increase the sample size). For the analysis here, I run regressions separately for same-sex adult dyads (father-sons, mother-daughters). Offspring must be at least 45 years old to enter the analysis (people who for the most part have completed reproduction). I have done additional analysis adding the restriction that parents should also be at least age 45 (analyses not reported here, but no results differ from those reported). By adding the additional restriction on age of parents, the sample is reduced and is biased towards survivors, i.e. those having parents that lived to at least age 45. I show results with and without age controls on parent and ego.

4.4.1. Descriptive statistics

Table A2.1 Descriptive statistics on fertility variables

	WOMEN >=45					MALES >=45				
Variable	**N**	**Mean**	**Std Dev**	**Min**	**Max**	**N**	**Mean**	**Std Dev**	**Min**	**Max**
AGE	749	58.14	9.67	45	83	758	59.83	9.10	45	88
numsurv	749	8.29	2.60	1	14	758	8.90	3.38	1	21
numdead	749	1.33	1.46	0	8	758	1.47	1.59	0	8
numabort	749	0.26	0.63	0	3	758	0.22	0.65	0	4
numtot	749	9.82	2.67	2	15	758	10.55	3.90	1	22

4.4.2. Results

Table 4.4a. Mother-daughter dyads

1. Females, Total number of births, n=87, r^2=0.113

Variable	Parameter Estimate	Standard Error	t Value	Pr > |t|	Standardized Estimate
Intercept	28.81399	20.38163	1.41	0.1613	0
numtot	**0.27049**	0.13675	1.98	**0.0514**	0.24696
AGE	0.04381	0.20001	0.22	0.8272	0.18500
age2	-0.00012724	0.00172	-0.07	0.9413	-0.06109
kage	-0.92162	0.65028	-1.42	0.1603	-2.58388

Variable	Parameter Estimate	Standard Error	t Value	Pr > |t|	Standardized Estimate
kage2	0.00838	0.00513	1.63	0.1061	2.74870
numtotkage55	0.00105	0.01372	0.08	0.9391	0.02580

2. Females, Total number of births, n=87, r^2=0.07, p=0.43, LOGGED

Variable	Parameter Estimate	Standard Error	t Value	Pr > |t|	Standardized Estimate
Intercept	4.13625	3.29950	1.25	0.2136	0
lnumtot	0.24585	0.16583	1.48	0.1421	0.19271
AGE	0.00851	0.02749	0.31	0.7578	0.27067
age2	-0.00005434	0.00023592	-0.23	0.8184	-0.19661
kage	-0.10993	0.09538	-1.15	0.2525	-2.32226
kage2	0.00105	0.00068886	1.52	0.1314	2.59499
lnumtotkage55	-0.00272	0.01384	-0.20	0.8448	-0.12509

3. Females, # surviving offspring, n=87, r^2=0.076, p=.375

Variable	Parameter Estimate	Standard Error	t Value	Pr > |t|	Standardized Estimate
Intercept	18.78962	19.28109	0.97	0.3327	0
numsurv	0.08639	0.14221	0.61	0.5452	0.07778
AGE	0.04773	0.20219	0.24	0.8140	0.19933
age2	0.00006759	0.00175	0.04	0.9693	0.03209
kage	-0.59866	0.63854	-0.94	0.3513	-1.65981
kage2	0.00557	0.00517	1.08	0.2844	1.80785

Variable	Parameter Estimate	Standard Error	t Value	Pr > |t|	Standardized Estimate
numsurvkage55	-0.00567	0.01366	-0.41	0.6794	-0.11498

4. Females, # surviving offspring, n=87, r^2=0.033, p=.839 LOGGED

Variable	Parameter Estimate	Standard Error	t Value	Pr > |t|	Standardized Estimate
Intercept	4.35764	3.83532	1.14	0.2593	0
lnumsurv	-0.02638	0.18608	-0.14	0.8876	-0.01916
AGE	0.02107	0.03654	0.58	0.5658	0.50532
age2	-0.00012554	0.00031430	-0.40	0.6906	-0.34231
kage	-0.11438	0.11946	-0.96	0.3412	-1.82114
kage2	0.00102	0.00092605	1.10	0.2733	1.90298
lnumsurvkage55	-0.00111	0.01396	-0.08	0.9370	-0.03492

Table 4.4b. Father-son dyads

1. Males, Total number of births, n=100, r^2=0.067

Variable	Parameter Estimate	Standard Error	t Value	Pr > |t|	Standardized Estimate
Intercept	-17.88352	30.12872	-0.59	0.5542	0
numtot	0.04779	0.18207	0.26	0.7935	0.03637
AGE	0.51307	0.28511	1.80	0.0752	1.37841
age2	-0.00393	0.00234	-1.68	0.0960	-1.24792
kage	0.26325	0.88230	0.30	0.7661	0.48271
kage2	-0.00159	0.00699	-0.23	0.8208	-0.34351
numtotkage57	-0.00914	0.02034	-0.45	0.6544	-0.15679

2. Males, # live births, R2=0.08, p=.21, n=100, LOGGED

Variable	Parameter Estimate	Standard Error	t Value	Pr > |t|	Standardized Estimate
Intercept	-3.92163	4.80592	-0.82	0.4166	0
lnumtot	0.03092	0.20569	0.15	0.8808	0.01986
AGE	0.07230	0.04168	1.73	0.0861	1.43066
age2	-0.00052666	0.00033822	-1.56	0.1228	-1.23077
kage	0.08835	0.12446	0.71	0.4796	1.19320
kage2	-0.00044570	0.00091826	-0.49	0.6286	-0.71049
lnumtotkage57	-0.01696	0.02188	-0.78	0.4402	-0.51571

3. Males, # surviving children, n=100, r^2=0.117, p=0.067

Variable	Parameter Estimate	Standard Error	t Value	Pr > |t|	Standardized Estimate
Intercept	24.38875	24.33719	1.00	0.3189	0
numsurv	**0.42540**	0.15999	2.66	**0.0092**	0.30609
AGE	0.17788	0.22357	0.80	0.4283	0.54622
age2	-0.00154	0.00186	-0.82	0.4119	-0.55733
kage	-0.73176	0.75387	-0.97	0.3342	-1.53368
kage2	0.00478	0.00608	0.79	0.4341	1.18152
numsurvkage57	0.02282	0.01683	1.36	0.1784	0.36771

4. Same as #2 but using logged values for parent and offspring **numsurv**, r^2=0.147, n=100 LOGGED

Variable	Parameter Estimate	Standard Error	t Value	Pr > |t|	Standardized Estimate
Intercept	5.82970	5.13304	1.14	0.2590	0
lnumsurv	**0.58217**	0.23267	2.50	**0.0141**	0.28305

Variable	Parameter Estimate	Standard Error	t Value	Pr > |t|	Standardized Estimate
AGE	0.02701	0.04122	0.66	0.5139	0.44721
age2	-0.00018485	0.00034324	-0.54	0.5915	-0.36143
kage	-0.14143	0.14761	-0.96	0.3405	-1.59822
kage2	0.00057636	0.00112	0.52	0.6065	0.76873
lnumsurvkage57	0.03526	0.02146	1.64	0.1037	0.82083

4.5. Summary

The intergenerational regression estimates for **total number of live births** are not significant when considering mother-daughter or father-son dyads, after controlling for the ages of parents and offspring. The standardized (logged) version of these regressions are also insignificant. If I run a regression WITHOUT controlling for ages of parents and of offspring, then the regression estimates (having similar magnitudes of about 0.23 for females, and 0.15 for males) are statistically significant for males.

For **total number of children surviving to age 5**, regressions are similarly insignificant for mother-daughter dyads. However, they are significant for father-son dyads, both for raw values and logged values. The regression estimates for raw and logged values are 0.43 and 0.58, respectively (these are highlighted in red above). Doing analyses on father-daughter dyads does not produce any significant effects in the multiple regressions.

5. *Household wealth and income*

Household wealth interviews, done on most households in our sample, query family members about the total number of common household items owned by each nuclear family. Rarer items associated with modern forms of wealth are also included. For now, we combine domesticated animals, shotguns and rifles, other items such as watches, radios and bicycles, into one category called "household wealth", based on the buying price for these items in San Borja (1 Bs=6.4 Bs in 2002-2003). "**Produce income**" refers to the sum of money earned in the past 12 months from palm thatch roof sales, corn and rice sales. "**Wage income**" refers to all income earned in the previous 12 months. Money is usually earned working with river merchants selling palm thatch for roof panels, loggers, farm hands, (or as assistants or translators for anthropologists!) Income is derived from interview questions about the past month, and the past year. I present descriptive statistics on these three sources of income separately, and then combine the three into a single income measure.

5.1. Descriptive Statistics

MEASURES	Offspring Household	Parent's Household	Daughter Wage	Son Wage	Father's Wage	Mother Wage	Daughter Produce	Son Produce	Mother Produce	Father Produce

	Wealth (Bs)	Wealth (Bs)	Income (Bs)	Income (Bs)	Income (Bs)	Income (Bs)	Income (Bs)	Income (Bs)	Income (Bs)	Income (Bs)
N	152	135	328	328	165	189	331	338	193	165
Mean	2090	5336	33	580	6	5	205	539	188	663
Std dev	2206	4489	249	1677	40	38	432	868	356	787
Range	10084	27195	3200	10800	300	300	3750	7500	2100	3100
Maximum	10088	27195	3200	10800	300	300	3750	7500	2100	3100
Minimum	4	0	0	0	0	0	0	0	0	0

5.2. Regressions

Household Wealth

Model Parameters	**Father/Mother-Daughter (n=29)**		**Father/Mother-Son (n=59)**	
	R^2	**Beta**	**R^2**	**Beta**
Wealth	.000	-.008 P=.967	.008	.091 P=.490
Wealth **OffspringAge**	.069	-.013 P=.946 .263 P=.169	.208	.244 P=.055 .473 P=.000
Wealth **OffspringAge** **Wealth*OffspringAge**	.074	-1.526 P=.720 -.410 P=.829 1.669 P=.722	.213	1.075 P=.461 .696 P=.094 -.791 P=.567

Wage Income

Model Parameters	**Mother-Daughter (n=92)**		**Mother-Son (n=93)**		**Father-Daughter (n=85)**		**Father-Son (n=70)**	
	R^2	**Beta**	**R^2**	**Beta**	**R^2**	**Beta**	**R^2**	**Beta**
Wage income	.001	-.026 P=.797	.001	-.029 P=.790	.051	.225 P=.037	.016	.125 P=.298
Wage income	.009	-.029 P=.774	.139	-.002 P=.984	.074	.166 P=.147	.079	.020 P=.875
OffspringAge		-.091 P=.372		-.373 P=.000		-.165 P=.150		-.274 P=.033
Wage income	.009	. .	.153	1.502 P=.268	.075	.561 P=.696	.090	1.727 P=.374
OffspringAge		-.091 p=.372		-.357 P=.001		-.145 P=.278		-.229 P=.097
Wage income* OffspringAge		-.029 p=.774		-1.510 P=.266		-.390 P=.783		-1.693 P=.379

Agricultural Produce Income

Model Parameters	**Mother-Daughter (n=97)**		**Mother-Son (n=94)**		**Father-Daughter (n=89)**		**Father-Son (n=74)**	
	R^2	**Beta**	**R^2**	**Beta**	**R^2**	**Beta**	**R^2**	**Beta**
Produce income	.002	.041 P=.678	.028	.166 P=.121	.104	.322 P=.002	.065	.254 P=.028
Produce income	.004	.055 P=.596	.084	.211 P=.049	.104	.322 P=.002	.081	.271 P=.020
OffspringAge		.052 P=.617		.241 P=.025		.016 P=.871		.129 P=.260
Produce income	.009	-.678 p=.535	.106	-.960 P=.237	.115	1.587 P=.188	.136	3.152 P=.023
OffspringAge		.003 p=.984		-.028 P=.895		.207 P=.319		.399 P=.021
Produce incom* OffspringAge		.725 p=.501		1.161 P=.146		-1.279 P=.292		-2.867 P=.036

5.3. Summary of wealth measures

A low but significant intergenerational correlation was found for household wealth from parents to sons (β=0.24). Wealth is measured at the household level, so the label of "son" or "daughter" reflects the interviewee. It is unclear why parent-daughter transmission is insignificant. For wage income, there is very little intergenerational effect. Only father-daughter dyads show a significant correlation, but not in the full model. As can be seen from Table 5.1, mean parental income is fairly low, and most incomes are at zero. It seems that the few daughters who earn wages are slightly likely to have fathers who earn wages. Many more sons earn wages than daughters, and so sons' correlation with parental income is statistically insignificant. Finally, earned income from produce sales does show significant intergenerational correlations (range 0.18-0.32). This is probably because families often travel to town together and so are likely to pool their crops. However, correlations only appear significant with father's agricultural sales and not with those of mother's.

6. <u>Skills</u>
6.1. **Education**
The highest grade achieved of formal education has been recorded for many adults in the sample. Schools exist in about two-thirds of the study communities. All schools are taught by bilingual Tsimane instructors and only offer classes up to the 5th grade, but opportunities sometimes exist for some Tsimane to receive further education, either at certain villages, or on rarer occasion, in other towns on scholarship. These high school degrees are like GEDs or vocational degrees. Schooling occurs according to the following system: 1-5 grade school, 1-3 intermediate, 1-4 secondary school, and is measured as 1-12 years.

6.2. Descriptive Statistics

MEASURES	Daughter Education (yrs)	Son Education (yrs)	Mother Education (yrs)	Father Education (yrs)
N	326	325	193	162
Mean	1.08	2.13	.16	.43
Std Dev	1.83	2.89	.62	1.21
Range	12	12	4	6
Maximum	12	12	4	6
Minimum	0	0	0	0

6.3. Regressions

Model Parameters	Mother-Daughter (n=94)		Mother-Son (n=88)		Father-Daughter (n=84)		Father-Son (n=66)	
	R^2	Beta	R^2	Beta	R^2	Beta	R^2	Beta
Education	.031	.177 P=.085	.003	-.055 P=.610	.043	.208 P=.057	.053	.231 P=.061
Education **OffspringAge**	.040	.185 P=.074 -.095 P=.355	.078	.024 P=.821 -.286 P=.010	.067	.257 P=.024 .163 P=.148	.055	.238 P=.059 .041 P=.742
Education **OffspringAge** **Education* OffspringAge**	.056	1.425 P=.172 -.005 P=.969 -1.256 P=.232	.111	1.921 P=.081 -.144 P=.282 -1.949 P=.083	.074	1.869 P=.398 .177 P=.124 -1.610 P=.465	.056	-.507 P=.854 .033 P=.794 .744 P=.786

7. ***Spanish fluency***
More people speak Spanish than those who attend school. People who have worked in wage labor with loggers or as farm hands are likely to be at least minimally conversant in Spanish. Spanish speaking ability was ranked on a three-point scale (0=none, 1=little, 2=fluent), as was Spanish literacy (0=none, 1=read and write a little, 2=literate) (although literacy is highly correlated with extent of formal education).

7.1. Descriptive Statistics

MEASURES	Daughter Spanish Fluency	Son Spanish Fluency	Mother Spanish Fluency	Father Spanish Fluency
N	331	335	193	162
Mean	.71	1.20	.56	1.11
Std. Dev	.78	.72	.82	.76
Range	2	2	2	2
Maximum	2	2	2	2
Minimum	0	0	0	0

7.2. Regressions

Model Parameters	Mother-Daughter (n=97)		Mother-Son (n=93)		Father-Daughter (n=88)		Father-Son (n=71)	
	R^2	**Beta**	**R^2**	**Beta**	**R^2**	**Beta**	**R^2**	**Beta**
Spanish	.056	.237 P=.019	.020	.140 P=.179	.204	.452 P=.000	.049	.221 P=.062
Spanish **OffspringAge**	.056	.238 P=.019 -.011 P=.915	.029	.168 P=.121 -.101 P=.351	.218	.464 P=.000 .118 P=.220	.049	.220 P=.067 -.007 P=.951
Spanish **OffspringAge** **Spanish * OffspringAge**	.058	-.101 P=.920 -.036 P=.775 .344 P=.734	.067	-1.899 P=.084 -.260 P=.057 2.127 P=.059	.218	.288 P=.818 .099 P=.565 .176 P=.888	.072	-1.729 P=.253 -.269 P=.252 1.939 P=.197

7.3. Summary of human capital measures

Daughters more capable in spanish and with more formal education appear more likely to have fathers than mothers with greater abilities (see Table A1). Sons' Spanish and education achievements are only correlated with father's Spanish ability and education. Overall magnitudes of the significant correlations hover in the 0.2-0.25 range, except for father-daughter Spanish ability, which is higher (β=0.46).

8. Future Measures to Consider

8.1. ***Health:***

At least once a year, about 80% of our census sample receives a medical checkup from our medical team. There are a variety of ways to characterize the health status of individuals. Each person receives medical diagnoses (based on the International Classification of Diseases ICD-10), which could be scored as presence or absence of different macro-categories of disease. For a subsample of over 1,000 individuals, we have preliminary blood examinations that would allow us to examine sedimentation rate, red blood cell count, hemoglobin levels, and white blood cell count. On a similar sample we also analyzed stool samples for the presence or absence of over nine types of parasites.

8.2. ***Hunting, fishing, crop production***

Economic production is an obvious choice given that these are the closest equivalent to wage income in non-monetary societies. However using production measures can be problematic. Skills are highly age-dependent and so most dyads will observe individuals at different wage rates, different incentives to produce (e.g. family dependency). However, it may be possible to distinguish hunting and fishing total production from wage rates by comparing total production against production rates (total production/total number of days or hours spent in production). The sample size for dyads where both individuals are in their adult prime is likely to be small for hunting and fishing. Agricultural production is not as problematic (because it is less skills intensive), but agricultural production is largely a function of family size (and whether you engage in cash cropping). My complication with the agricultural production is that very liitle of these data are coded. Data exist as measured fields for a six village subset of the larger sample, and from field interviews done on a majority of the households in the large sample. Estimating production will require some imputing. After controlling for age differences and family dependency, I don't imagine agricultural production to show high intergenerational correlations.

TABLE A1. Summary of β estimates

Pop & sample	**Beta, Log-log**	**Father-son**	**Mother-daughter**	**Father-daughter**	**Mother-son**
Growth: adult-adult					
Height	β	.23 (.10)	.21 (.07)		
Weight	β	.19 (.07)	.26 (.07)		
Growth: adult-teen					
Height	β	.35 (.08)[a]	.25 (.09)[a]		
Weight	β	.35 (.07)[a]	.19 (.08)[a]		
Fertility					
#livebirths	β	.03 (.20) ns	.25 (.17) ns		
#surviveto5	β	.58 (.23)	-.03 (.19) ns		
Wealth					
Household[b,c]	β[d]	.24 ( )	n/a	-.01 ( ) ns	n/a
Wages[c]	β[d]	.13 ( ) ns	.25 ( )	.17 ( ) ns	-.08 ( ) ns
Produce inc[c]	β[d]	.27 ( )	.18 ( )	.32 ( )	.20 ( )
Human Cap					
Spanish[c]	β[d]	.22 ( )	.24 ()	.46 ()	.17 () ns
Education[c]	β[d]	.24 ( )	.19 () ms	.26 ()	.02 () ns

[a]Regression controls for age, age^2, age*sex; offspring here includes both sexes
[b]Interviews done at household level so parent is not exclusively father
[c]Controls for offspring age
[d]Standardized coefficient
ns=not significant; ms=marginally significant, p<0.10

TABLE A2. Additional descriptive statistics for child height and weight

BOYS

Descriptives

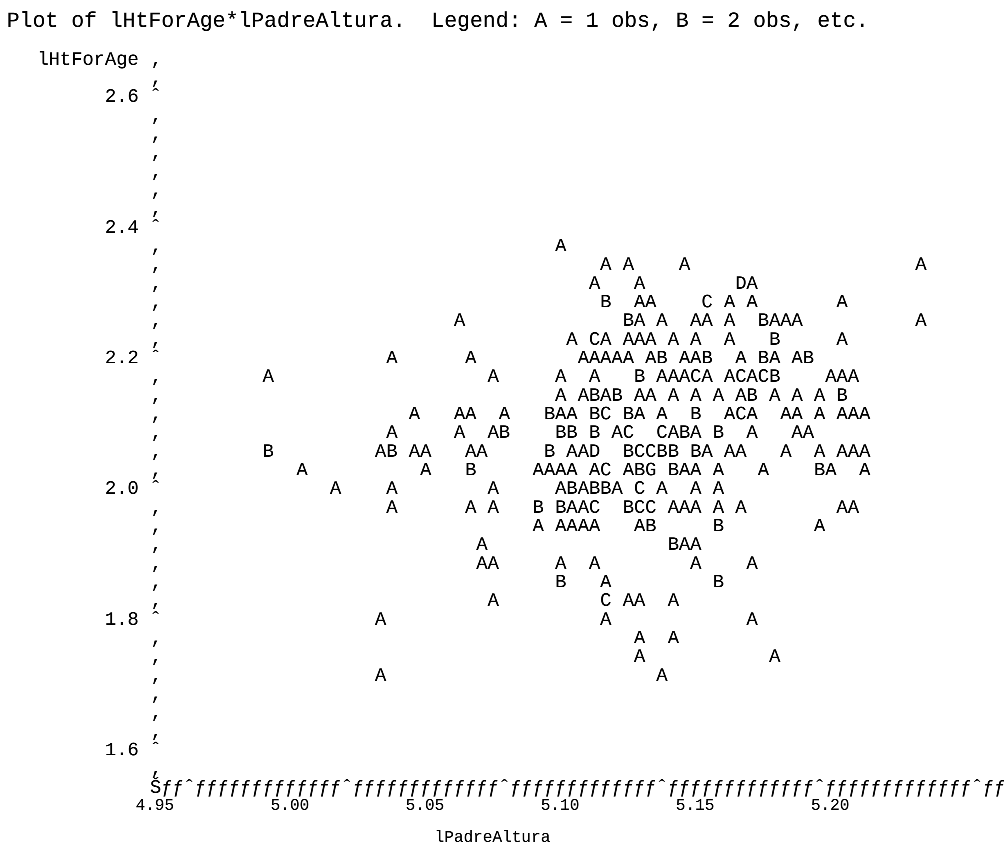
		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
						Lower Bound	Upper Bound		
Altura	10	40	125.300	7.5314	1.1908	122.891	127.709	101.6	147.3
	11	25	129.204	8.1897	1.6379	125.823	132.585	118.3	145.5
	12	35	135.306	10.4337	1.7636	131.722	138.890	110.7	155.4
	13	31	140.255	7.9437	1.4267	137.341	143.169	130.0	156.2
	14	26	149.708	7.7749	1.5248	146.567	152.848	135.0	163.3
	15	20	157.510	6.1311	1.3710	154.641	160.379	146.5	166.9
	16	19	156.737	5.4410	1.2483	154.114	159.359	149.8	167.1
	17	14	160.321	4.8240	1.2893	157.536	163.107	153.5	168.1
	18	8	155.300	9.3531	3.3068	147.481	163.119	137.5	165.2
	Total	218	141.437	14.6431	.9918	139.482	143.391	101.6	168.1
Peso	10	40	25.758	4.3544	.6885	24.365	27.150	15.3	44.5
	11	25	28.412	5.1857	1.0371	26.271	30.553	18.5	39.2
	12	34	33.882	8.2253	1.4106	31.012	36.752	20.0	58.3
	13	30	35.407	5.9508	1.0865	33.185	37.629	28.4	50.2
	14	25	44.072	7.4773	1.4955	40.986	47.158	32.3	56.8
	15	20	51.655	8.4310	1.8852	47.709	55.601	36.1	66.0
	16	19	50.742	6.9067	1.5845	47.413	54.071	42.0	67.0
	17	14	53.550	5.8692	1.5686	50.161	56.939	42.9	62.3
	18	8	53.763	11.4400	4.0447	44.198	63.327	30.5	67.0
	Total	215	38.296	12.1749	.8303	36.659	39.932	15.3	67.0

Girls

Descriptives

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
						Lower Bound	Upper Bound		
Altura	10	30	126.810	7.1355	1.3027	124.146	129.474	113.5	140.4
	11	24	131.562	8.8392	1.8043	127.830	135.295	114.8	149.0
	12	36	139.394	7.9743	1.3290	136.696	142.093	117.6	152.6
	13	21	145.281	5.6384	1.2304	142.714	147.848	131.6	159.6
	14	29	146.545	5.4758	1.0168	144.462	148.628	134.1	156.3
	15	18	149.600	3.5701	.8415	147.825	151.375	144.2	156.5
	16	22	147.945	9.9271	2.1165	143.544	152.347	119.0	169.9
	17	17	148.871	4.7425	1.1502	146.432	151.309	140.6	157.4
	18	13	150.885	3.5404	.9819	148.745	153.024	146.2	159.6
	Total	210	141.527	10.7107	.7391	140.070	142.984	113.5	169.9
Peso	10	30	27.090	4.1477	.7573	25.541	28.639	20.8	37.1
	11	24	30.513	8.4568	1.7262	26.942	34.083	20.3	57.0
	12	36	36.411	7.2990	1.2165	33.941	38.881	22.9	55.9
	13	21	43.310	6.9242	1.5110	40.158	46.461	31.9	56.6
	14	29	46.793	8.7085	1.6171	43.481	50.106	28.5	71.8
	15	18	48.667	7.6521	1.8036	44.861	52.472	34.6	64.8
	16	22	46.455	8.3279	1.7755	42.762	50.147	22.3	60.9
	17	17	49.035	6.0721	1.4727	45.913	52.157	40.7	61.8
	18	13	53.962	5.0863	1.4107	50.888	57.035	44.5	60.7
	Total	210	40.740	11.0913	.7654	39.231	42.249	20.3	71.8

FIG. Father-son height correlation, where son values are z-scores, 10-18 yrs old. Beta=0.84, s.e.=.18, p<0.0001, r2=.059.



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