



Physical stature of adult Tsimane' Amerindians, Bolivian Amazon in the 20th century

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Abstract

We examine the association between exposure to the market and Western society on the height of adult Tsimane', a foraging-farming society in the Bolivian Amazon. As with other contemporary native peoples, we find little evidence of a significant secular change in height during 1920–1980. Female height bore a positive association with own schooling and fluency in spoken Spanish and with maternal modern human capital (schooling, writing ability, and fluency in spoken Spanish), but male heights bore no association with parental height or with modern human capital. The absence of a secular change likely reflects the persistence of traditional forms of social organization and production that protect health.

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1. Introduction

As a barometer of personal well-being, adult physical stature responds to socioeconomic upheavals produced by changes in modes of production and in forms of social organization (Bogin and Keep, 1999; Steckel and Rose, 2002; Komlos, 1994, 1998; Fogel, 2005). For instance, archaeologists have found examples in which physical stature initially declined as people shifted

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from a foraging to a more sedentary farming lifestyle (Larsen, 1995, 2002; Steckel, 2003; Steckel and Rose, 2002; Salzano, 1990). Economic historians have found that during the transition to industrialization in the nineteenth century, the physical stature of city dwellers and people of low socioeconomic status declined in Europe, Japan, and in the USA (Komlos, 1994; Haines, 2004; Arora, 2005). The decline was brief, and the long-run economic prosperity of industrial nations has produced significant increases in physical stature over the last 150 years in those nations (Bielicki, 1986; van Wieringen, 1986; Eveleth and Tanner, 1990).

Despite our increasing understanding of secular trends in physical stature over broad swaths of time and space (Prince, 1995; Bogin, 2001; Bogin and Rios, 2003; Steckel, 1995; Komlos, 1994; Haines, 2004; Dufour et al., 1994), we know little about whether the physical stature of contemporary highly autarkic native peoples changes as they enter the market economy. Past research yields equivocal guidance about what to expect.

1.1. Decline in physical stature

Anthropologists find that contemporary foragers often enjoy adequate nutrition and general health (Froment, 2001; Eaton and Eaton, 1999). Some have hypothesized that changes in lifestyle from exposure to the market economy and Western society lower the quality and the level of foods consumed by foragers, thus eroding their general health and, it would follow, their physical stature (Wirsing, 1985). Shephard and Rode draw on longitudinal information from Inuit males and females 65 years of age and find that between 1970 and 1990 males lost 2.1 cm and females lost 0.4 cm on average in physical stature (Shephard and Rode, 1996). They attribute shrinking among males to the vertebral compression associated with the use of snowmobiles, and among females to lower consumption of Vitamin D, increased reliance on a jejune diet, reduced exposure to sunlight, and to the decline in the practice of carrying children on the back, that may have reduced the likelihood of developing osteoporosis. But counterbalancing the finding from the Inuit, one finds evidence from Asia, Africa, and other parts of the New World, including the arctic (Zammit et al., 1993; Jamison, 1990), showing that exposure to the market economy bears tenuous links to physical stature. Some have questioned the notion that ‘affluent’ modern foragers consume an ideal diet (Wilmsen, 1989).

1.2. Increase in physical stature

Leonard et al. (1996) estimated secular trends in physical stature for a period covering 90 years for a sample of 241 female and 273 male herders in Siberia. After correcting for the loss of physical stature from aging, they found that average adult physical stature had increased by 1.6 cm/decade among males, and that it had remained constant among females. They found that males 18–29 years of age were seven cm taller than males over 50 years of age, and six cm taller than their age peers from the late nineteenth century. Nicholas et al. (1998) estimated secular trends (1890–1955) in physical stature among indigenous peoples in Australia and found an improvement among females and no change among males. In contrast, Barrett and Brown (1971) found an increase in physical stature during the twentieth century among Australian aborigines of the Northern Territories.

In the Nuñoa district of the southern Peruvian highlands, researchers (Leatherman et al., 1995; Carey, 1990) found that adolescent boys and girls measured in the 1980s were much taller than their counterparts of the 1960s. In Nuñoa Leonard et al. (Leonard, 1989; Leonard et al., 1990) found that among children of the 1980s, there was evidence of secular trends in growth of

physical stature, but only among wealthier households, which had more adequate diets than poor ones. In Oaxaca, Mexico, Zapotec Amerindians have experienced significant increases in physical stature since the 1960s (Malina et al., 2004; Dittmar, 1998). Laure (1991) measured the physical stature of 29 adult female and 25 adult male Mojeño Amerindians in the Bolivian Amazon and found that they had grown taller by 2.5 cm during the last three generations.

1.3. No change in physical stature

During 1984–1985, Prazuck et al. (1998) measured 2158 males 20–50 years of age from different ethnic groups in rural Mali, West Africa, and found no change in physical stature compared with a sample of males measured a century earlier. Stinson (1989) presents historical evidence from Chachi Amerindians of Ecuador and shows no change in physical stature over the previous 77 years. Dangour (2003) measured the physical stature of adults in two Amerindian populations of Guyana and found insubstantial trends in physical stature. Among the Xavánte Amerindian of the Brazilian Amazon, Coimbra et al. (2002) compared the physical stature of adults 20–50 years of age between 1962 and 1990 and saw no change. In Nuñoa, researchers found small differences in adult physical stature between the 1960s and the 1980s (Leatherman et al., 1995; Carey, 1990).

The ethno-historical record from North America Indians lends further support to the finding of no salient change in adult physical stature among native peoples despite exposure to Westerners. Prince (1995) estimated secular trends in physical stature for the equestrian Sioux plain Indians of the nineteenth century and found no change despite their immurement in reservations. He attributes the absence of a decline to government transfers, which might have included adequate levels of animal protein. Steckel and Prince (2001) hypothesize that the exceptional physical stature of the Sioux reflected a rich and varied diet, resilience in adversity, a light disease load (other than epidemics), and the supportive role of local social capital.

1.4. Explanation for absence of strong adverse secular trends

What accounts for the wide variation in how exposure to the market economy and national society influences physical growth? If transmutations in modes of production and social organization in a historical context could be associated with a reduction in physical stature (Komlos, 1998), why would the expansion of a market economy not be associated with similar outcomes among contemporary native peoples? One would expect large associations because native peoples are underlings in the national socioeconomic ladder (Patrinós, 1994) and such people are most affected in physical growth during adversity. Several possible explanations come to mind.

In contrast to the past, market exposure among contemporary native peoples might not be associated with changes in physical stature because economic development at present often comes with modern health services.¹ Indeed, growth stunting during early childhood development often stems from infectious diseases, which limits nutrient absorption and raises nutritional needs. Consequently, even in the face of dietary stability or decline, access to modern health services could improve physical growth by reducing the metabolic burden of infectious diseases (Pelletier et al., 1995; Campbell et al., 2003; Solomons et al., 1993).

¹ On the methodological side, failure to correct for age-related shrinking in physical stature for people over 30 years of age and random errors measuring age would enhance the likelihood of detecting no change in secular trend in physical stature.

Moreover, exposure to the market economy today likely goes *pari passu* with the accumulation of modern human capital, which has direct and indirect associations with physical stature. Modern human capital includes formal schooling, academic skills (e.g., writing, reading, math), and behaviors learned in school (e.g., punctuality). Improvements in parental modern human capital should increase earnings and, through earnings, the food consumption of children. Parental modern human capital would also ease access to modern health services and expand knowledge about modern health and nutritional practices—knowledge that parents could use to improve the health and nutrition of their children.

In addition, if rural markets for credit and labor work well, then exposure to the market economy might make it easier for people to smooth food consumption. Recent reviews of the ethnographic, biological, and archaeological record of foragers suggest that foragers often enjoy adequate but variable levels of food consumption. That is, they might suffer from marked seasonal and inter-annual changes in food consumption. Such variability would limit human growth during the lean seasons (Jenike, 2001; Panter-Brick et al., 2001). Improvements in the rural labor and capital markets that accompany economic development (Ray, 1998) should increase food security, making it easier for native peoples to maintain adequate food availability when idiosyncratic or covariant mishaps strike. More efficient, flexible forms of protecting food consumption would substitute for traditional forms of social capital, such as gift-giving and generalized reciprocity, that in the past might have cushioned health. Furthermore, changes in work and activity levels frequently associated with economic development may reduce energy demands.

Last, as Steckel and Prince observe based on their reading of the Sioux evidence, exposure to the market economy might bear no association with changes in physical stature if native peoples are sheltered with their local social organization, subsistence, and social capital.

In sum, the sign of the association between exposure to the market and secular trends in adult physical stature among contemporary native peoples will depend on the offsetting boons and curses of the lifestyle changes that come with such exposure. Here, we contribute to studies of secular trends in adult physical stature and try to answer the riddle posed by analyzing how exposure to the market and lifestyle changes during 1920–1980 affected the adult physical stature of a contemporary highly autarkic native society. We analyze information from Tsimane' Amerindians, a society of hunters, gatherers, and horticulturalists in the Bolivian Amazon which has been in continual contact with Westerners since the middle of the twentieth century.

2. Sample and methods

Information comes from two cross-sectional waves of data collected from Tsimane' over 20 years of age in the department of Beni. During each wave we used a questionnaire and took anthropometric measures. In 2000, we collected information from Tsimane' in 59 villages; in each village we selected at random 8–12 households and in each household we selected at random either the female or the male head of the household to take anthropometric measures and to answer survey questions. In 2004, we surveyed and took anthropometric measures of all people (242 females, 242 males) in 13 of the 59 villages surveyed in 2000. To arrive at the final sample, we dropped from the first survey of 2000 any of the 13 villages that we surveyed again in 2004. The 46 remaining villages of the 2000 survey yielded a sample size of 377 people (202 females, 175 males). Because the two waves of data collection took place only 4 years apart, and such a short time does not affect secular changes in growth, for the regressions we pool information from the two waves, ensure villages appear only once, and include a dummy variable for the year

of the survey. The final sample from the two survey waves included a total of 861 participants (444 females, 417 males).

2.1. *Physical stature*

We took two steps to estimate secular trends in adult physical stature from the cross-sectional information. First, we estimated and compared mean adult physical stature by birth decade (1920–1980) for females and for males. Though adequate as a first cut, the approach does not allow one to control for unmeasured personal or household heterogeneity or for biases from selective mortality.

To overcome the shortcoming, during the 2004 survey we asked participants whether they were taller, shorter, or the same physical stature as their mother or their father. The second step allows one to compare the physical stature of the adult whose physical stature we measured with the physical stature of their same-sex parent even if their same-sex parent was not in our sample. It has obvious faults common to any study of health that relies on self-assessed measures (Thomas and Frankenberg, 2005). It allows one to detect only the direction—not the amount—of change in physical stature. Furthermore, people shrink in physical stature after about 30 years of age. The age of the parent that participants had in mind as they compared their parent's physical stature with their own physical stature would introduce random measurement errors. When they answered the question about their parent's physical stature, some participants may have had in mind a young and tall parent whereas others may have had in mind an older and shorter parent.

We used the protocol of Lohman et al. (1988) to measure physical stature. We recorded physical stature (standing height) to the nearest millimetre using a portable stadiometer or a plastic tape measure. We used the Trotter and Glesser (Trotter and Glesser, 1951) correction of 0.06 cm/year for age-related decline in physical stature for people over 30 years of age. We found evidence of heaping in measures of physical stature. Measures of physical stature ending in the digits zero or five occurred with the most frequency (~15%), and those ending in the digits one, eight, or nine occurred with the least frequency (~7%).

2.2. *Age*

We asked participants for their age. Information on age contains random measurement errors because most people did not have a birth certificate so they guessed when answering. The measurement error of age is not unique to the Tsimane'. Measures of age contain random rather than systematic measurement errors. In 2001, we asked 4657 people for their age or the age of their children, and recorded the date of the interview. We returned about a year later for another survey, and asked the same people the same question even though we knew their age had increased by about 1 year. Since we recorded the date of the first interview in 2001, we could estimate the elapsed time from the first interview in 2001 to the second interview in 2002. Only 20% of participants reported their age consistently between the two interviews. Consistency does not guarantee accuracy since people may have guessed their age the first time, and stuck to that estimate in the second interview. A quarter of the sample reported an age that represented an increase of more than a year and a half; for example, a participant who had reported being 20 years old in June 2001 would have reported being 21 years and 6 months old in June 2002. Fifty-five of people reported an age that represented a decrease of more than 6 months. The evidence would therefore suggest that the age variable contains random rather than systematic measurement errors—some people overestimated and others underestimated their age.

For the analysis we include only people over 20 years of age because people grow very little thereafter (Bogin, 1999), and because 20 years is a standard age for a lower threshold in studies of secular trends in adult physical stature.

2.3. *Modern human capital: Schooling and competence in spoken Spanish*

We measured two forms of own modern human capital: the highest school grade reached and competence speaking Spanish, the national language in Bolivia. To increase accuracy in the measure of spoken language competence, we did not rely on participant's own assessment. Instead, surveyors judged participant's ability to answer survey questions in Spanish and coded participant's competence as follow: 0 = unable, 1 = with difficulty, and 2 = fluent. To make easier the interpretation of results, we lumped the three answers into one dummy variable, which took the value of one if the participant spoke any Spanish, and zero if the participant was monolingual in the Tsimane' language. To obtain information about the human capital of the participant's parents, we asked participants about the school attainment, writing skills, and competence in spoken Spanish of their mother and father. The variable maternal modern human capital took the value of one if the mother spoke any Spanish, could write, or had completed at least 1 year of school; the variable took the value of zero if the mother had no modern human capital. We coded paternal modern human capital in the same way we coded maternal modern human capital.

3. History of Tsimane' exposure to the market economy

In an earlier publication in this journal (Godoy et al., 2005a) we provide general historical and ethnographic information on the Tsimane', so we limit the discussion of this section to selected aspects of Tsimane' history and ethnography that could have affected secular trends in adult physical stature that we have not discussed before. The aspects include small size and mobility of settlements, diet, history of contact with Westerners, village income inequality, local social capital, and modern human capital (Steckel and Prince, 2001).

The Tsimane' number 8000 people and live in 100+ villages scattered along river banks and logging roads. Villages are small and contain an average of 24 households (S.D. = 10.8); each household has 7.3 people (S.D. = 2.6) made up of 1.1 adult females (S.D. = 0.4) and 1.1 adult males (S.D. = 0.4).

Like other native Amazonian societies, Tsimane' practice cross-cousin marriage (Daillant, 1994); a man marries his mother's brother's daughter. Residence is with the wife's kin group shortly after marriage, followed by neolocal or independent post-marital living arrangement, neither with the husband's nor with the wife's relatives (Reyes-García, 2001). Polygynous in the past, the Tsimane' today practice monogamy and live in nuclear households, run jointly by a wife and a husband. Only 10% of the households were run by only one parent (8% headed by a single female and 2% headed by a single male).

Independent post-marital residence plus preferential cross-cousin marriage creates a wide and thick tangle of relatives linked by blood and marriage potentially available for social support. 36% of wives and 39% of husbands lived in their village of birth, hinting that wives and husbands each likely benefit from social support of people known since childhood. Village composition is fluid because people move constantly in and out of settlements in search of better places to farm, hunt, and fish (Ellis, submitted for publication).

During the 2004 survey we asked the husband and the wife, separately, who was the main decider in 10 domains about the household (e.g., who decides what to cook or buy, or how much

schooling the children should receive). On average, wives were the main deciders in only 1.0 domains (S.D. = 0.08), whereas husbands were the main deciders in almost three times as many domains (mean = 2.8; S.D. = 0.1) ($t = 11.4$; $p = 0.001$). Those results would suggest that the husband has a greater say in running a household than the wife. We then estimated whether the decision making in the household bore a relation with indicators of well-being, such as anthropometric indices of short-term nutritional status, and found no association.

Published censuses of the Tsimane' from 1971 until 2002 suggest that the population grew at an annual rate of 4.8% (Reyes-García, 2001). We cannot identify the reasons for the growth rate, but the eradication of epidemics likely contributed to population growth. Smallpox ravaged the area during the nineteenth century (Chicchón, 1992). During the last five decades, Protestant and Catholic missionaries and the Bolivian government have provided health services, including vaccinations, so the 4.8% annual population growth rate may reflect declining mortality from better health (Fresard and Moreno, 1999).

Most Tsimane' still have enough land to farm. The nucleated portion of a typical village contains 825 ha of habitable land, yielding a population density of 5.7 ha/person in a village. The amount of land available to each person surpasses 5.7 ha if one takes into account forests, savannahs, rivers, and ponds abutting villages. Tsimane' have ample farmlands for traditional slash-and-burn farming, but villagers close to towns and those facing encroachment from loggers, ranchers, and colonist farmers have started to shorten the length of the fallow period, a practice that signals agricultural intensification (Vadez et al., 2004). Tsimane' say they have fewer wild animals to eat owing to the growth of the human population, the introduction of modern hunting technologies, and to the pressure of outside encroachers.

Like other lowland South American native populations, Tsimane' have adequate energy availability (Berlin and Markell, 1977; Orr et al., 2001). Among 228 Tsimane' households, daily energy and protein intakes averaged 2858 kcal (S.D. = 1293) and 85.0 g of protein (S.D. = 55.2) per person, higher than the estimated requirements of 2040 kcal (S.D. = 207) and 33.8 g of protein (S.D. = 5.1) based on the World Health Organization's recommendations (James and Schofield, 1990; Food and Agriculture Organization, World Health Organization, and United Nations University, 1979). Crops such as manioc and plantains contribute 65–70% or more of dietary energy among lowland Amerindian groups. Animal foods from hunting, fishing, and domestic production contribute 16% of energy intake and 55% of dietary energy.

Tsimane' adults appear to obtain adequate amounts of energy and protein from their staples, and generally do not show evidence of acute nutritional stress. Nevertheless, the Tsimane' diet may not be adequate to fulfill the high nutrient demands of young children. Indeed, many of the staple foods (e.g., manioc, plantains) may not be sufficiently dense in energy, protein, or in key micronutrients to sustain the rapid growth rates that typically characterize infancy and early childhood. Low dietary quality combined with a high infection rate may contribute to the high incidence of stunting in physical growth among the Tsimane', discussed below (Foster et al., 2005; Tanner, 2005; McDade et al., in press).

The first recorded contact of Tsimane' with Westerners goes back to the seventeenth century, but continual exposure dates back only to the 1940s. Mobile, scattered, decentralized, and without a central political authority, Tsimane' avoided sedentary living in Catholic missions or in Spanish towns. The history of the Tsimane' during the seventeenth and eighteenth centuries is peppered with attacks against missionaries and Spanish towns (Ellis, 1996; Chicchón, 1992). We do not have information to assess how the rubber, quinine, and mineral booms of the nineteenth and early twentieth century in Bolivia affected the Tsimane', but they probably had a weaker effect than among neighboring native peoples because Tsimane' lived in small, scattered, and

mobile settlements, making it hard for employers to recruit Tsimane' laborers (Chicchón, 1992). Also, the Tsimane' territory lacks rubber trees. The boom of pelts (1940–1970) affected some Tsimane' communities, but not enough to cause dislocation of settlements or modes of production; Tsimane' adopted firearms, but continued to sell pelts and buy goods out of their villages without having to go to towns (Jones, 1995).

The 1950s produced a torrent of socioeconomic changes in the department of Beni. The changes included the establishment of permanent Catholic and Protestant missions, the expansion of cattle ranches, the construction of landing strips to transport fresh beef to mining camps in the highlands, and the building of roads across the Tsimane' territory as part of a government policy to thin out the highlands by encouraging migration to the lowlands (Riester, 1993; Jones, 1995; Chicchón, 1992).

Protestant missionaries from the USA came to the area in 1942, and their activities took off during the 1950s when the Bolivian Government gave them the responsibility of schooling remote lowland Amerindians, such as the Tsimane' (Castro and Dolores, 1997). The agreement lasted from 1954 until 1985. As part of the agreement, Protestant missionaries in 1955 set up a center in the town of Tumichuco to train Amerindians to become bilingual teachers and political leaders, and to translate the Bible into Amerindian languages. Protestant missionaries offered scholarships to promising Tsimane' young men so they could attend Tumichuco for 3 months a year to work as linguistic informants for missionaries. While in Tumichuco, missionaries taught Amerindians academic skills, offered practical training in agriculture, health, and hygiene, and taught the Scriptures so Tsimane' could proselytize in their tongue when they returned to their villages. In 1985, when the agreement with the Government of Bolivia ended, the Government of Bolivia took over the responsibility of schooling the Tsimane', which meant keeping Tsimane' as teachers while covering their salary. To this day Protestant missionaries produce the textbooks used in Tsimane' classrooms, run training seminars for Tsimane' teachers, and offer training courses in reading and writing twice a year for Tsimane' adults. Most of today's top Tsimane' political and educational leaders received their training from Protestant missionaries.

Tsimane' adults have low levels of schooling and academic skills, and little fluency in spoken Spanish; males have higher levels of these attributes than females. The average female had finished only 0.7 years of schooling (S.D. = 1.2) (Table 1), but 63% of the females had no schooling. In contrast, the average male had more than twice as many years of schooling (1.9 years; S.D. = 2.6) as the average female. Only 43% of males had received no schooling. 89% of males but only 47% of females knew some Spanish, and 38.5% of males but only 9.3% of females spoke Spanish fluently.

Besides Protestant missionaries, other agents of change have included trespassers such as loggers, cattle ranchers, colonist farmers, and traveling traders (Godoy et al., 1998). Encroachers hire Tsimane', buy crops and forest goods, and supply Tsimane' with commercial goods and credit (Godoy et al., 2005b). Non-government organizations started to work in the area during the late 1980s in projects of health, education, farming, land demarcation, and the sale of forest goods (Añez, 1992). Despite five decades of exposure to the market economy, Tsimane' remain highly autarkic. The survey of 2004 suggests that 61.8% of adults of working age (20–65 years of age) had spent no money and 40.7% had earned no cash during the 2 weeks before the day of the interview.

With earnings from the sale of farm and forest goods such as rice and thatch palm, and with earnings from wage labor in logging camps, cattle ranches, and in the farms of colonist farmers, Tsimane' acquire commercial goods, principally food. Commercial foods rank at the top in frequency (59.1%) and in value (44.0%) of all purchases of commercial goods bought by

Table 1
Definition and summary statistics of variables used in regressions

Definition	N	Mean	S.D.
A. Dependent variable (physical stature in centimeters corrected for age shrinkage)			
Females	417	151.0	4.8
Males	444	162.9	4.8
B. Independent variables			
B.1. Participant			
Age of participant in years			
Females	417	38.1	15.4
Males	444	38.2	15.1
Modern human capital: schooling (maximum school grade achieved by participant)			
Females	417	0.7	1.2
Males	444	1.9	2.6
Modern human capital: Spanish (Participant's Spanish fluency; speaks Spanish = 1; no Spanish = 0)			
Females	416	0.4	0.4
Males	444	0.8	0.3
B.2. Participant's parents (only 2004)			
Mother's modern human capital: 1 if participant's mother had at least 1 year of schooling, spoke Spanish, or could write; 0 otherwise			
Females	239	0.01	0.11
Males	242	0.004	0.06
Father's modern human capital: 1 if participant's father had at least 1 year of schooling, spoke Spanish, or could write; 0 otherwise			
Females	240	0.12	0.33
Males	239	0.10	0.31
Physical stature of same-sex parent (%)			
Mother is/was			
Same height as female participant	234	26.4%	
Taller than female participant	234	41.4%	
Shorter than female participant	234	32.0%	
Father is/was			
Same height as male participant	222	22.5%	
Taller than male participant	222	50.9%	
Shorter than male participant	222	26.5%	

Tsimane' (Godoy et al., 2005b). Whether measured by frequency or by value, commercial foods also accounted for the largest share of goods obtained in barter (frequency = 58.2%; value = 56.7%). Among commercial foods, fresh, canned, and sun-dried meat topped the list, followed by staples (e.g., oil, noodles), sugar, and candy. Among all goods obtained through barter, clothing ranked second after meat in frequency (13.7%) and in value (17.5%). Household utensils (e.g., plates), medicines and goods related to personal hygiene (e.g., soap), and metal tools accounted for 9.6, 6.7%, and for 6.6% of the value of goods obtained through barter. Luxury items were the least important type of commercial good obtained through barter (2.6%) or purchase (0.8%). These findings matter for the story of secular change in physical stature because they suggest that Tsimane' use monetary earnings and barter transactions to get commercial foods, principally animal proteins, rather than to acquire luxuries, junk foods, or meretricious

goods. Recall that animal proteins from hunting, fishing, and from their own domesticated animals (or animal products) account for 16% of energy intake and 55% of dietary energy, so markets and barter transactions fill a large hole in the diet.

4. Results

Mean physical statures for adult Tsimane' females and males are 150.42 cm (S.D. = 4.85) and 162.29 cm (S.D. = 4.93) (Table 2, part A). Corrected for shrinking that comes with age after people reach 30 years, the mean adult physical stature increases to 151.0 cm (S.D. = 4.8) for females and to 162.9 cm (S.D. = 4.8) for males (Table 2, part B).

Tsimane' are tall compared with other Amerindians from Latin America, but short when compared with their neighbors (the Mojeño), USA citizens, or Europeans. In the early 1970s, Comas compiled information on adult physical stature among Latin American female Amerindians from 42 studies, and he did the same for male Amerindians from 140 studies (Comas, 1971). The average Tsimane' adult female is taller than the average Amerindian female

Table 2

Mean and standard deviation (S.D.) of physical stature in centimeters by birth decade (1920–1980) and self-assessed certainty of age among Tsimane' females and males over 20 years of age

Birth decade	Females			Males		
	<i>N</i>	Mean	S.D.	<i>N</i>	Mean	S.D.
A. Participant uncertain of age; physical stature uncorrected for age-related shrinkage						
1920s	18	146.3	5.4	18	161.1	6.2
1930s	31	150.4	4.4	31	160.4	4.8
1940s	36	150.2	5.2	39	161.8	4.7
1950s	48	150.2	4.2	56	161.7	4.5
1960s	100	150.7	4.2	121	162.3	5.3
1970s	140	150.4	5.0	126	162.8	4.6
1980–1984	44	151.6	5.2	53	163.3	4.4
Total	417	150.4	4.8	444	162.2	4.9
B. Participant uncertain of age; physical stature corrected for age-related shrinkage						
1920s	18	149.0	5.5	18	163.9	6.2
1930s	31	152.6	4.4	31	162.5	4.8
1940s	36	151.7	5.2	39	163.4	4.7
1950s	48	151.2	4.2	56	162.6	4.5
1960s	100	151.0	4.2	121	162.6	5.4
1970s	140	150.4	5.0	126	162.8	4.6
1980–1984	44	151.6	5.2	53	163.3	4.4
Total	417	151.0	4.8	444	162.9	4.8
C. Participant certain of age; physical stature corrected for age-related shrinkage						
1920s	12	148.0	3.9	16	164.7	6.1
1930s	22	152.7	4.6	22	162.2	4.9
1940s	30	151.7	5.4	31	163.9	4.7
1950s	33	151.8	4.4	44	163.2	4.6
1960s	73	151.4	4.2	97	162.9	5.3
1970s	104	150.9	4.9	106	163.0	4.5
1980–1984	35	152.0	5.2	45	163.7	4.3
Total	309	151.3	4.7	361	163.2	4.8

In parts B and C, physical stature corrected for age-related shrinkage using the Trotter and Glesser (1951) method.

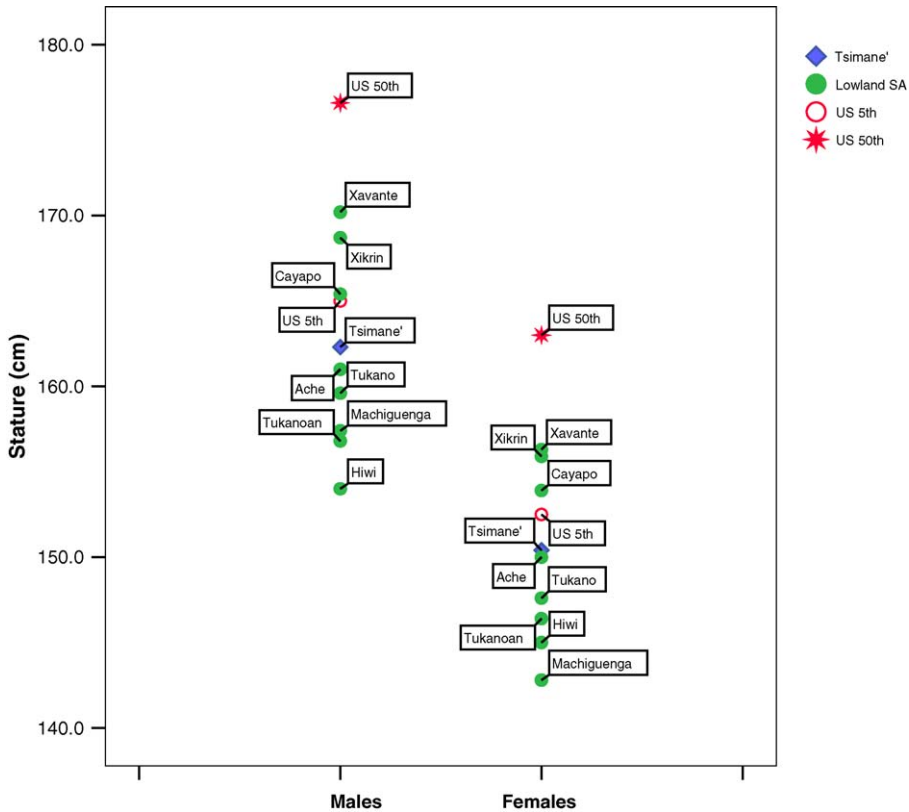


Fig. 1. Adult stature (cm) of Tsimane' and other native lowland South American populations compared with USA references. South American data are from [Katzmarzyk and Leonard \(1998\)](#) and [Byron \(2003\)](#). USA reference data are from [Frisancho \(1990\)](#).

in 80% of the studies reviewed by Comas, and the average Tsimane' adult male is taller than the average Amerindian male in 83% of the studies reviewed by Comas.

In [Fig. 1](#), we compare mean adult physical stature for the Tsimane', 20 other lowland South American Indian groups ([Byron, 2003](#); [Katzmarzyk and Leonard, 1998](#)), and the USA 5th and 50th percentiles from [Frisancho \(1990\)](#). As a group, indigenous lowland South American populations are short, with most falling at or below the USA 5th percentile (76% of females and 80% of males). Tsimane' are taller than the mean in the sample of Amerindians (sample: females = 149.8 cm, S.D. = 4.8; males = 161.7 cm, S.D. = 5.5) ([Godoy et al., 2005c](#)).

Compared with [Frisancho's \(1990\)](#) norms from the USA, Tsimane' are stunted, as mean physical stature averages almost two standard deviations below their peers of the same age and sex in the USA. Tsimane' are also short compared with pre-modern Europeans. [Komlos \(1989: 244\)](#) reproduces information on the physical stature of rural, unskilled soldiers 20–45 years of age for Moravia, Bohemia, Hungary, Galicia, and Lower Austria for the eighteenth and nineteenth centuries by decade of birth from 1730 until 1840; for every decade of birth and region, Europeans were taller than the Tsimane' adult males of our sample. Army recruits during 1740 in the Habsburg Monarchy had to be at least 165.8 cm tall to join the army; that height requirement exceeds the mean physical stature of contemporary Tsimane' adult males

(162.9 cm). Elsewhere, Komlos et al. (2003: 183) compare the physical stature of male adults from Sweden, France, England, Bohemia, and Hungary from 1710 until 1790, and find only one case of males shorter than 163 cm (Hungarians in the late eighteenth century who were 163 cm tall), so the average Tsimane' male in our sample would have been at the lowest rung of the European ladder of physical stature. In fact, the average adult male Tsimane' today has the same physical stature as the typical French army soldier during the seventeenth century (Komlos et al., 2003). Komlos et al. call those soldiers “extremely short” (p. 168) and attribute their shortness to a combination of crises, including famines, the “Little Ice Age”, and wars, all of which depressed human growth.

In Fig. 2, we draw on part B of Table 2 to plot physical stature (corrected for age shrinking) by birth decade (1920–1980) and by sex for the Tsimane'. Fig. 2 shows that the tallest Tsimane' females (mean = 152.6 cm; S.D. = 4.4) were born during the 1930s. An ordinary least squares (OLS) regression (not shown) with corrected physical stature as a dependent variable and birth decade and year of survey as independent variables suggests that the physical stature of females declined by 0.01 cm/decade, but the trend was statistically insignificant ($p = 0.44$) ($n = 417$). Fig. 2 also shows that the physical stature of adult males oscillated without a clear secular time trend. A similar regression for males (not shown) suggests that physical stature declined at a rate of 0.006 cm/decade, but, again, the decline was imperceptible ($p = 0.66$) ($n = 444$). In sum, descriptive and visual evidence suggests no obvious secular time trend in adult physical stature during 1920–1980.

41.4% of females said they were shorter than their mothers, 32.0% said they were taller than their mothers, and 26.4% said they were of the same physical stature as their mothers ($n = 234$) (Table 1). 50.9% of males said they were shorter than their fathers, 26.5% said they were taller than their fathers, and 22.5% said they were of the same physical stature as their fathers ($n = 222$).

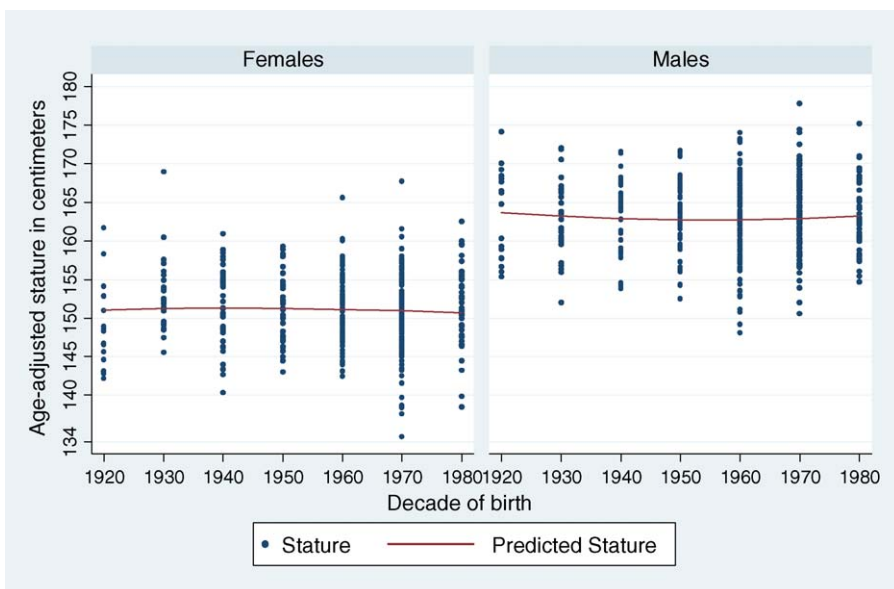


Fig. 2. Secular trends in stature among Tsimane' adults, 1920–1980: 20+ years of age, by sex and decade of birth.

Open-ended ethnographic probing with elders suggests that physical stature may have declined, probably over a stretch of time going further back than the earliest birth decade in our sample (1920s). Tsimane' elders said their ancestors were taller, and at least one nineteenth-century source lends indirect credence to the observation. During 1829–1833 the French naturalist Alcide d'Orbigny measured the adult physical stature of the neighboring Mojeño, and found that females and males were 156 and 167 cm tall (d'Orbigny, 1944). He commented that adult Mojeño females were taller than European females (p. 86). d'Orbigny does not describe the criteria he used to select his sample, nor does he mention the size of his sample, so one must be cautious of his estimate. Nonetheless, d'Orbigny's observation suggests that nineteenth-century adult Mojeño would have been taller than their descendants today (females = 152.5 cm; males = 164.7 cm) (Laure, 1991) or than Tsimane' at present (females = 150.4 cm; males = 162.2 cm).

Elders attributed the decline in physical stature to several causes. Some attributed it to a decline in the frequency and quality of *chicha*, a beverage fermented at home made from manioc, maize, or plantains. *Chicha* was so thick in the past, they say, that Tsimane' households with *chicha* to share would invite others to come and "eat" *chicha*. Today people invite each other to "drink" the potation, with the implication that it is more diluted and perhaps less nutrition than in the past. Elders also complained about the decline in the amount of edible wild animals. At least three elders said the disappearance of cannibalism, particularly the eating of human fat, contributed to physical shrinking. Others said that the age of cohabitation had fallen, with adverse consequences for the nutrition of young households. In the past, adult men had to prove they could hunt before they could set up a new household because hunting skills signaled to the bride and her family that the young man could supply the household with meat, a valued food among native Amazonians (Good, 1987). If the age for establishing a new household has fallen while the age at which men mastered hunting skills has remained constant or increased (say from increasing school attendance), an unskilled young hunter could have established a new household, thereby imposing a nutritional burden on his new family.

We next present separate regression results of physical stature against covariates for females (Table 3) and males (Table 4). The dependent variable is the physical stature of people over 20 years of age, with an adjustment for shrinking from aging for people over the age of 30. In columns [1]–[6], we present the regressions results, starting with the simplest model in the first column and then gradually adding independent variables in the other columns. In column [1] we include only age as a covariate. In column [2] we include only six dummy variables for birth decades starting with the 1920s. In column [3] we include the participant's own schooling level and birth decade, but not age. In column [4] we add the variable for Spanish fluency of the participants and the variables for the modern human capital of their parents, but drop the variable for participant's schooling. In column [5] we add variables about perceived parental physical stature. In columns [4] and [5] we find that competence in spoken Spanish is associated with greater physical stature, but only among females, so in column [6] we add two dummy variables for different levels of competence speaking Spanish to identify the threshold beyond which Spanish competence matters. In column [6] we restrict the analysis to females because we did not find evidence that man's competence in spoken Spanish bore an association with their physical stature. The bottom of Tables 3 and 4 contain the results of tests for joint statistical significance for variables related to birth decade, parental modern human capital, and perceived parental physical stature.

Age by itself (column [1]) or with other covariates (columns [2]–[6]) bore no statistically significant association with physical stature. Nor did birth decade bear an association with

Table 3

OLS regression of covariates of physical stature among Tsimane' females 20+ years old (dependent variable = physical stature in centimeters corrected for age-related shrinkage)

Independent variables	Females					
	[1]	[2]	[3]	[4]	[5]	[6]
Age	0.01	∧	∧	0.1	0.1	0.1
Birth decade (1980 = reference)						
1920s	∧	−2.2*	−2.0	−9.1	−8.1	−8.1
1930s	∧	1.4	1.5	−6.0	−5.8	−5.8
1940s	∧	0.8	0.9	−5.0	−4.9	−4.9
1950s	∧	0.4	0.5	−3.8	−4.1	−4.1
1960s	∧	0.1	0.2	−1.9	−2.6	−2.5
1970s	∧	−0.4	−0.4	−1.7	−2.1	−2.1
Modern human capital of						
Participant						
Schooling	∧	∧	0.08	∧	∧	∧
Spanish (Spanish ability = 1; no Spanish = 0)	∧	∧	∧	2.5***	1.9***	∧
Some Spanish (reference = no Spanish)	∧	∧	∧	∧	∧	1.9***
Fluent Spanish (reference = no Spanish)	∧	∧	∧	∧	∧	2.0**
Participant's parents						
Mother's modern human capital	∧	∧	∧	3.5	4.8*	4.8*
Father's modern human capital	∧	∧	∧	−1.8*	−1.2	−1.2
Parental stature (reference = offspring say they have the same stature as parent)						
Mother						
Mother taller than self	∧	∧	∧	∧	−1.9**	−1.9**
Mother shorter than self	∧	∧	∧	∧	2.1***	2.1***
Father						
Father taller than self	∧	∧	∧	∧	−0.2	−0.2
Father shorter than self	∧	∧	∧	∧	2.9	2.9
Constant	−522**	−578**	−557**	147***	147***	147*
Observations (<i>N</i>)	417	417	417	238	228	228
R2	0.02	0.04	0.04	0.09	0.22	0.22
Joint tests						
Birth decades	na	1.62 (0.13)	1.64 (0.13)	0.68 (0.66)	0.65 (0.68)	0.65 (0.69)
Participant's Spanish	na	na	na	na	na	4.90 (0.00)
Parental human capital	na	na	na	2.39 (0.09)	2.44 (0.09)	2.42 (0.09)
Parental stature	na	na	na	na	9.37 (0.00)	9.31 (0.00)

Sample includes people certain and uncertain of their age. For definition of variables see Table 2. Year of survey not shown. (∧) Indicates variable excluded from model. Under "joint" we show *F* and, in parenthesis, $p < F$; na = not applicable.

* Significant at the $\leq 10\%$ level.

** Significant at the $\leq 5\%$ level.

*** Significant at the $\leq 1\%$ level.

Table 4

OLS regression of covariates of physical stature among Tsimane' males 20+ years old (dependent variable = physical stature in centimeters corrected for age-related shrinkage)

Independent variables	Males				
	[1]	[2]	[3]	[4]	[5]
Age	0.01	^	^	0.02	-.03
Birth decade (1980 = reference)					
1920s	^	0.8	0.9	-0.9	2.6
1930s	^	-0.3	-0.2	-0.2	2.8
1940s	^	0.5	0.6	-0.5	3.2
1950s	^	-0.1	-0.1	-1.3	0.6
1960s	^	-0.1	-0.08	-0.6	0.8
1970s	^	-0.04	-0.04	-0.4	0.4
Modern human capital of					
Participant					
Schooling	^	^	0.04	^	^
Spanish (Spanish ability = 1; no Spanish = 0)	^	^	^	0.4	0.2
Participant's parents					
Mother's modern human capital	^	^	^	5.7	6.7
Father's modern human capital	^	^	^	-0.8	-1.1
Parental stature (reference = offspring say they have the same stature as parent)					
Mother					
Mother taller than self	^	^	^	^	0.9
Mother shorter than self	^	^	^	^	2.2**
Father					2.2**
Father taller than self	^	^	^	^	-0.9
Father shorter than self	^	^	^	^	2.2**
Constant	-304	-285	-259	162***	161***
Observations (N)	444	444	444	239	217
R2	0.01	0.01	0.01	0.01	0.12
Joint tests					
Birth decades	na	0.22 (0.97)	0.24 (0.96)	0.18 (0.98)	0.39 (0.88)
Parental human capital	na	na	na	0.86 (0.42)	1.38 (0.25)
Parental stature	na	na	na	na	6.15 (0.00)

Same as in Table 3.

** Significant at the $\leq 5\%$ level.

*** Significant at the $\leq 1\%$ level.

physical stature. Most dummy variables for birth decade were statistically insignificant, as were the tests of joint statistical significance for all the variables of birth decade. The regression results fit with the results of the descriptive analysis presented earlier showing no obvious secular time trend in adult physical stature from the 1920s until the 1980s. Since results could reflect attenuation bias from measurement errors of the age variable, we re-estimated regression [2], but only for participants who reported being certain of their age. Those results (not shown) also revealed no secular time trend in physical stature.

Own and parental modern human capital and perceived parental physical stature were associated with improved own physical stature, but only among females. In fact, in the

regressions for males of Table 4 few of the independent variables bore a statistically significant relation with physical stature, so in the rest of the article we focus mainly on females, but we turn to males when discussing parental physical stature.

In column [4] of Table 3 we see that females competent in spoken Spanish were taller. A female who spoke Spanish stood 2.5 cm taller than a female monolingual in Tsimane'. The modern human capital of the mother bore no significant statistical relation to a woman's own physical stature, but a woman whose father had at least 1 year of schooling, spoke Spanish, or could write was 1.8 cm shorter than an otherwise identical woman whose father had no modern human capital.

Since the estimated relation between competence in spoken Spanish and adult physical stature among females could reflect biases from omitted variables, particularly unobserved individual and household attributes, in column [5] we introduce variables for parental physical stature. The results of column [5] suggest that competence speaking Spanish was associated with an increase in physical stature of 1.9 cm.

The results of column [5] suggest that only maternal modern human capital mattered, and that it was associated with greater physical stature only of daughters, not of sons. Mothers who had completed at least 1 year of school, who knew how to write, or who could speak Spanish (however competently) had daughters who stood 4.8 cm taller than women of mothers without modern human capital. The association would appear if participants, as children, were taught or learned Spanish in schools run by missionaries where food and medical care were provided.

In column [5] of Table 3, we see that only the physical stature of the mother was associated with the physical stature of the daughter. A woman who said her mother was taller was 1.9 cm shorter than a woman who reported having the same physical stature as her mother, and a woman who said her mother was shorter was 2.1 cm taller than a woman who reported having the same physical stature as her mother. The perceived parental stature of the women's father bore no association with the women's physical stature. In column [5] of Table 4, we see that males who said that their mother or father was shorter than they, were 2.2 cm taller than males who reported being of the same physical stature as either of their parents. The variables for parental physical stature capture perceived parental stature and bear the correct sign; offspring who came from parents perceived as shorter were taller than offspring who came from parents perceived as being of the same physical stature.

In column [6] of Table 3, we identify the level of competence in spoken Spanish beyond which Spanish competence bears an association with physical stature. In column [6] we take out the variable for competence speaking Spanish and replace it with two dummy variables for different levels of Spanish competence: (1) whether the female spoke *some* Spanish and (2) whether the female spoke *fluent* Spanish. The result of the regression in column [6] suggests that even some competence in spoken Spanish goes with an improvement in physical stature of 1.9 cm. Fluency in spoken Spanish is associated with an increase of 2.0 cm in physical stature. Maternal modern human capital continues to be associated with an improvement in the physical stature of daughters of 4.8 cm.

We estimated the parameters of regression [6] again, but restricted the sample to participants certain of their age. The sample shrunk from 228 to 171 observations, but produced results pointing in the same general direction as those of column [6]. The coefficients were as follow: some Spanish = 1.5 ($p = 0.04$), fluent Spanish = 1.5 ($p = 0.16$), mother's schooling = 4.6 ($p = 0.07$), and father's schooling = -2.2 ($p = 0.02$). Two noteworthy changes include the fact that Spanish bears an association with physical stature at low levels of competence of Spanish fluency and father's schooling has a statistically negative association with a women's physical stature.

5. Discussion and conclusions

In sum, we find (a) an absence of a secular change in adult physical stature among the Tsimane' between 1920 and 1980, (b) a prominent association of own modern human capital with adult physical stature among females, and (c) a link between the modern human capital and physical stature of mothers and the physical stature of daughters, but not of sons.

Has exposure to the market economy been associated with changes in the physical stature of the Tsimane'? The answer depends on how far back in time one goes to estimate secular changes. One might say that initial contact dating back to the nineteenth century, if not earlier, might have had an impact on the physical stature of Tsimane', as the ethnographic and historical fragments intimate. If so, the Tsimane', like their neighbors, the Mojeño, might have shrunk sometime last century, and remained shorter but stable in height. The trends in physical stature starting during the 1920s that we measured cannot pick up any earlier trends in physical stature and merely show stability at a lower level—two standard deviations below USA norms. One could call this the 'short but stable' hypothesis. We acknowledge the possibility, but also the paucity of information to support it.

If we focus on the more recent period starting during the 1920s, then the evidence of stasis is more compelling. The absence of recent changes in adult physical stature could reflect shortcomings in methods, such as attenuation bias from random measurement errors of age, or inflated standard errors from random heaping in measures of physical stature. We doubt attenuation bias drove results because when we re-estimated regression [2] restricting it to participants certain of their age, we obtained essentially the same results as those reported in the original regression [2] of Tables 3 and 4. One might question whether seven decades of continual contact with the market economy provides enough time to spot secular changes in adult physical stature. Some forms of socio-economic change, such as industrialization in the nineteenth century, produced visible changes in only a few decades and Bogin's (Bogin and Keep, 1999) research in Latin America, and Komlos' work in pre-modern France, show that environmental and socioeconomic turbulence take a short time before producing effects, so we doubt that the narrow chronological window of observations would explain the negligible secular changes in physical stature that we observe among the Tsimane'.

The absence of a recent change in physical stature likely has to do more with substance than with methods. During the past half century, contact with the market has been sporadic rather than continual and intense. The Tsimane' remain highly autarkic despite half a century of exposure to the market. The type of exposure may have been too mild to produced palpable effects on adult physical stature.

Substantial access to Western medicine is recent. Consequently, what appears to be one of the major determinants of early childhood growth stunting in the Tsimane' and in other lowland South American groups—high infectious disease loads—has remained a persistent stressor over the last half century.

The absence of a recent secular change in physical stature might also reflect the prominent role of social capital in inoculating people against the presumptive harms of income inequality. We doubt this is a likely explanation because we showed earlier that village-level attributes, such as social capital and village income inequality, explain only 13–19% of the variation in age and sex-standardized anthropometric indices of nutritional status among Tsimane' (Godoy et al., 2005a). Also, the most recent, comprehensive reviews of the literature on income inequality and health continue to produce inconclusive results about the role of income inequality on health, at least in industrial nations (Lynch et al., 2004a,b; Subramanian and Kawachi, 2004). We also doubt social capital protects health because in an earlier panel study over five quarters (1999–2000) in two

villages we asked whether households had suffered unanticipated shocks, and, for each shock, we asked how people had coped with the misfortune. Most households (82.08%) weathered mishaps on their own, without help from friends or kin (Godoy et al., submitted for publication). Sharing and reciprocity might permeate everyday life, but prudential generosity does not get galvanized to help those who suffer. Another piece of evidence bearing on the last point comes from the results of recent experimental games played with the Tsimane'. Gurven (2004) found that the Tsimane' scored low in pro-social behavior compared with people of other small-scale, pre-industrial societies.

As with the Sioux and pre-modern Europeans, so too with the Tsimane': the absence of a marked recent secular change in adult physical stature likely has to do with propinquity to food sources, the persistence of autonomous forms of village social organization that shape daily living, and to the use of the market and barter to obtain staples rather than mere bagatelles. Protestant missionaries used the Tsimane' language to teach Tsimane' modern farming, health, and hygiene, and academic skills. Unlike other Amerindian groups, Tsimane' did not abjure all their culture and language to acquire modern human capital or to enter the market economy. Tsimane' teachers to this day run their own schools using the Tsimane' language as the language of instruction; the practice allows Tsimane' children to blend rather than to replace language skills and cultures.

The absence of a marked secular trend in adult physical stature meshes with much of the ethnographic and ethno-historical literature from other societies reviewed earlier, which also shows weak evidence for such trends. It also meshes with the record of early modern Europe showing that physical stature and propinquity to food sources went together (Komlos et al., 2003). More surprising is the finding that even slight competence in spoken Spanish bears a positive association with physical stature, but only among females. This presents a puzzle because males have more modern human capital than females, and the earliest and best school of the Tsimane', Tumichuco, catered to males. Why then would Spanish skills be associated with greater physical stature only among females, and, more importantly, why would maternal modern human capital only bear an association with the physical stature of daughters, but not of sons? We have no convincing answer to the queries, but sketch some leads by way of conclusion.

Studies in developing nations, including Bolivia, suggest that even after controlling for schooling and for various forms of unobserved heterogeneity, skills speaking, reading, or writing the majority national language among ethnic minorities enhance earnings (Chiswick et al., 2000; Angrist and Lavy, 1997). In an unpublished study in progress we show that competence speaking Spanish among Tsimane' is associated with 36–46% higher monetary earnings, so it may be unsurprising to find that fluency in spoken Spanish would bear a positive association with physical stature, probably through its association with income. Studies from developing and developed nations suggest that using OLS to assess the association between language skills and earnings underestimates the true effects of language skills. Valid instrumental variables for language skills produce asymptotically unbiased and larger estimates of the private market returns to language skills than estimates from OLS regressions (Chiswick and Miller, 1995; Chiswick, 1998). If the same applies to our sample and outcome, then one might read the estimated association between competence in spoken Spanish and adult physical stature that we presented as a conservative approximation of the true value.

One reason why competence in spoken Spanish bears a different association with the physical stature of females and males might have to do with the occupations people pursue once they learn Spanish. Young females who learn to speak Spanish remain in their village, whereas young males who learn Spanish seek employment in logging camps, the farms of colonists, and cattle ranches, all occupations that pull them away from their culture and village, with possible adverse consequences

for their nutritional status. Fathers being absent might help explain why we did not find a strong association between the modern human capital of fathers and the physical stature of their sons.

The positive link between maternal modern human capital and the physical stature of daughters fits with what we have learned about divergence in parental preferences between investing in girls over boys in Tsimane' households (Godoy et al., *in press*). In a forthcoming article that draws on principles from evolutionary biology, we develop and test a model that predicts preference for girls by the parent facing more resource constraints and preference for boys by the parent facing less resource constraints. We show that Tsimane' mothers face more resource constraints than fathers. Mothers have less monetary income, wealth, and credit and contribute less to the value of household consumption than fathers. As predicted by our model, we find that mother's resources protected daughter's BMI, but not son's BMI. The finding that maternal physical stature is associated with improved physical stature only of daughters fits with our model's predictions and also with findings from studies in other nations, which show that mothers prefer to invest in girls and that fathers prefer to invest in boys (Thomas, 1994).

Perhaps the single most important tentative policy lesson we draw from the case study has to do with the blending of traditional and modern human capital, in their own terms, in their own villages, with their own social organization, that the Tsimane' have managed to achieve and the implications of such blending for well-being. So far, market expansion has not broken up local systems of preferential marriage, village institutions, or land tenure. It has not destroyed the Tsimane'. Until now, the Tsimane' have managed to live between two cultures and economic systems. We wait to see how much longer the balance will last.

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