

Yanomamö

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ALTERNATIVE NAMES

Yanomami, Waika, Waica, Guaica, Shori, Yanoama, Yanomama, Shiriana, Xiriana, Shidishana, and Guajaribo. The names Sanema, Sanumá, and Sanima are auto denominations of Yanomamö people to the north and east of the main tribal distribution. They are culturally and genetically very closely related to the larger Yanomamö groups and their dialect is partially intelligible.

The name Yanomamö means person, individual, or human. Alternative names such as Shamatari or Waika (Waika) are relative terms used by some Yanomamö to refer to other Yanomamö living to the south or north, respectively.

LOCATION AND LINGUISTIC AFFILIATION

The Yanomamö are located in the extreme southeastern corner of the Venezuelan state of Amazonas and in the northern portions of the Brazilian states of Roraima and Amazonas. In Venezuela, the northern extension of the Yanomamö is delimited to the north by headwaters of Erebató and Caura rivers, east along the Parima Mountains, and west along the Padamo and Mavaca in a direct line to the Brazilian border. In Brazil, they concentrate themselves in the headwaters of the Demini, Catrimani, Araca, Padauari, Uraricoera, Parima, and Mucajai rivers. In Brazil and Venezuela there are about 20,000 Yanomamö in 200-250 villages, covering an area of approximately 192,000 sq km. Dense tropical forest covers most of the land but sparse savannas may be found in higher elevations. The topography is flat to gently rolling with elevations ranging from 250 to 1,200 m.

The Yanomamö language has not been confidently associated with any other South American language group. Linguists have attempted to provisionally place the language in Macro-Chibchan (Greenberg, 1960), Carib (Migliazza, 1972), or Panoan (Speilman, 1979). Migliazza divides Yanomamö into four major dialectical groups known as Sanema (3,262 speakers), Yanam (856 speakers), Yanomam (5,331 speakers), and Yanomamö (11,752 speakers). The last two dialects, accounting for 81% of the total, are mutually intelligible while the others may not be.

OVERVIEW OF THE CULTURE

The Yanomamö are horticultural people with a strong dependence on foraging (Hames, 1989; Lizot, 1977). Hunting is still accomplished with bow and arrow and swidden cultivation of plantains and bananas (manioc in some places) is central to the subsistence economy. Except for villages associated with missions, no locally produced goods are traded with outsiders. Although steel goods such as machetes and axes are common, they have had little impact on subsistence other than to make it more efficient (Hames, 1979).

Village size ranges from about 40 to more than 250 with a mode of between 60 and 100 (Chagnon, 1997; Early & Peters, 2000). Where raiding is intense, villages tend to be large, and where raid is relatively uncommon, they are smaller (Chagnon, 1997). Villages tend to be located about a day's walk apart and in areas between major rivers. Over the last 30 years some villages have begun to concentrate near missions on large rivers. All villagers inhabit a circular communal lean-to (*shabono*), and in higher elevations fully enclosed communal houses are built. These houses begin to deteriorate within 2-3 years. As the thatch and structural members deteriorate, the house becomes infested with cockroaches, crickets, and fleas (*Tungans penetrans*) (Hagen, Hames, Craig, Lauer, & Price, 2001), and fecal and soil-born parasites. Sand fleas can be a serious health problem for children, especially orphans. This unsanitary and vexatious situation is resolved by building a new communal structure nearby.

Yanomamö social organization could be characterized as tribal and egalitarian (*sensu*; Service, 1975). The headman and the shaman are the only two socially differentiated roles and, in some villages, there may be more than one headman. Descent is patrilineal and residence is patrilocal. Lineages are local, of shallow genealogical depth, and lineage members do not own communal property. The major role of lineages is in dispute settlement, vengeance and the regulation of marriage. Each village is an independent political entity. Weak and ephemeral alliances between several villages are frequently established for mutual defense and aggression. In some areas, warfare is chronic while in others it is episodic and rare.

Most Yanomamö live in simple nuclear families. Anywhere from 20% to 25% of all families are polygynous (Hames, 1996). Polyandry is not uncommon in some areas comprising 2% of all marriages (Early & Peters, 2000). Each household owns one or more garden and is responsible for realizing its subsistence requirements. Sharing of food resources is common but families tend to restrict their reciprocity to only a few other families (Hames, 1999).

THE CONTEXT OF HEALTH: ENVIRONMENTAL, ECONOMIC, SOCIAL, AND

POLITICAL FACTORS

Disease patterns among the Yanomamö are affected by a variety of physical and social environmental factors that are only now beginning to be understood. Malaria appears to be endemic throughout much of their territory but there appears to be considerable variation in the species of *Plasmodium* involved and in the intensity and prevalence of infection. Other diseases may be dependent on geography; for example, higher elevations appear to have greater incidences of river blindness (*Onchocerciasis*). Contact by non-Yanomamö is by far the most serious health problem faced by the Yanomamö. Influenza, measles, and hepatitis have been introduced by nonnative peoples who visit the area, or, in the case of gold miners in Brazil, have illegally invaded Yanomamö land.

Patterns of Disease

There has been a considerable amount of biomedical and epidemiological research done on the Yanomamö since 1966 that we cannot hope to effectively detail here. Elsewhere (Hames & Kuzara, in press) we present a much more complete review of this research, especially as it relates to the complexities of disease processes, origins, interactions, epidemiology, genetic susceptibilities, and the role of contact and acculturation. The pattern of diseases that affects the Yanomamö has been changing rapidly since first contact with Europeans and others.

It is difficult to know with certainty what the disease pressures acting on the Yanomamö prior to contact would have been; it is likely that many of the infectious diseases affecting the Yanomamö today were absent before the last century. Presently, in addition to introduced infectious diseases, the Yanomamö suffer widely from macroparasite infections. The humoral immune defenses that are most effective against macroparasites preclude the T-cell driven immune defenses that would be of most aid against many introduced diseases, such as tuberculosis. Thus, the matrix of both diseases to which the Yanomamö have been exposed since before their first contact, exacerbated by the conditions of sedentism in which many Yanomamö now find themselves, and those to which they are newly exposed, is complex. Because first contact occurred so recently, many diseases which have been introduced can be traced to their original source or point of introduction. Others, however, seem to have preceded actual contact with Europeans, either through contacts between the Yanomamö and other Amerindians of the area, or through infected animal vectors.

One of the most serious parasitic diseases now afflicting the Yanomamö is malaria, a serious infection that can result in high fevers, hemolytic anemia, and potentially dangerous enlargement of the spleen and liver. Of the two species of *Plasmodium*, *P. vivax* is the most common species, while *P. falciparum* results in the most severe infection. In Yanomamö territories, *P. falciparum* accounts for most infections (68.6%, Torres, Magris, Villegas, Torres, & Dominguez, 2000; 57.1%, Mato, 1998). The patterns of the distribution and prevalence of *P. falciparum* among the Yanomamö seem to be much different than in other regions, even in Venezuela itself: the average Venezuelan distribution of infections in 1992 showed that 76% were *P. vivax* and only 24% *P. falciparum*. Additionally, a study by Laserson et al. (1999a) showed that two entire Yanomamö villages were infected with a single genotype of *P. falciparum*, suggesting that the epidemic in these villages was introduced by a single carrier.

Malaria is related to several long-term health problems: hepatomegaly (enlargement of the liver) and splenomegaly (enlargement of the spleen). Both conditions can be severe and sometimes chronic, and may result in portal hypertension and eventual cirrhosis. Malaria can also result in acute hemolytic anemia, as infected blood cells are killed by the exiting parasites or by the immune system. Anemia, including hemolytic anemia, has been shown to affect nearly the entire population of Yanomamö, and may have severe health consequences for these people (Torres et al., 1988).

In one study of the Yanomamö villages of Ocamo and Mavaca (Torres, Noya, Mondolfi, Peceno, & Botto, 1988), however, 44% of individuals were subject to some degree of splenomegaly. In some cases a syndrome known as hyperreactive malarial splenomegaly (HMS) results in those who have suffered repeated infection. In the same study, 23% of malaria cases resulted in the syndrome. In some of these, subjects' spleens occupied up to two thirds of their abdominal cavities.

One explanation for this may be related to the previously mentioned characteristic of Yanomamö immune reactions that seems to favor humoral rather than T-cell driven immune responses. Research has shown a link between a decreased number of T-lymphocytes and the development of HMS in other study populations. Related overproduction of IgM seems to be implicated in the development of HMS.

Torres et al. (2000) established a link between HMS and hemolysis in the Ocamo and Mavaca villages in Venezuela. In the year prior to the study, 38 of the 550 inhabitants of Ocamo and Mavaca had to be evacuated for emergency transfusions because of severe hemolytic anemia. In the study, 26 patients exhibiting severe hemolysis were studied, all of whom fulfilled the diagnostic criteria for HMS. The condition seems to be related to a cold agglutinin-mediated autoimmune response, one of the B-cell mediated immune responses. Whatever the cause of the syndrome, it seems to have a higher prevalence among the Yanomamö than among many other populations living with endemic and hyperendemic malaria, and the health consequences, in the form of hemolysis and anemia, can be severe.

Onchocerciasis, also known as river blindness, is caused by a parasitic infection with filarial worms of the genus *Onchocerca*, often *O. volvulus*. The parasite was introduced to the Americas via European and African immigrants, and may not have affected the Yanomamö prior to contact. Studies have shown the disease to be endemic to varying degrees among the Yanomamö of Brazil

(Grillet et al., 2001; Rassi, Laurda, & Giuaimaraes, 1976), from a prevalence of 240 cases per 1,000 in one village to 606 cases per 1,000 in another.

The prevalence of onchocerciasis seems to be greater at greater altitudes, thus highland Yanomamö may be more at risk than lowland. In a study of biting rates of three species of black fly (the vectors), the biting rates of two species increased with altitude (Grillet et al., 2001). This may be related to the fact that the larval stage of the fly requires fast-flowing, highly oxygenated water, which is more likely to be found at higher altitudes.

While onchocerciasis is not fatal, it can be severely disfiguring and debilitating. Blindness and disorders of lymphoid tissue are potential results. The most adverse consequences of this infection are caused by the inflammatory immune response to the microfilariae by the host, rather than the infection itself. This can sometimes involve intense itching, cracking and thickening of the skin, related bacterial infection, and eventual fibrosis. Inflammation of lymph nodes can also ensue, resulting in a condition known as hanging groin. Of 75 Yanomamö subjects who had tested positive in skin biopsies, only 17 had palpable nodules (Rassi et al., 1976). Lymphatic involvement was not found in any of the Yanomamö subjects of this study. In the study conducted by Rassi et al. (1976), vision problems were only found in two Yanomamö subjects.

Yanomamö are widely infected with various macroparasites, with varying degrees of pathogenicity. Lawrence et al. (1980) conducted a study surveying several types of parasite in two newly contacted Yanomamö villages, as well as in three native, though non-Yanomamö, villages of the same region that are in the process of acculturation.

One of the main routes through which parasites such as nematode worms are spread is oral-fecal contact. Among swidden agriculturalists such as the Yanomamö, periodic relocation is common, which helps to mitigate the effects of a lack of sanitary means of defecation, which generally takes place outside, but near, the village or *shabono*. When populations become more sedentary, such as in areas near missions, parasites can build up in the soil and infection can thus become more prevalent, more severe, or both, if the settlement does not also include some form of sanitation, such as designated pit latrines.

Ascaris lumbricoides, among the more common intestinal helminthes infecting the Yanomamö, is passed through ingestion of feces. The primary complication, particularly in children, is intestinal obstruction. The two Yanomamö villages had infection rates of 90% and 100%, higher than in the acculturating villages.

The Yanomamö villages had hookworm infection rates of 76% and 80%. Hookworm enters a new host through the skin, particularly that of bare feet. The primary complication of infection with hookworm is iron-deficiency anemia, through the loss of blood; no information was available on the prevalence specifically of this type of anemia among the Yanomamö; considering the prevalence of other types of anemia, as well as the prevalence of hookworm infection, this should be the subject of future investigations into Yanomamö health.

Infection rates of *Trichuris trichiura*, also a nemathelminth, in the Yanomamö villages were 66% and 92%. *T. trichiura*, like *A. lumbricoides*, requires a period of incubation in the soil before eggs are infectious. Once ingested, they reside in the intestine and can cause diarrhea and abdominal pain, and potentially rectal prolapse.

Strongyloides stercoralis, a roundworm, involves infection through the skin. In some individuals, particularly those who are immunosuppressed, fever, abdominal pain and even shock may occur. The prevalence of this infection was 4-12% in the two Yanomamö villages, similar to acculturating villages.

Several species of amebic parasites were surveyed in the same study. Two parasites had higher infection rates in Yanomamö villages than in acculturating villages. *Entamoeba histolytica*, the parasite that is responsible for amebic dysentery and tropical liver abscess, had a prevalence of 28% in one village and 78% in another. *Chilomastix mesnili*, which can cause diarrhea, was more prevalent among the Yanomamö, almost half of whom in one village were infected.

Escherichia coli was nearly ubiquitous in the Yanomamö villages, although it is most often non-pathogenic. *E. hartmanni* was far less common than other microparasites and did not differ from the acculturating villages. Other generally nonpathogenic parasites were studied. *Endolimax nana* and *Iodamoeba buschlii* were both more than twice as prevalent among Yanomamö as among non-Yanomamö.

Giardia lamblia, infection with which can cause severe symptoms, such as diarrhea, vomiting, and weight loss that may last for several months, was not present in one Yanomamö village, and present among 5% of the population of the other, but infected about a quarter of the residents of acculturating villages. The low rates among the Yanomamö are surprising, considering that much of the fresh water of the Americas is infected with this parasite. *G. lamblia* infected about a quarter of the population of the acculturating villages, meaning that this may be a health concern for the Yanomamö in the future. While not generally fatal, the severity of the symptoms and especially the duration of the infection make it an important concern.

One must be careful in interpreting these results; in acculturating villages, 14 different species of intestinal parasites were found, while only 11 species were found in Yanomamö villages. However, in the Yanomamö villages, a higher average number of species were found per person, ranging from 4.2 to 6.8. In acculturating villages, the average number of species per person was

much lower, from 1.3 to 6.0. Whether this fact points to the health of the Yanomamö as being more precarious than that of Amerindian groups who are farther along on the road to acculturation is dependent on two things: the severity of each individual infection and the pathogenicity of each species.

It is possible that Yanomamö are better able to deal with certain parasitic infections than some other groups. Many of these infections are dangerous, not because of the parasite itself, but because of the body's reaction to the parasite during some stage of its development in the body. Allergic reactions, for example, are the primary cause for the most severe symptoms of onchocerciasis. These reactions, ranging from mild itch to shock, are caused by an overabundance of immunoglobulin E (IgE). Some studies have suggested, however, that South American Indians can have levels of IgE higher than many Europeans would be able to cope with. Indians living with such high levels of IgE show no signs of ill-health as a result, however, which may make for a reduced negative reaction to the presence of certain parasites in the body.

In addition to parasites, viruses present a great health risk to the Yanomamö. Particularly threatening are the hepatitis viruses, as well as the polyoma viruses and the measles virus. Hepatitis B (HBV) and hepatitis Delta (HDV) may both be found among the Yanomamö. The severity of the health risks of these viruses varies, but the primary threat is the damage done to the liver, which can be very serious, and often fatal, in chronic cases.

HBV is the most common form of the virus among the Yanomamö. In general, this virus can be asymptomatic or associated with mild liver disease and jaundice, and the body's defenses can overcome it in a few months. After this, the infected person becomes immune, and can no longer transmit the infection. In about 10% of adult cases, and 30% of cases in children, however, the disease is not overcome. Chronic HBV lasts through the person's lifetime, potentially causing jaundice, cirrhosis, ascites (abdominal distention and discomfort), and eventual hepatic failure. The chronically infected person may transmit the infection, primarily through blood contact, as well as through contact with saliva and sexual secretions. HDV, first described in 1977, is more acute and often fatal, particularly in individuals who already carry HBV, even those who were previously asymptomatic.

A 1986 study (Torres & Mandolfi, 1991) of Ocamo and Mavaca villages showed that of samples assayed, only 16.2% of the population had not been infected and 53.7% had developed immunity to HBV. A full 30.3% showed current infection with HBV, meaning that they were either chronic or newly infected. As the virus was introduced 18 years prior, and the prevalence of infection was so high, it is likely that many of these were chronic cases. These rates seem abnormally high, since generally only 10% of adult infections are chronic. However, 39.7% of those infected with HBV also tested positive for HDV, which can greatly exacerbate the HBV infection. This may explain why the rates of chronic HBV were so much higher than average.

In the same study, an examination of serum samples that had been collected in 1975 and preserved, 52.7% showed infection with HBV. This rate is likely so high because this was near the time of the first introduction of the disease, by a missionary in 1968 who had been infected and had been known to reuse needles in the administration of vitamin complexes to himself and to the Yanomamö of the area. In this case, a full 96.5% of the samples showed that the individual had been exposed to HBV at some point. Although only six samples were tested for HDV, all six of them were positive for the presence of anti-delta antigens, showing that this particularly severe form of hepatitis was present among the Yanomamö prior even to its description in the medical literature. However, these results may not be representative of the entire population, as the samples from 1975 were collected from individuals who showed some sign of liver disease.

Hepatitis poses a severe health risk for the Yanomamö who engage in many practices that make the wide and rapid spread of this blood- and saliva-borne disease likely. Breast-feeding, which can last 2-3 years, the pre-mastication of children's food, the sharing of instruments used to pierce the body, the sharing of chewed tobacco, and the early onset of sexual activity are only some of the examples of this.

Venereal disease has been present among the Yanomamö since the 1960s, and gained greater prevalence since then (Peters, 1998, p. 247). HIV is also a concern, as Boa Vista, one of the larger settlements in close proximity to the Yanomamö, has one of the highest rates of HIV in Brazil.

Another kind of virus with long-term effects that is now a concern for the Yanomamö is the polyoma virus. Working in the field in 1969, James Neel and Arthur Bloom showed high rates among the Yanomamö of cytogenetic damage similar to that caused by SV40, the simian polyoma virus. The polyoma virus is a type of papova virus, or DNA tumor virus, a class of viruses which have been implicated in carcinogenesis. These viruses can also produce kidney, neurological, and lymphoid disease. A study by Major and Neel (1998) showed that among individuals from 33 villages, 43.06% had significant titers of antibody to JCV polyoma virus, and 40.65% had significant titers of antibody to BKV polyoma virus. The distribution and heterogeneity suggested that the viruses were of recent introduction to the Yanomamö, and that there were probably two points of entry of the virus into the group, with introduction from the eastern (Brazilian) portion of their territory more significant than that from the western (Venezuelan) side. Other studies have shown unexpected chromosomal damage among the Yanomamö (Neel, 1971). The Yanomamö were chosen for a study of chromosomal damage as an example of a population who had been exposed to minimum levels of toxic agents in the environment. The results were surprising, showing that compared to the controls (members of the expedition) and a group of Japanese examined in a similar study, the Yanomamö had very high rates of chromosomal damage. Particularly surprising was the number of dicentric chromosomes, in some cases several in a single cell, a condition which is exceedingly rare. The reasons for this have not been discovered, but may be related to congenital defect, the presence of a virus

or other pathogen, or possibly an environmental agent such as one of the hallucinogenic plant preparations used by the adult males of the group (although this latter possibility is less likely, as similar damage was shown among female Yanomamö, who are prohibited from using these preparations).

Measles, although generally not fatal among urban peoples, is a severe health risk to the Yanomamö. A serological study conducted in 1966 and 1967 (Neel, Centralwall, Chagnon, & Casey, 1970) showed that all but a handful of Yanomamö had not before been exposed to measles; in only two villages of 18 did a significant number of individuals test positive, one of which was located near a mission and had been known to have experienced an epidemic. In the other village, none of the positive responders was younger than 28 years, suggesting that this village had sustained an epidemic of measles prior to contacts with people of European descent.

As a consequence of this discovery, Neel secured measles vaccine and was about to begin a vaccine campaign when he learned of the outbreak of measles in Brazil and Venezuela. He quickly entered the field, treated the infected and vaccinated a cordon around those who had not contracted measles.

Again, although measles is generally not fatal in western populations, fatality rates in non-western populations can be quite high. The primary complications are bronchopneumonia and a high febrile response, as well as encephalitis in severe cases. In this epidemic, at least 36% of those suffering from measles were estimated to have developed pneumonia as well, and it is thought to be the primary cause of death associated with the disease.

The other complicating factor in the spread of a disease such as measles among naïve populations is the incapacitation of the population. Measles incurs an acute febrile response, as well as prostration and dehydration. Adequate water, nutrition, and care are essential to recovery. When an entire village is stricken, however, there is often no caretaker available; hunting and garden work are suspended, breastfeeding is suspended by ill mothers. It is important to note that Neel and others believe that the complete breakdown of the economic and care system among New World peoples is largely responsible for the devastating effects of Old World diseases on these populations (Neel et al., 1970). In this epidemic, most villages were visited by a government team or missionaries, and antibiotics were supplied to help prevent secondary infections. For some, especially distant, villages, treatment was provided late in the epidemic, however. Neel et al. (1970) estimate that of about 170 cases, 29, or 17.7%, proved fatal. This number, while disheartening, would certainly have been staggering had the team not been able to vaccinate so many. This would likely have been the case had Neel not predicted the fact that the Yanomamö were likely naïve to measles and tested them for resistance, and then worked to procure vaccine. It also shows what a devastating effect such an outbreak could potentially have had if health care workers had not been vigilant.

Finally, tuberculosis must be considered a significant threat to the health of the Yanomamö. The disease may be treated with some success; however, drug resistant strains have developed with an associated 80% mortality. More effective than treatment is vaccination with bacille Calmette-Guerin (BCG), a live attenuated *Mycobacterium bovis* vaccine. Sousa et al. (1997) examined individuals from five villages. Serum samples were taken and tuberculin skin tests were administered. Subjects were also examined for BCG scars and they were found in 76% of the sample. The results were somewhat surprising. Prevalence of active tuberculosis was high, at 6.5%. Reactivity to the skin test was found among only 42% of Yanomamö who had received the BCG vaccine just 3 years earlier. The control group, European Brazilian army recruits, had a reactivity of 72% after having received the vaccine a full 18 years previously.

While analysis of T-cell response in this study was not possible, this study suggested that the Yanomamö had a reduced T-cell responsiveness to the disease, with an elevated humoral response. This is based in part on the low reactivity to the tuberculin skin test. Also noted was the fact that among the Yanomamö, production of antibodies, particularly IgM, but also IgG, was elevated in comparison with the control group.

Most disturbing in this study was the fact that of 28 new cases of tuberculosis, 82% occurred in individuals who had received BCG vaccine 3 years earlier. This incidence is higher than that seen in many other populations, and should be of concern, considering that the prevalence of tuberculosis is 100 times higher among Brazilian Yanomamö than the average for Amazonas State, Brazil. If the vaccine is less effective for the Yanomamö, other types of treatments will need to be readily available, and health care workers will need to be especially vigilant in detecting tuberculosis early, if the 50% mortality associated with the untreated disease is to be avoided.

Diet and Nutrition

Aside from the effects of the infections described above, the general health of the Yanomamö is good. In terms of diet and by many standard measures of cardiac and circulatory health, they fit an ideal profile. The traditional diet of the Yanomamö consists primarily of manioc and plantains, supplemented with wild fruits, fish, game, and insects. Except near missions, domestic animals and their products are not consumed by the Yanomamö, and there is very limited access to processed or refined sugars and grains (Lizot, 1977). The resulting diet, similar to that of some other isolated groups, is low in fat and sugar, and high in protein, fiber, and complex carbohydrates.

The effects on their health of this diet, as well as a lifestyle necessarily including a great deal of physical activity, are evidenced in a variety of measures. Mancilha-Carvalho and Douglas Crews (1990) measured anthropometric traits and serum lipids among a group of Yanomamö of the Surucucu area in Brazil. The study showed that total serum cholesterol levels among Yanomamö

adult men were half that of American men, and among Yanomamö adult women, were two thirds that of American women. Mean levels among the Yanomamö for all age groups were 121.9 mg/dl for men and 142.5 mg/dl for women.

They also showed that both height and weight were lower among Yanomamö of both sexes than among Americans. Mean Body Mass Index (BMI) was 20.4kg/m² for Yanomamö men, compared to 25.3 kg/m² for comparable samples of American men, and 21.3 kg/m² for Yanomamö women, compared to 25.0 kg/m² for comparable samples of American women. BMI, as well as lipid level, was higher for Yanomamö women than for Yanomamö men. This is likely due to the fact that about half of the women in the sample were either breast-feeding or pregnant at the time of the examination. Additionally, total serum cholesterol increased with age among the Yanomamö in this study. This must be interpreted with the consideration that the sample size for each age group was small, ranging from 1 to 17 individuals. The increase was, however, statistically significant, suggesting that age-related increase in cholesterol is not solely a product of a high-cholesterol, Western-type diet.

A study of sodium metabolism (Oliver, Cohen, & Neel, 1975), close to the time of first contact for those studied, showed that the mean blood pressure for Yanomamö was low, from 93.2 to 108.4 systolic and 58.6 to 69.4 diastolic for men, and 95.7 to 105.7 systolic and 61.6 to 64.5 diastolic for women. In contrast to most Western and acculturating groups, the Yanomamö did not seem to experience any age-related increase in blood pressure. These results certainly implicate diet as a factor; likely the fact that the Yanomamö diet includes no significant source of sodium chloride. Urine excretions of sodium were also measured, and were quite low.

In this study, excretions of potassium, found in high quantities in plantains and bananas, were much higher for the Yanomamö than for the control group. Aldosterone excretions, for which potassium is an important stimulus, were also high. Yet plasma renin suppression was not affected. The authors suggest that given these results, sodium deficiency is a more important stimulus upon renin activity than potassium suppression.

Mortality among the Yanomamö remains high, in spite of this picture of overall physical well-being. This is largely a result of infectious and parasitic diseases, which accounts for about 70% of Yanomamö mortality. The second leading cause of death is physical violence, accounting for about 13% of Yanomamö mortality (a figure that varies greatly depending on area). Accidental trauma and degenerative disease account for 7% and 6%, respectively (Melancon, 1982). Thus it is obvious that while the resources available to the Yanomamö are adequate, infectious disease poses by far the greatest threat to Yanomamö health and life than any other factor, even warfare.

MEDICAL PRACTITIONERS

Shamans (*shabori*) are the major medical practitioners among the Yanomamö. Young men who wish to become shamans are apprenticed by an experienced shaman who is usually a senior agnate (Taylor, 1976). They are taught appropriate chants to call spirits (or *hekura*, who are causes and cures for illnesses and exist in the form of tiny humanoids) and supernatural lore. The training is demanding often lasting more than a year and during this time, trainees are required to obey a series of taboos such as dietary restrictions and refraining from sex. In some villages, up to a quarter of all men may have done through shaman training but only a few distinguish themselves as consistent and effective healers.

A shaman may have dozens of *hekura* living in his body. All have animal counterparts, different personalities, and habits and may be male or female, with male *hekura* more powerful than the females. *Hekura* dwell inside the shaman's chest going about their daily activities until called upon.

Recent research among Brazilian Yanomamö suggests that contrary to previous observations on Yanomamö health practices, the Yanomamö use a wide variety of medicinal plants and that women were the main practitioners (Miliken & Albert, 1996). This research shows that male shamanic cures are typically followed by the use of medicinal plants administered by women. This same research reveals that the Yanomamö employ 113 medicinal plants, 11 of which are cultivated. Many of the plants used are also used by other Amazonian groups to treat many of the same illnesses. Knowledge of the uses of these plants is being rapidly lost through acculturation. It is possible that one of these plants (*Aspidosperma nitidum*) may have anti-malaria properties. Pharmacologists in Brazil are currently investigating this possibility.

CLASSIFICATION OF ILLNESS, THEORIES OF ILLNESS, AND TREATMENT OF ILLNESS

The Yanomamö believe that nearly all illness (and most misfortunes) are caused by either spirits (*hekura*) or the ghosts (*bore*) of deceased Yanomamö. The Yanomamö have a complex conception of the soul. One of these, the *möamo*, can be attacked or lured out of the body by *hekura* sent by a malevolent shaman (Chagnon, 1997, p. 113). If counter magic is not preformed by a curing shaman, death will ensue.

There are two kinds of spirits that can cause illness: *bore* or sprits of dead Yanomamö and *hekura*. A *bore* is that part of the soul that travels to a distant area of forest when a person dies. If a kinsman offended the deceased during his lifetime, the ghost may

avenge himself by causing sickness. An important offense is an improper mortuary ceremony which includes, among other things, destruction of the deceased's property and cremation. Alternatively, a warrior who kills an enemy is in danger from the ghost of the slain if he does not carefully follow the *unokaimou* ceremony to cleanse himself (Chagnon, 1997).

A much more common cause of illness is an attack by a *hekura* sent by an enemy shaman. Shamans have a variety of *hekura* at their disposal, which they send to destroy the souls of Yanomamö. Some are especially powerful and can only be counteracted by equally powerful shamans.

If someone falls ill, a shaman is called for a diagnosis. The shaman begins by taking hallucinogenic snuff so he may easily communicate with his *hekura*.

SEXUALITY AND REPRODUCTION

The Yanomamö are relatively permissive of premarital sex. Men aggressively seek sex with women whenever they have the opportunity and women acquiesce, sometimes, out of fear. Extramarital sex leads to fights among men over sexual rights to particular women. The most significant reproductive outcome of an illicit affair is abortion or infanticide (Peters, 1980). A strongly enforced postpartum sex taboo lasts for the 2-year duration of breast-feeding. The effectiveness of this taboo is reflected in the inter-birth intervals.

Ideas about Conception

If a woman fails to become pregnant, she is deemed to be at fault and is stigmatized (Peters, 2000). A shaman will be called to help a woman overcome this problem. In some cases, a shaman discovers that a man other than the woman's husband is using magic to cause her to be sterile or abort her fetuses. Women are expected to produce numerous children and to assiduously care for them. If twins are born, the weaker or the female is killed. The Yanomamö believe that a woman cannot adequately care for twins.

HEALTH THROUGH THE LIFE CYCLE

Pregnancy and Birth

The Yanomamö believe that each act of sexual intercourse contributes to the formation of the fetus: a man makes the child while a woman delivers it. In effect, the uterus is a passive receptacle for the formation of the fetus which grows with each contribution of semen. Consequently, as many men who contributed to the formation of the fetus are fractional fathers. This belief in "partible paternity" is not uncommon in Amazonia and elsewhere (Beckerman et al., 1998).

Abortion is common among the Yanomamö: one researcher estimates that by age 30 most women are likely to have had at least one abortion (Early & Peters, 2000). There are a number of reasons for abortion which include: the woman is too young to bear a child; a current child is nursing; or the husband believes that the child his wife is bearing is not his own. Abortion is both crude and probably dangerous for the mother. It is accomplished by direct pressure or blows to the uterus to damage the fetus or placenta.

Birth takes place immediately outside of the village where a woman is assisted by several other women, usually her mother or sisters. No men are allowed to be present. The expectant mother elevates her self by sitting on a log or other object while other women hold her from behind. The infant is allowed to fall onto a bed of fresh plantain leaves. After delivery the umbilicus is severed with a bamboo knife, the infant is inspected and washed by the assistants, and returned to the mother.

Infancy

Infanticide occurs for all the reasons listed above for abortion and, in addition, if the child has a congenital defect. Preferential female infanticide is widely reported for the Yanomamö. The Yanomamö show a decided preference for males (as in the case of twin births described above) and in many villages there is an infantile and juvenile sex ratio strongly skewed towards boys. To some extent, this skewing is a consequence of preferential female infanticide. Early and Peters (2000, pp. 210-212) in a careful analysis of infanticide for Brazilian Yanomamö show that 8% of all births results in infanticide and of these 32% are preferential female infanticides. However, in nearly all cases the decision to kill a child is made prior to birth.

During an infant's first 6 months of life, it is in the exclusive care of his mother or a close female relative when the mother is indisposed. During this time fathers are believed to lack the competence to care for infants. Mothers are expected to provide attentive care for the child and nurse on demand. Throughout most of the day the infant is attached to the mother via a sling that runs diagonally from the mother's shoulder to her hip where the child is suspended. From this position the child has easy access to the breast. A Yanomamö infant travels with its mother as she journeys to forest or garden to collect food. If the infant is out of the sling, it is never more than a few feet from the mother. One of the most traumatic events a child faces is when it is weaned from the sling. Even though a child is able to walk, it expects to be carried when the mother takes it to the forest or garden. On the trail the mother sets the child down and encourages it to follow her. The child will follow for a short distance but ultimately refuses to walk and cries or throws a tantrum until the mother picks it up. Over a period of several days, the mother repeats the process until she ultimately refuses to carry the child and it now walks on its own.

Children nurse until they are about 3 years old or until a new child is born. Supplemental feeding begins at about 6 months with soft food such as plantains. During the period of breast-feeding, a mother should not have intercourse with her husband to prevent the birth of a new child who would deprive the infant of milk.

Childhood

During the first 3 years of life children are seldom disciplined. However, if discipline is meted out, it can be very severe. If the child cries or becomes upset, it is given the breast or its genitals are gently rubbed, or it is pacified in other ways. Between the ages of 4 and 8 children roam immediately about the village in mixed age and sex groups. However, during this time boys and girls begin to segregate in same-sex groups with boys having more freedom to range further from the village and the girls are encouraged to help their mothers or care for younger siblings.

Adolescence

During this period boys and girls begin to take on labor activities that ultimately mirror adults patterns. Girls begin this process much earlier. By the time they are 9 years of age, they help carry firewood, fetch water, and prepare food. By the time they are 12-13, they have mastered the rudiments of nearly all of a woman's tasks. Throughout this period they are expected to avoid boys and young men when they are bathing or otherwise out of sight of their parents. At the sign of their first menses, they are confined to a small enclosure near their parents' hearth where they enter their puberty confinement. While in confinement they are subject to a variety of taboos and rituals that mark their transition to adulthood. When a girl emerges from confinement, she is recognized as a mature woman eligible for marriage. Frequently, she takes up residence with her betrothed.

There is no rite of passage ceremony that marks the transition from boyhood to manhood. During adolescence boys are expected to hone their hunting skills and assist their fathers in heavy work such as house construction and garden clearance. They tend to associate with other males of their age: they hunt and fish, seek female companionship, and visit other villages.

Adulthood

There are few Yanomamö women who do not bear the scars of their husband's violence. Women may be jabbed in the buttocks or thigh by arrow points, burned with firewood, or cracked across the head with firewood splitting the skin on the skull. Sometimes these injuries lead to significant disability or death. There are probably no Yanomamö men who do not bear injuries from dueling or warfare. Most injuries are on the head in the form of split skin. In fact, the men will shave their tonsure to show these dueling injuries. Death through violence accounts for 5-30% of all adult male mortality (Hames, 2001).

The Aged

The aged are treated well especially if they are surrounded by numerous kin and can still make economic contributions to families with whom they are associated. Common ailments include arthritis and old injuries that limit mobility.

Dying and Death

As mentioned above, the Yanomamö believe that nearly all deaths are supernaturally caused. They are products of *hekura* sent by long distance by enemy shamans to weaken and destroy the soul. Alternatively, death may be the result of the blowing of charms (*oka*) by enemy Yanomamö from the edges of the settlement. An inquest is usually made by a local shaman in an attempt to identify the likely source of the death magic.

Immediately after death, the body is placed on a scaffold in the forest where the bones are picked clean by scavengers. After the flesh is removed, the bones are brought back to the village where they are ceremonially incinerated. Alternatively, the whole body may be cremated in the village. In either case, the bones are removed from the fire and crushed to powder, and stored in a gourd. Later, amid much ceremony, the bone ash is mixed into a puree of plantains and/or bananas and is consumed by close kin as a final mortuary rite. In many cases, the dead are mourned on a regular basis just after sunset. The mourners cry and sob while they speak of their sadness and bitterness at the loss of a loved one. Women often lead in these evening rituals and will smear their cheeks black with ashes to mark their mourning status. Mourning may last for years. Its duration and intensity is dependent on a complex of factors such as the deceased's social status (e.g., infants are mourned the least while prominent men are mourned the most), how deceased, and the cause of death.

CHANGING HEALTH PATTERNS

Centers for contact such as mission stations, government installations (frequently they are in the same place), and mining installations influence Yanomamö morbidity and mortality patterns. Chagnon (1997, pp. 241-254) claims a higher rate of mortality for Yanomamö villages at an intermediate distance from missions. Early and Peters (2000, pp. 187-188) cast reasonable doubt on this assertion. With regard to mission contact in Brazil, Early and Peters (2000, pp. 188-190) find no consistent variation in mortality patterns. Nevertheless, it is abundantly clear that HIV, measles, influenza, tuberculosis, and various forms of hepatitis have been introduced through contact with devastating consequences for the Yanomamö.

While the missions might be implicated in the introduction of potentially life-threatening diseases to the Yanomamö, as was the case with the introduction of hepatitis and measles, the missions do not constitute the only contact the Yanomamö have, especially in Brazil, where gold miners and even farmers living in relatively close proximity can present an even greater hazard to the Yanomamö. A case is cited by Peters (1998, pp. 245-246) of what is believed to be the first case of tuberculosis among the Yanomamö, which the individual likely contracted while in the employ of Brazilian farmers, in 1966. Beginning in 1973, the Perimetral Norte, a spur of the Transamazon Highway, was constructed through the southern edge of the Brazilian Yanomamö region in the Catrimani area. Contact with road construction crews and travelers led to outbreaks of influenza and measles that killed between 30% and 50% of the people in three different villages in 1977 (Saffirio & Hames, 1983, p. 11).

There is little doubt that the invasion of gold miners beginning in 1980 has had and continues to have a devastating impact on the Yanomamö. Ramos (1995, pp. 278-279) documents huge increases in malaria, anemia, splenomegaly, respiratory infections, and tuberculosis in the Surucucu and Paapiú regions inhabited by the Yanomamö and invaded by gold miners.

John Peters (1998), a long-time missionary and ethnographer among the Yanomamö, describes the health care and facilities available to the Brazilian Yanomamö with whom he has worked. Missions and government health centers, such as *Fundação Nacional do Índio* (FUNAI) and *Fundação Nacional de Saúde* (FNS) provide medical care for the Yanomamö. For the Brazilian Yanomamö at least, the *Casa do Índio* and *Casa da Hekula* in Boa Vista are available to meet many health needs, and hospital care is available in Boa Vista as well, in cases of dire emergency. The FNS makes transport available via airplane. Finally, the Comissão Pró Yanomami (CCPY) is an umbrella organization devoted to enhancing the quality of medical care and health monitoring (as well as assisting the Yanomamö politically) for the Yanomamö. Their web site at

http://www.proyanomami.org.br/index_fl.htm is an important source of current information on the variety of health crises facing the Yanomamö.

Obviously, the availability of proper medications, such as tuberculosis treatments and antibiotics is crucial to maintain the health of the Yanomamö. Until 1995 these were available from FUNAI and FNS personnel, by missionaries, and by field nurses (Yanomamö trained to provide basic care). Currently, medications are available from FUNAI and FNS at specific centers.

Thus, some care and treatments are available to the Yanomamö; however, these remain problematic. Transportation to Boa Vista for emergency care may not be fast enough in many cases. Also, many Yanomamö continue to move often, or to spend a great deal of time away from their villages: ensuring that all receive treatment or vaccination is difficult. Better sanitation, facilities (e.g., latrines), and practices especially with sedentism becoming more common near mission posts, must be implemented if conditions are to improve.

Nonetheless, disease being the greatest threat to Yanomamö life and health, these conditions must be augmented by access to medical resources, such as medicines and supplies, and vigilant health care, whether from missionaries, government posts or others, if these conditions are to be ameliorated for the Yanomamö.

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