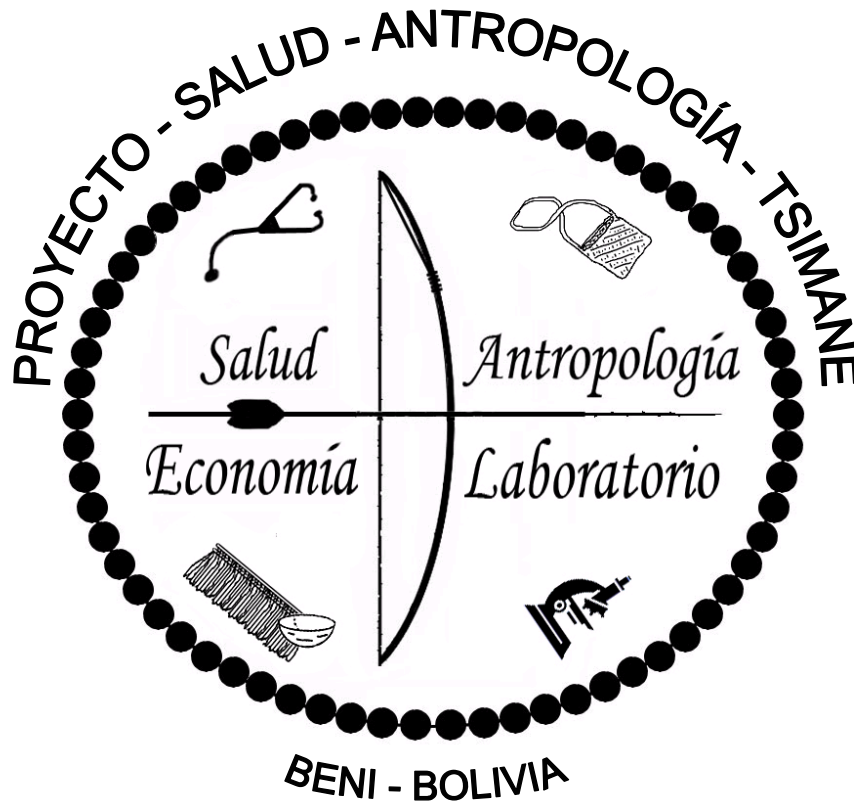


# INFORME

## TRABAJO REALIZADO 2005-2009

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## **MISIÓN**

Comprender como las enfermedades, el estado nutricional y el comportamiento afectan la salud y proceso del envejecimiento en varias poblaciones del mundo, incluyendo indígenas de la cuenca Amazonica y ciudadanos de otros países.

### *Metas del Proyecto*

1. Documentar las enfermedades y problemas que afligen los Tsimanes (infantes, niños, adultos y mayores; varones y mujeres) en lugares diferentes de su territorio.
2. Hacer un estudio integrado de crecimiento, desarrollo, envejecimiento, producción, redes sociales, salud y la mortalidad con los Tsimane.
3. Examinar el efecto de integración, educación, y acceso al mercado sobre la salud y bienestar de los Tsimanes, y comparando los Tsimanes con otras poblaciones del mundo.
4. Examinar relaciones entre la salud, flujo de recursos y redes sociales dentro y entre familias.
5. Estimular investigaciones colaborativas sobre envejecimiento y desarrollo en lugares diferentes del mundo.

### *Metas Operativas*

Proveer atención médica a indígenas viviendo en lugares aislados y mejorar las condiciones de vida de los indígenas de las tierras bajas de Bolivia.

Facilitar la capacitación de responsables de salud en sus comunidades y la llegada de servicios de salud para poblaciones de indígenas aislados.

## **MUESTREO**

From 2002-2009 the Tsimane Health and Life History Project has worked in 26 communities, providing medical attention to about 3,900 individuals (see table 1 and villages in black text in figure 1). The project consists of a “Mobile Team” and a “Fixed Team”. The Mobile Team consists of 3 medical doctors, 2 biochemists in a mobile laboratory, 5 Tsimane assistants, and 3 Tsimane anthropologists. This team travels across communities collecting health and behavioral data from medical and physical exams, interviews, and analyses of blood, urine, and feces while providing free health care. Visits to communities range in length from 2 days to 3 weeks depending on the size of the community. The Mobile Team visits each community about once per year. During each visit, patients are seen twice – once to receive attention and treatment, and again to receive results of lab analyses and follow-up attention.

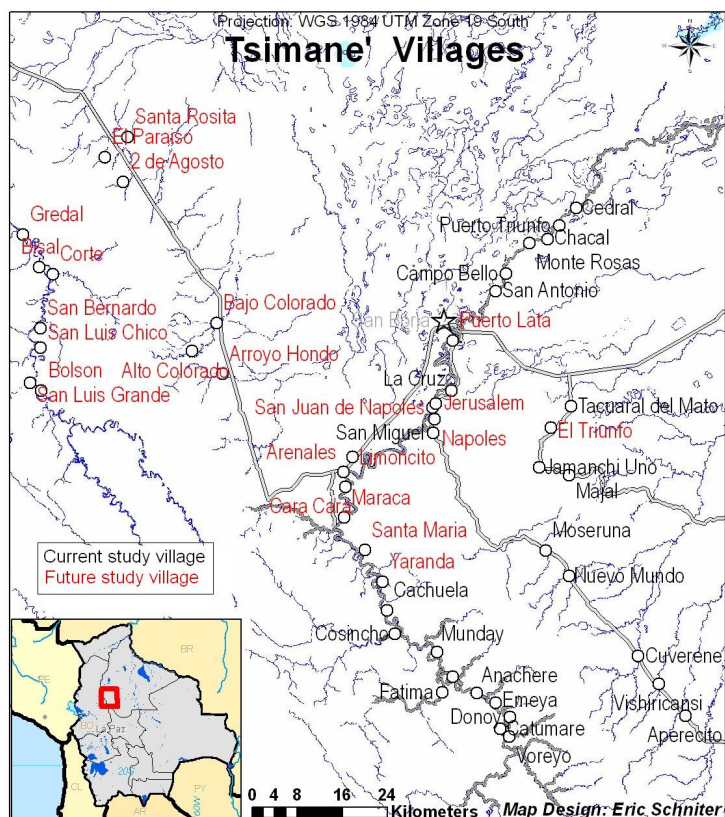
The Fixed Team usually consists of graduate students of Drs. Gurven and Kaplan from UCSB and UNM, along with several Tsimane anthropologists. The team remains in a village from 6 months to a year, collecting long-term data on health, household economics, and the use of time.

With the consent of the Gran Consejo Tsimane and study participants, we hope to continue work and expand the current sample of villages for in-depth behavioral and physiological analysis of aging (see villages in red text in figure 1).

**TABLE 1.** Tsimane' Project Sample  
Note: \* indicates "fixed" community

Comunidad	Nº de habitantes
Anachere	72
Aperecito*	63
Boreyo	65
Cachuela	44
Campo Bello	205
Catumare	78
Cedral*	193
Chacal*	208
Cosincho*	230
Cuverene*	40
Donoy	29
Emeya	65
Fátima*	532
Jamanchi Uno*	125
La Cruz	362
Las Maras	34
Majal	97
Monte Rosa	96
Moseruna*	86
Munday*	73
Nuevo Mundo*	84
Puerto Trionfo	93
San Antonio	258
San Miguel	359
Tacuara del Mato*	353
Uishiricansi	57
	3901

**FIGURE 1.** Map of study villages  
Note: black/red indicate current/future study village



### *Health Assistance*

El proyecto Tsimané a lo largo de su historia a tratado de mejorar el apoyo en salud a la gente enferma cubierta por nuestro estudio, inicialmente solo se contaba con atención primaria en el campo que se limitaba al manejo de infecciones y tratamientos paliativos para dolencias crónicas, ocasionalmente cuando los pacientes eran de gravedad se los trasladaba hasta el hospital de segundo nivel en San Borja, para el año 2007 a través de acuerdos con la ONG Solidaridad Médica Canaria de San Ignacio de Moxos, la organización de Solidaridad en Cochabamba y la organización Mano a Mano pudimos mejorar las opciones de tratamiento para algunos enfermos. En San Ignacio de Moxos con la ONG solidaridad Médica Canario se logro atender en los 3 años 167 pacientes, de los cuales 165 casos eran quirúrgicos, esencialmente problemas de hernias y prolapsos en las mujeres. Enfermedades que eran discapacitantes y que aquejaban a los pacientes por muchos años.

También un logro importante fue iniciar la captación de pacientes con lesiones premalignas de Cáncer Cervicouterino que fueron oportunamente intervenidas a través de el tamizaje de Ca Cu por medio del PAP. Esto fue particularmente complicado dada la cerrada cultura de la gente a ese tipo de procedimientos.

Con la ONG Solidaridad y Mano a Mano se tuvo algunos éxitos importantes como la recuperación de pacientes graves con accidentes como heridas de bala y fracturas graves, que en su caso, por la forma de vida que llevan es discapacitante. Las transferencias a Cochabamba era el nivel más especializado de atención y era donde trasladamos a los pacientes realmente graves, es por esa razón también que perdimos algunos casos que eran demasiado avanzados como ser los cánceres terminales, insuficiencias cardíacas y renales, que aún con el mejor intento no pudimos salvarlos.

#### Collaborations with Bolivian Institutions

Gran Consejo Tsimané: Jorge Añez Claros, Presidente (Convenio)

Hospital San Borja: Dr. Javier Jimenez, Director (Convenio)

Dr. Pepe Solidaridad Médica Canario

Hermana Adelina Solidaridad Iglesia Católica Arzobispado Cochabamba

Universidad Mayor de San Simón (Convenio)

Universidad Autónoma Gabriel San Moreno (Convenio)

Centro Nacional de Enfermedades Tropicales (CENETROP) (Convenio)

Instituto Nacional de Laboratorios de Salud (INLASA) (Convenio)

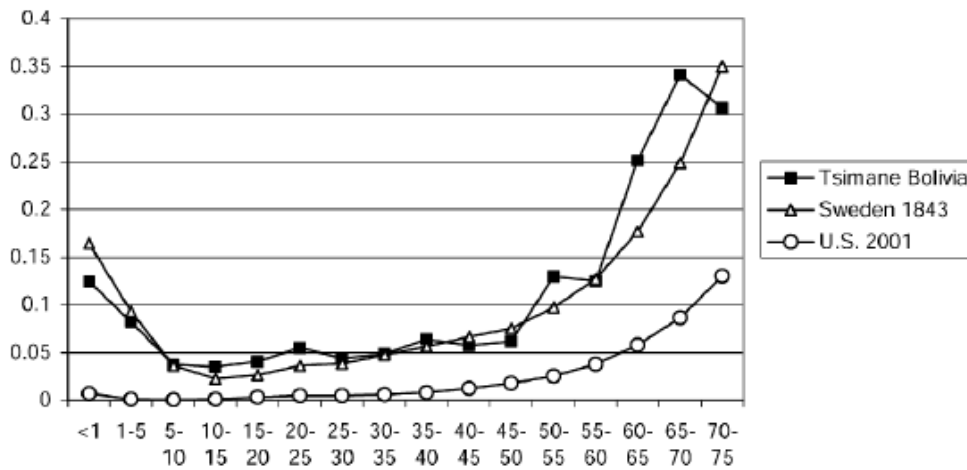
## RESULTADOS

### Demography

#### a) Past mortality and causes of death

Interviews conducted with all 1,097 individuals over age 16 in our sample cover birth and marital histories, and residential patterns. Birth histories of siblings and parents (alive or dead) were also included in the interviews. The demographic interviews are the basis for estimating ages and causes of death. Before 1990, life expectancy at birth among the Tsimane was 43 years. However, conditions are rapidly changing as life expectancy increased to about 53 years from 1990 to 2002. Despite recent improvement, Tsimane death rates at all ages are similar to those observed in Europe in the 1800's, and much higher than recent American estimates (figure 2).

**FIGURE 2.** Probability of dying by age in 3 populations



Tsimane villages located farther from town show 2-4 times higher mortality rates than villages located near town. Over half of all deaths were due to infectious disease, especially respiratory and gastrointestinal infections. These two types of infection represent a common cause of morbidity as well (see below). Accidents and violence accounted for 25% of all deaths. Since 1990, we found a great reduction in death rates for adults but not for infants or children. We think that this is due to differences in access to medical interventions for adults and children, since adults have a greater ability to seek treatment. Tsimane cultural beliefs about sickness and death may also deter people from seeking medical attention.

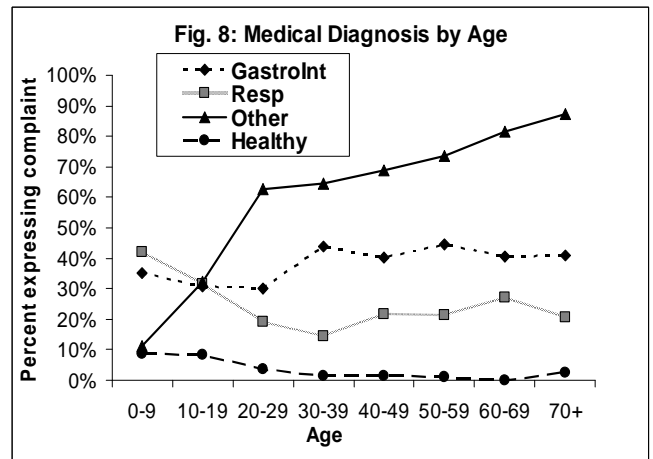
#### b) Fertility

The Tsimane population is a high fertility population. The Total Fertility Rate (TFR) is 9, meaning that a woman can expect to give birth 9 times during her reproductive years based on current trends. In general, the Tsimane population is very young, where 51% are younger than age 15, 35% are between ages 15 and 40, 9% between ages 40 and 60, and 4% are age 60 and older. The fertility rate has changed very little since the 1950's in all areas of the Tsimane territory. Fertility is lower in forest areas (TFR=8.0) and highest near San Borja (TFR=9.6). There has been no fertility decrease, which is often characteristic of a transition to life in cities. The sex ratio is biased towards males for most age classes, except for that of teenagers, which is biased towards females.

### Health

Medical and physical exams by our physicians and biochemists during Mobile Team visits provide diagnoses of current and previous illnesses and disabilities. Tsimane show high rates of infections, especially parasites. During any medical visit, over 66% of Tsimane have at least one intestinal parasite, the most common being hookworm (*Ancylostoma duodenale* or *Necator americanus*, prevalence 48%), roundworm (*Ascaris lumbricoides*, 21%) and whipworm (*Trichuris* sp., 4%). Pathogenic protozoan infections are also common, especially *Giardia lamblia* (19%), and *E. histolytica* (5%). About 50% of men and women have anemia, with children and adolescents showing the highest risk (56% of girls, 63% of boys). Individuals with hookworm are almost twice as likely to have anemia. Over 90% of individuals complain of some illness during their medical visit. Gastrointestinal illness and respiratory infections are frequent diagnoses: 30-40% of infants and young children suffer from each; 30-40% of adults continue to suffer from gastrointestinal illness and 20-30% of adults suffer from respiratory infections (figure 3). These illnesses often occur together. The probabilities of being diagnosed with gastrointestinal, respiratory and other disease were significantly correlated with one another at all ages.

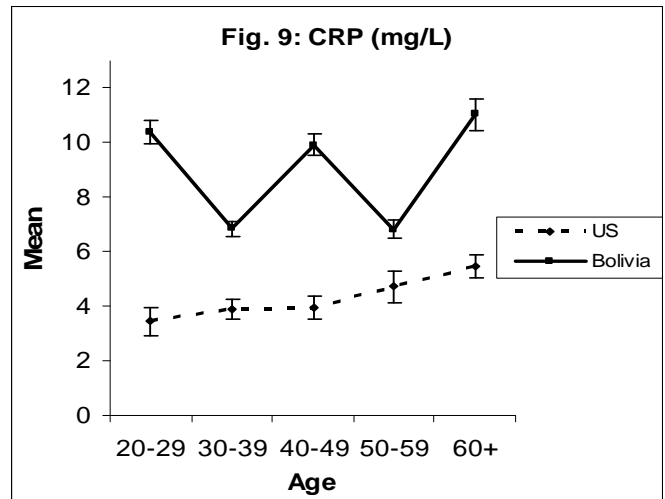
**FIGURE 3.** Medical diagnosis by age



### Blood analysis

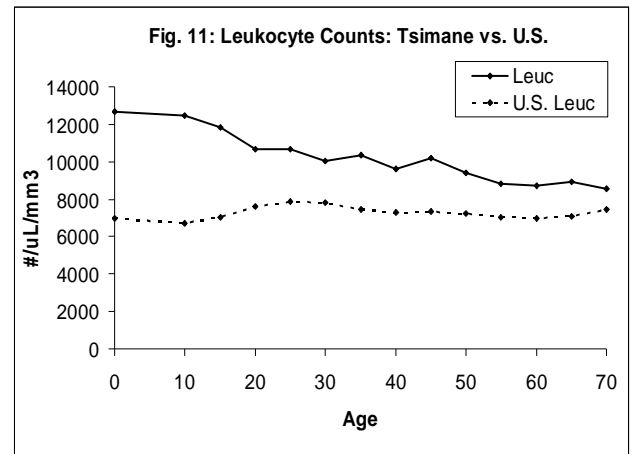
Analysis of blood show high levels of inflammation among the Tsimane. High levels of inflammation suggest that the immune system must use a lot of energy due to constant exposure to infection. Tsimane levels of one indicator of inflammation, C-reactive protein (CRP), were found to be much higher at all ages than levels among Americans (figure 4). Estimates of life lived with high CRP for the Tsimane compared to Americans indicate that by age 34 Tsimane have spent an average of 15 years or 42% of life with high CRP; in America the numbers are 6.8 years and 19%. CRP levels among Tsimane are higher than those sampled among other populations, including Italians, Mexicans, Philipinos, and Native Americans in the EEUU. Tsimane living farther from town show higher CRP levels than Tsimane living closer to town, suggesting higher exposure to infectious disease in remote villages.

**FIGURE 4.** CRP levels by age



Other blood analyses also indicate high levels of immune activity throughout life. Tsimane have higher levels of leukocytes than Americans at all ages (figure 5). On average, 20% of Tsimane white blood cells (WBC) are eosinophils, which shows evidence of parasitic infection, compared with the normal range of 0-5%. The high WBC counts decline with age, probably because of fast aging of the immune system and the inability to produce more cells, rather than less frequent exposure to infection. Other blood indicators of infection are also very high: average IgG is 1,971 mg/dL and IgE is 10,719 IU/mL. Normal adult ranges for Western populations are for IgG: 850-1,600 mg/dL and for IgE: <100 IU/mL. IgE is of special interest because average levels for the Tsimane are 100 times greater than among Western populations, and it is associated with parasitic infections.

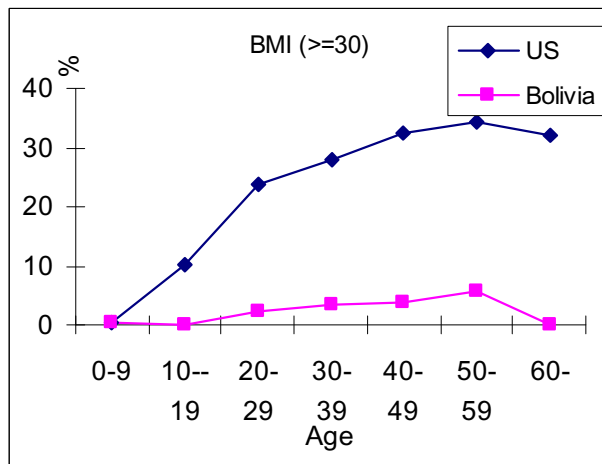
**FIGURE 5.** Leukocyte counts by age



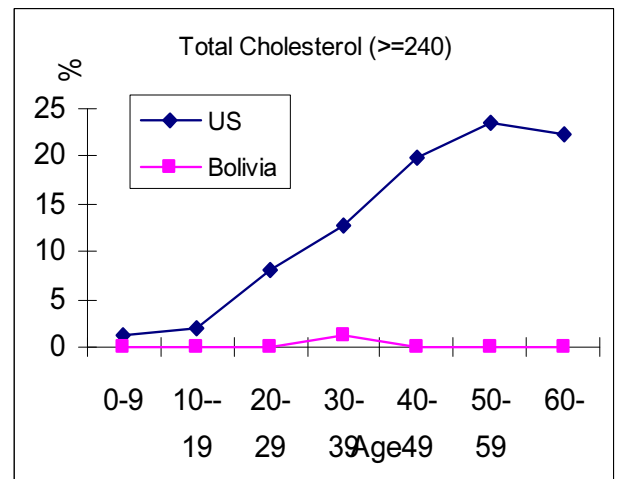
*Cardiovascular disease*

Risk indicators for cardiovascular disease (CVD) among Tsimane differ from those found in other countries. Obesity, high cholesterol, and high blood pressure are all related to much of the CVD among adults in Western countries. But the percentage of adults that are either obese (Body Mass Index [BMI]>30) or with high total cholesterol (>=240) is much greater in the EEUU than among the Tsimane (figures 6 and 7).

**FIGURE 6.** Obesity prevalence by age

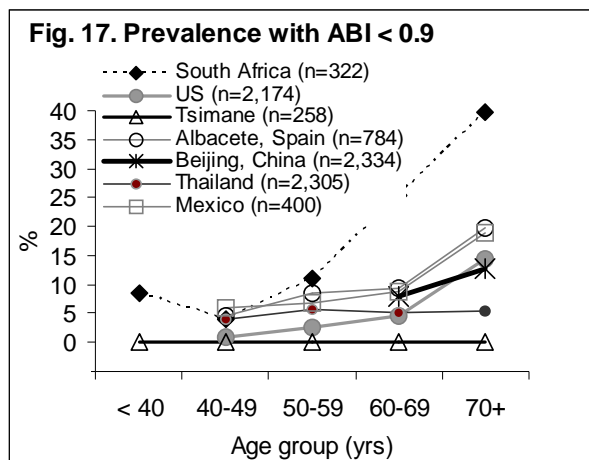


**FIGURE 7.** High cholesterol prevalence by age

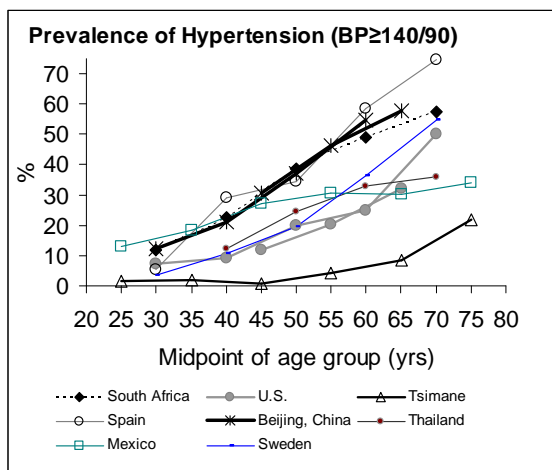


Our investigation of peripheral arterial disease (PAD), a pre-cursor to fully developed arteriosclerosis and measured by the ankle-brachial blood pressure index (ABI) indicates that PAD is not common among Tsimane adults: not 1 of 258 individuals over age 40 showed evidence of PAD (an ABI<0.9). In every population it has been studied, PAD increases with age except among the Tsimane (figure 8). Hypertension (blood pressure >= 140/90) is also of very low prevalence among the Tsimane, occurring in less than 5% of individuals over age 25. Compared to other populations, the percentage of individuals with high blood pressure is lower among Tsimane throughout adult life (figure 9).

**FIGURE 8.** Prevalance with PAD (ABI <0.9)



**FIGURE 9.** Prevalance of hypertension



Low BMI and cholesterol may protect against CVD by reducing inflammation and improving metabolism. We think that low hypertension, low cholesterol, and high levels of physical activity are responsible for the low levels of CVD among Tsimane. Tsimane men and women age 40-49 expend, on average, an additional 850 and 450 kcals/day more, respectively, in physical activity than do Americans. In America, 66% of adults age 18+ never engage in vigorous leisure-time physical activities lasting 10 minutes or more per week, and only 15% of adults engage in moderate physical activity for 30 minutes or more per day. In contrast, Tsimane men and women spend some 4.5 and 1.5 hours per day in such activity, respectively.

Although there is little evidence of CVD among Tsimane, we have found evidence of other heart conditions. Our preliminary sample of electrocardiograms on 357 adults age 40 and over showed atrial and ventricular damage and lesions on about 2% of individuals. This might indicate a history of heart disease due to infections that increase levels of inflammation.

#### *Kidney disease*

We have also found evidence that Tsimane may suffer from high levels of a kidney disease called cystinuria. This leads to frequent kidney stones. Although the disease is extremely rare in most populations (ranging from 1 in 2,500 to 1 in 10,000), the low levels of marriage and reproduction with other ethnic groups might increase the prevalence of cystinuria among Tsimane.

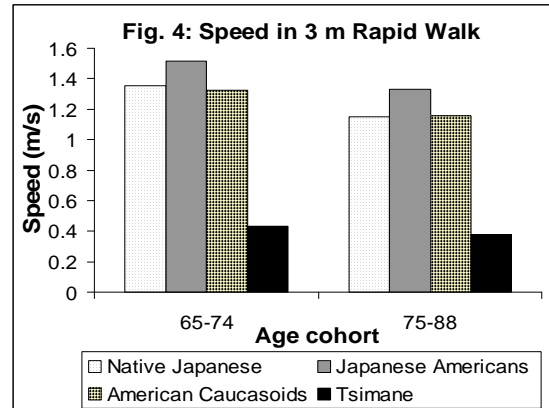
#### **Papanicolao**

Desde el año 2007 hasta el 2009 se hizo examen de Papanicolao para detección precoz de Cancer Cervicouterino a 457 pacientes, en colaboración conjunta con el Insituto Nacional de Laboratorios Salud (INLASA La Paz), donde encontramos 29 casos con lesiones premalignas, de las cuales 1 caso resultado ser cáncer in situ. De los 29 casos, 14 correspondian a mujeres menores de 40 años, con un patrón de distribución similar entre regiones cercanas y alejadas de SB. De esas 29 mujeres por un acuerdo con la ONG Solidaridad Médica Canaria se logro realizar conificación terapéutica por el método de asa fría a 14 mujeres que accedieron y acudieron para la realización del procedimiento. Falta recolectar datos de Hospital SB sobre hospitalizaciones y leishmaniasis, registro que se realizara la próxima semana.

### *Functional ability*

We have studied the physical condition and performance of older adults in an attempt to understand the aging process among Tsimane. We have done this through a series of interviews, performance tasks, and observations. Preliminary analysis of functional status among 260 adults over age 40 shows greater disability after age 60. Over 60% of Tsimane over age 60 complain about hearing loss, over 80% have trouble seeing close distances, and over 70% can no longer chop large trees in their fields. About 50% of men and 70% of women over age 70 can no longer walk long distances, and complain frequently about painful arthritis in their legs, back, and hips. Over 90% of men over age 60 can no longer carry a heavy weight a distance of 50 meters. Over 70% of men no longer hunt by age 70. Men complain about becoming too tired, having poor eyesight, hearing loss, and being too weak. Living many years with these disabilities lowers the quality of life and might accelerate the aging process compared to people living in other countries. For example, Tsimane take 91% longer than Japanese and 29% longer than Americans to stand up 5 consecutive times after sitting down, and are slower in walking a distance of 3-meters (figure 10).

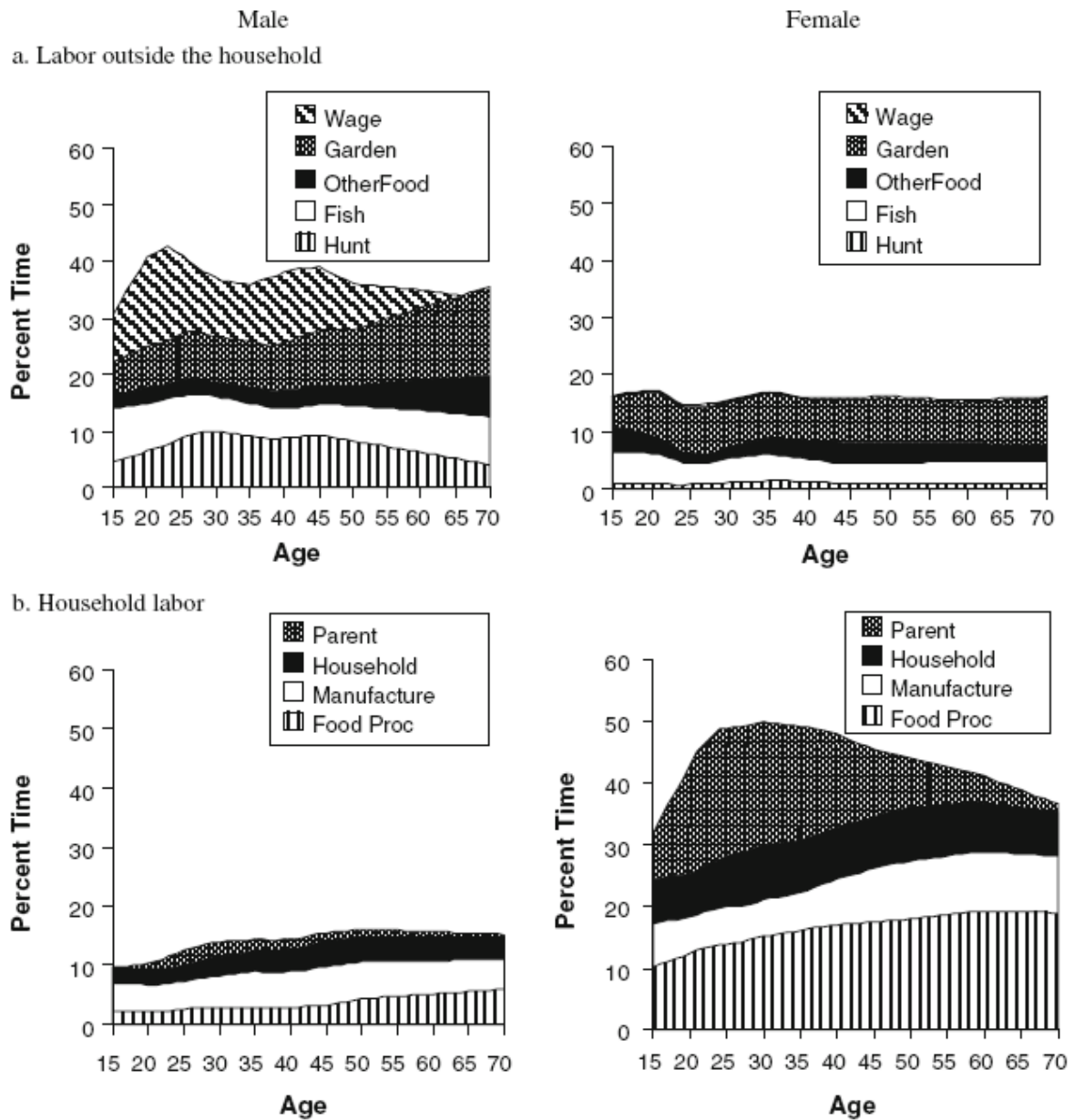
**FIGURE 10.** Speed in 3-meter walk



### *Food production and household labor*

A combination of behavioral observations and interviews regarding people's use of time, daily food production, and food sharing have been conducted. We studied the division of labor between spouses and other family and extended family members to see how daily nutritional needs are met. Women spend about 2 hours per day in food production, and about 5 hours per day in other work activities. Men spend about 5 hours per day in food production or wage labor, more than twice as much as women. However, men spend only about 1.5 hours per day in domestic work, less than half that spent by women. Therefore, total work time is about the same for men and women (figure 11). The total time men and women spend in domestic labor increases later in life, with the greatest increase coming from time spent in food processing and manufacture. Men and women are productive into their 60s, with older men producing more calories than younger men in their 20s.

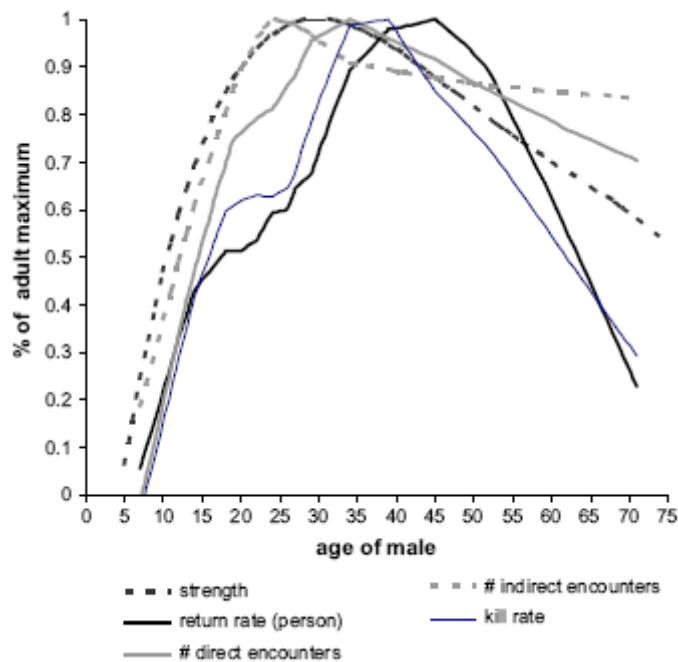
**FIGURE 11.** Time allocation to labor by sex a) outside the house, and b) inside the house



### *Hunting*

We conducted a focused study of men's hunting. Hunting ability peaks in the 40s, about 20 years after physical body size and strength reaches a peak, indicating that a long period of learning is necessary to be a good hunter (figure 12). Two aspects of hunting ability, indirect encounters (e.g. smells, sounds, tracks, and scat), and shooting of stationary targets, improve as men get bigger and stronger, but the more difficult components of hunting, direct encounters with animals and capture, take an additional 15 to 20 years to develop after reaching adult size. We have also found that better hunters have higher status, receive more social support during conflicts, marry earlier, and have more surviving children than poorer hunters. For men and women, productive ability is highly valued in spouses.

**FIGURE 12.** Perfil de esfuerzo en hombres por edad: Encuentros directos y indirectos con animales durante de la cacería, rendimiento de cacería (calorías ganado por cada hora de trabajo), y esfuerzo



### *Social Status*

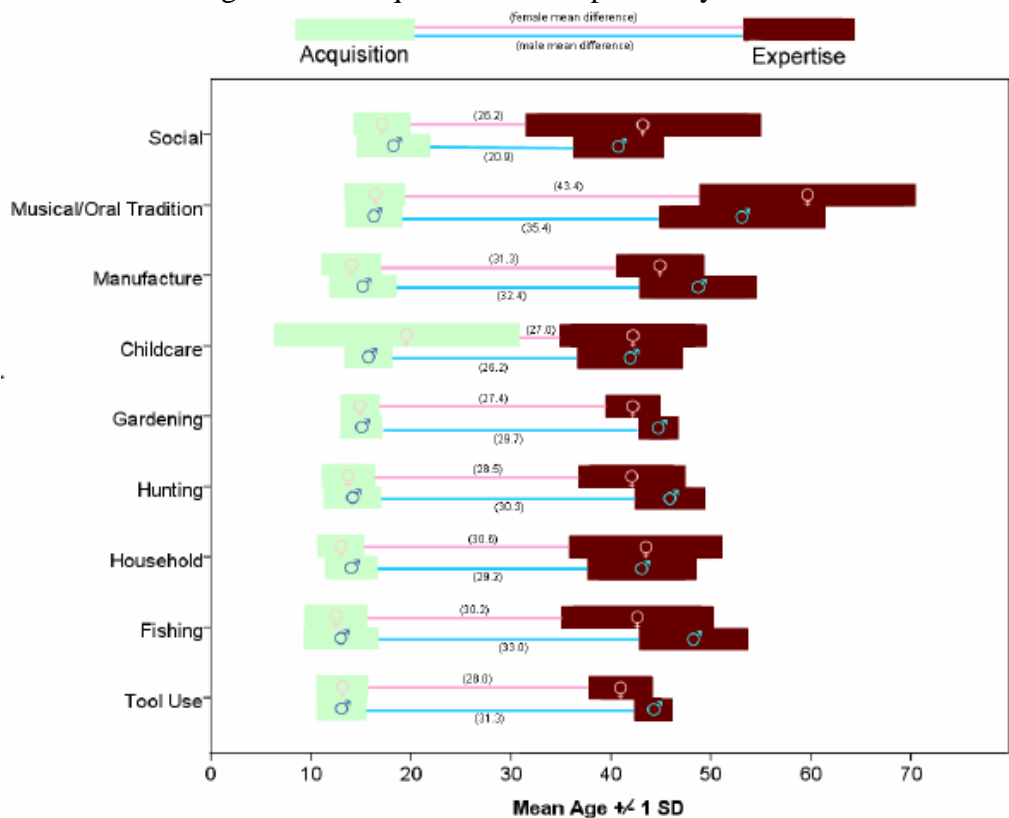
In addition to hunting ability, we have studied other factors that influence different components of men's social status. We have found that body size best predicts others' judgements of a man's fighting ability, while the amount of social support a man has best predicts whether that man is perceived to be influential and worthy of respect. Men's market involvement also influences social status: men who speak better Spanish and who are more educated are more likely to be viewed as influential. Being known as a good food producer is also associated with higher respect.

### *Cultural knowledge and expertise*

Figure 13 shows the average age that Tsimane men and women report becoming proficient for different abilities. It also shows the average age of Tsimane identified as "experts". The average age of named experts for various abilities, based on a sample of 150 interviews with adults from 3 villages, is over 40. Experts in traditional knowledge (e.g., medicinal plants and animals) and music/oral

tradition are all over age 45. Parents accounted for 50-60% of those named as influential people who helped teach a variety of skill, while grandparents accounted for 5-10%, older siblings accounted for 10%, and aunts and uncles accounted for 10%. These results show that older kin have a great impact on the development of skills that make up Tsimane lifestyle.

**FIGURE 13.** Age of skill acquisition and expertise by sex for different activities



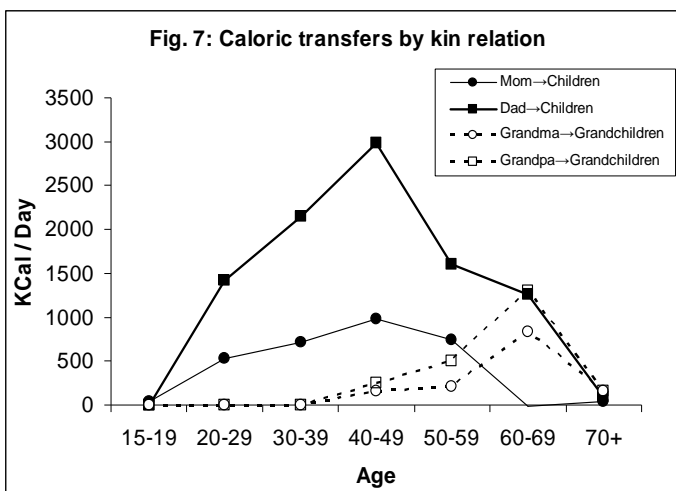
*Sharing*

By the age of peak production, men and women share over 50% of their production with children. For both men and women, however, production decreases in the 60s and 70s. After peaks in production the proportion of calories directed towards children declines and more is given to grandchildren (figure 14). By the 70s, adults no longer produce more than they consume. While the oldest adults do not produce much, they are not great problems for kin.

*Men's familial involvement*

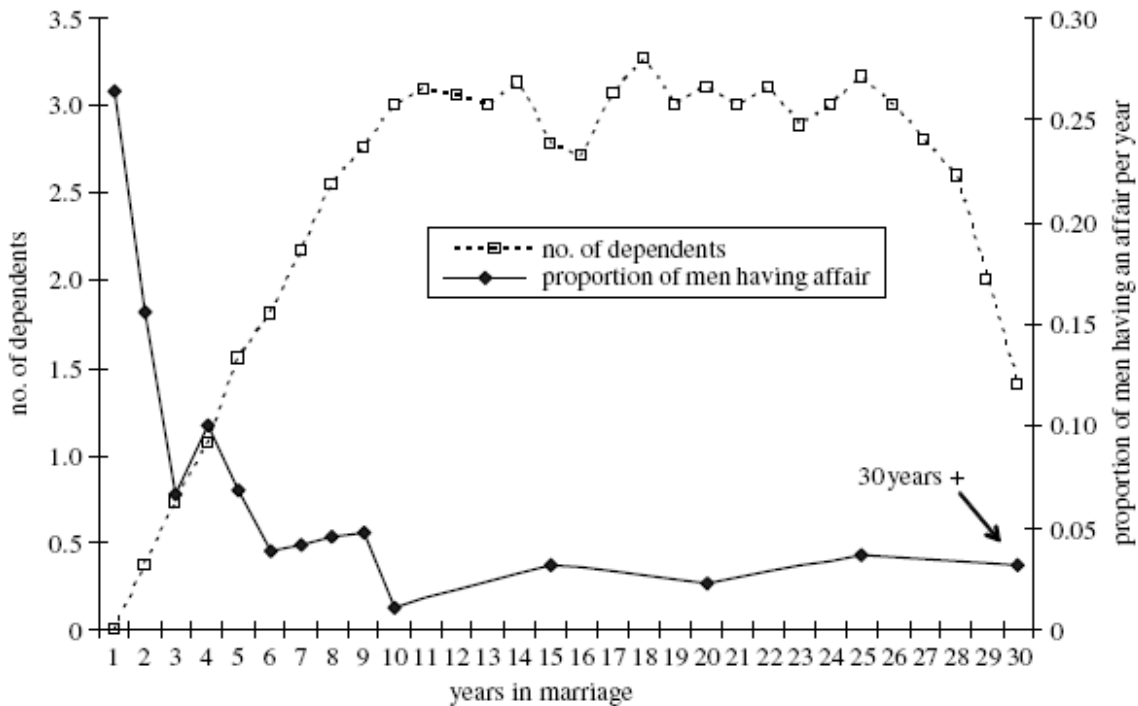
We examined the motivation behind men's childcare. One hypothesis is that men care for children to improve their well-being; another hypothesis is that men care for children to impress the wife and continue reproducing with her during

**FIGURE 14.** Energy transfers by family relation



marriage. Our results show that men generally offer childcare to increase the well-being of their children, and not to display to their wives. For example, men provided more childcare when a wife was involved in other work. We also found that men were less likely to have extra-marital sex as they (and their wives) aged and together produced more children (figure 15). Together, these results support the idea that the main goal of men's familial involvement is to increase children's quality rather than pursue their own self-interest.

**FIGURE 15.** Proportion of men having an affair and number of dependent children by years in marriage



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