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COCA-LEAF CHEWING: A PUBLIC HEALTH ASSESSMENT[1, 2]

Juan C. Negrete[3]

Scientific interest and controversy has long surrounded the Andean practice of coca-leaf chewing. Recent research indicates that chronic chewing produces lasting brain function changes that show up as a cognitive deficit. This article reviews that work as well as current theories concerning the habit's other possible medical effects.

Introduction

The chewing of leaves of the coca bush (*Erythroxilum coca*) is a habit currently practiced by some 4 million people in Bolivia, Peru, and northern Argentina. In the past coca was also used by some sectors of the Ecuadorean and Colombian populations, but the practice has reportedly ceased in those countries (*16*).

Coca chewing is a widespread and culturally accepted habit in the Andean highlands, very much like cigarette smoking or coffee drinking elsewhere. Relatively few norms are attached to it, and little social pressure is exercised for people to engage in the practice or abstain from it. However, in places where social stratification and upward mobility exist, a social and racial stigma is associated with coca chewing.

Within this context it may be said that, together with Indian blood and Quechua monolingualism, coca chewing is viewed as a symbol of low standing in Bolivian and Peruvian society. Good examples of this adverse connotation are found in Peruvian slang expressions such as "cholo coquero" (coca chewing half-breed) that are commonly used as insults. Not surprisingly, the practice is also associated with illiteracy and overall poverty. In Peru a mere 2 per cent of all coca chewers (vs. 22 per cent of the nonchewing population) are reported to have reached high school, and illiteracy among chewers is estimated at 60 per cent, as compared to 18 per cent among nonchewers (*5*).

Cocaism, then, is clearly more prevalent among the native Quechua peoples who have undergone little or no racial mixture and who have had slight exposure to modernization and socioeconomic development. The largest concentration of such peoples is found in the higher areas of the southern Peruvian Andes and in the Bolivian *altiplano*.

It is a well-established fact that there is a positive correlation between the prevalence of coca chewing and high-altitude living. In this vein, a study conducted in several Peruvian villages found that only 3 per cent of the adult population practiced the habit at sea level, whereas the prevalence reached 29 per cent at 3,500 feet and exceeded 70 per cent at 11,500 feet (*4*). Indeed, coca chewing is almost universal at the less acculturated Quechua settlements in the mountains, being practiced there by men and women, young and old alike. In areas exposed to a higher degree of European influence and urban values, however, it has been observed that the prevalence of the practice is higher among older males, lower among younger males, and significantly lower among females (*5*).

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[3] Associate Professor, Department of Psychiatry, McGill University, Montreal, Canada.

Traditional coca chewers practice their habit daily; agricultural laborers or mine workers start chewing early in the morning and keep it up throughout their working hours. They may also chew while resting after meals. During days off and on festive occasions they may chew late at night, frequently while drinking heavily as well. Typically, a chewer keeps a quid of leaves in his mouth between two and three hours and renews it three to four times a day. This amounts to an average daily consumption of about 50 grams of dry leaves yielding some 250 milligrams of cocaine (*21*).

Reports of different field surveys indicate that consumption varies considerably, amounts consumed ranging from 10 to over 100 grams of leaves per day (*1, 6*). A consistent finding, however, is that older male chewers tend to consume more, while younger users usually chew less (*2, 8*). Many coca users only chew during their leisure hours—at nighttime gatherings, on fishing and hunting trips, or during other non-working periods. This latter modified practice is more typical of the younger generations of mixed European blood, who live in larger towns and who have received more formal education and professional training.

It has been known for some time that regular chewers tend to abandon the habit when they migrate to the cities in search of work and better living conditions. This is particularly true of the younger age groups. This author had the opportunity to revisit a coca chewing area after 10 years and received the definite impression that the habit was becoming much less prevalent in the younger generation. It would appear that the greater the available educational and socioeconomic opportunities, the less interest is shown by the young in retaining habits seen as associated with backward and impoverished rural living conditions.

Even though it would appear that the total number of users is diminishing, coca leaf production has nevertheless shown a steady rise over the years. Peru's official estimate for 1970 production is 9,000 tons of leaf, approximately 20 per cent more than the amount recorded 10 years earlier (*5*). In Bolivia the number of farming units producing coca leaf is growing constantly, with official production estimates indicating that between 1971 and 1974 the yield doubled, reaching a 1974 total of 12,000 tons. There are good reasons to believe, however, that this growth of production relates more to a higher worldwide demand for cocaine than it does to increased need of leaves for local consumption. Indeed, more and more farmers are using their crop to make coca sulfate through a rather primitive process that they are able to carry out on their own premises. This product, in turn, is sold through intermediaries and converted into cocaine hydrochloride at plants operating illegally in Peru, Bolivia, and elsewhere (*18*).

From a public health standpoint, however, coca chewing remains an important problem which should not be neglected. In fact, given the size of the populations involved, it must be considered among the largest if not the most extensive narcotic problem in today's world.

Health Issues

There has always been much scientific controversy about coca chewing. In more recent years, arguments have centered around the desirability of banning the habit and expelling it from its traditional habitat in the Andes. Several authors believe that coca chewing is needed for optimal high-altitude living and that it helps endure the difficult geoclimatic and working conditions to which Andean populations are subjected. This opinion is supported by recent field research which

indicates that coca chewing helps cope with the cold temperatures and low oxygen pressures prevailing in the high Andes (*12*). In addition, some findings have been reported to support the hypothesis that the metabolic effects of coca help correct the low blood sugar levels believed common in the Quechua population (*2*).

Unlike other psychoactive drug habits, coca-leaf chewing does not seem to have a hedonistic purpose, the consistent opinion of writers on this subject throughout the years being that coca chewing is practiced within a utilitarian context. Most authors assert that it helps users at work by reducing fatigue, hunger, and thirst, and by augmenting their endurance—and thus their performance—in the fields and mines. Surveys of attitudes and opinions on coca chewing among chewers themselves have repeatedly found these to be the main reasons given to justify the habit (*8*).

An obvious question, however, is whether the chewing of coca leaves should be considered to have an effect of the same general nature as the direct use of the alkaloid, cocaine hydrochloride. Laboratory experiments would tend to support the view that pure cocaine ingestion and coca-leaf chewing produce similar effects. Gutiérrez Noriega and Zapata-Ortiz (*11*) measured the responses of native subjects to the ingestion of varying doses of cocaine (up to 4 mg per kg of body weight) and of habituated chewers to some 80-100 g of dry leaves. In both cases the subjects experienced hyperglycemia, hyperthermia, an elevated pulse, and increased rates of metabolism and respiration. Measuring some psychological functions, it was found that both coca leaves and cocaine cause a delay in reaction time and decreased accuracy in completing a task. All these effects appear to be dose-related and are most evident when the subjects take the equivalent of 3 mg cocaine per kg of body weight.

Other less objectively measured psychological changes are said to occur similarly under the influences of cocaine and coca leaves. Gutiérrez Noriega and Zapata-Ortiz (*11*) report alterations in the perceptions, thought processes, and emotional reactions of the subjects studied. However, these changes are more difficult to measure and are believed to be highly dependent upon the attitudes, expectations, and personalities of the subjects as well as upon the experimental setting. Moreover, the individuals participating in this study were volunteer students and prison inmates in Lima, whose psychological characteristics and urban identity were not representative of the traditional coca-chewing population.

Field observations, made mostly by social scientists in the Andes, have repeatedly failed to detect behavioral or psychological changes in chewers. One possible explanation for this apparent discrepancy is the fact that the experimental subjects in Lima were asked to chew larger amounts more quickly than is customary among spontaneous users. However, recent experiments conducted with indigenous chewers at a high Andes location replicated the Lima results with regard to physiological changes; that is, the coca chewing was also found to elevate internal body temperature and increase endurance for tasks requiring physical effort (*12*).

It would seem logical to assume that the factor responsible for the observed effects of coca chewing is the cocaine contained in the leaves. Most authors believe that the alkaloid is absorbed during its passage through the digestive system and reaches the central nervous system in an active form. Montesinos (*14*) opposes this view on the basis of laboratory experiments indicating that cocaine is largely altered by the digestive juices and undergoes further metabolism in the liver. It has been argued that Montesinos' experiments in vitro, using digestive juices from dogs, might not faithfully reflect the process occurring in human beings. In addition, it is believed that an important share of the alkaloid is

absorbed through the buccal mucosa, without reaching the stomach where the more active metabolic changes begin (*21*).

Thus, on balance, it may be said that coca chewing produces the same short-term physiological changes observed after the administration of cocaine. What remains to be established is whether it has the same addictive properties as the latter.

For most chewers the craving is not overpowering, and they are able to go without the leaves if circumstances force them to do so. Although some mild withdrawal symptoms such as constipation and general malaise have been described (*11*), the general impression is that the average user does not suffer in deprivation. Tradition requires, however, that heavy work such as mining or cutting of sugar cane be done with the help of the leaves. Many workers would refuse to perform such tasks without them, and a ration of coca is still used as partial payment for services in some areas.

As in the case of cocaine use, coca chewing does not seem to induce a condition of physiological tolerance. The larger daily amounts consumed by older chewers seem to be more a function of higher purchasing power than true tolerance.

This conclusion is supported by the fact that customary doses tend to reach a plateau and stay at the same level for many years.

Coca chewing in the high Andes and cocaine use in urban settings present differences comparable to those observed between traditional opium smoking in South-East Asia and heroin addiction in industrial societies (*19*). The sociocultural setting of these activities, the motivation and psychological characteristics of the users, the doses involved, and the intake routes are sufficiently different to produce the distinct patterns observed. Coca chewing is a case of orderly, moderate, and social use of narcotics. It cannot be equated with the usually individualistic, anarchic, and more symptomatic problem of cocaine abuse.

Long-Term Effects

The problem of addiction, then, is a relatively minor one in the case of coca chewing. Nevertheless, one must wonder whether the chronic use of this psychoactive substance with measurable effects on body functions is apt to produce harmful effects that are long-lasting or irreversible.

It has been claimed, for example, that by reducing hunger coca chewing may contribute to a lower food intake and consequent malnutrition. A comparative study between chewers and nonchewing control subjects in the Peruvian community of Cachicoto found that the former did show indications of a poorer overall nutritional state. Their average weight/height ratio, skin-fold thickness, and levels of serum albumin and serum cholesterol were significantly lower. A significantly larger proportion of chewers were also found to suffer from hypochromic anemia (*3*).

These findings are impressive and deserve careful attention. However, because of the extreme difficulties usually encountered in matching chewers and control subjects in the Andean region, they must be interpreted with great caution. In this particular study, Buck et al. paired their subjects by sex, age, and ethnic identity, thus ensuring comparability of three important factors. But the nutritional disparities found could also have been related to social and educational inequalities suggested by marked differences in the groups' religious affiliations. That is, a large number of the control subjects were listed as being Protestants, which in the particular region studied characterizes them as belonging to a selective minority of people who are rather militant about matters of life-style, who do not use alcohol, and who are generally felt to be more resourceful from a socioeconomic standpoint.

Another interesting finding of the Cachicoto study was that a significantly higher proportion of chewers had enlarged livers.

Although their reportedly heavier alcohol intake could have accounted for this particular difference, the observation is consistent with a previous experimental finding that laboratory animals developed hepatomegaly following prolonged administration of cocaine (*11*).

There are some indications, then, that coca chewing is associated with malnutrition, anemia, and liver damage. But the evidence would seem insufficient to attribute a primary etiological role to the practice, especially if other significant factors such as poverty, an unbalanced diet, alcohol abuse, and parasitic diseases have not been taken into account.

Coca chewing has also been associated with a poorer overall state of health. Two separate surveys report that chewers perceive themselves as having more health problems (*9*) and that they miss more time at work for reasons of illness than do their non-chewing counterparts (*3*). Again, these findings would gain greater significance if other pertinent social factors could be ruled out.

On the other hand, it has been suggested that chewers may derive some nutritional benefit from coca. A reliable analysis of coca leaf content concluded that "the ingestion of 100 g of leaves would satisfy the dietary allowance for [a] reference man and woman of calcium, iron, phosphorus, vitamin A, vitamin B_2, and vitamin E" (*7*).

Furthermore, field observations have suggested that coca chewing serves as a palliative when no food is available, and that it helps the individual to endure longer periods of fasting when work conditions demand it, but that it does not interfere with food intake when the supply of food is adequate (*13, 15*).

Long-Lasting Psychological Effects

Given the fact that cocaine has a proven pharmacological effect on the central nervous system (CNS), an obvious concern is whether or not the prolonged use of this drug causes long-lasting or permanent alteration of CNS functions. It has been claimed that coca chewing was responsible in some cases for severe neuropsychiatric conditions—such as epilepsy and psychotic states of a delusional and hallucinatory nature (*10*). Although it is possible that a rather deviant minority of very heavy users may develop such conditions, it has been more commonly observed that most chewers conduct their lives without noticeable difficulty in regard to social functioning or work performance.

A less disputed impression is that chronic chewers appear rather dull and apathetic (*20*) , that they seem to lose drive and initiative, and that their ability to handle more complex matters is diminished. For example, Gutiérrez Noriega and Zapata-Ortiz (*11*) remark that Quechua Indians look much brighter and more alert when they are young, and that as they age some tasks requiring sharper psychological performance, such as negotiation of transactions, are usually taken over by women, who tend to chew considerably less than men. These observations describe manifestations consistent with a psychological picture of altered brain fuction. A few years ago, we at the McGill University Section of Transcultural Psychiatric Studies undertook research aimed at testing the hypothesis that chronic coca chewing causes deterioration of cognitive functions.

These studies have been published (*17, 15*), and the reader is referred to the original reports for details concerning study design and the interpretation of results. The following points stress some of the more pertinent findings relating to this discussion:

1) The assessment of psychological functions in the Andean population is rendered difficult by a number of cultural factors such as illiteracy, a tradition of limited verbal expression, and an attitude of

resistance to alien activities such as psychological testing. (We have found that psychometric tests involving complex verbal responses or paper and pencil work are intimidating or poorly understood. Their validity would seem questionable, both for chewers and nonchewers, so they were excluded from the battery used in our study.)

2) It was not possible to assemble a well-matched sample of nonchewers to be used as controls. Completely abstinent individuals tended to be significantly younger and more educated. Our control group therefore included a number of occasional users; the contrast here was based on the fact that their counterparts in the chewers' group were known to chew daily during working hours.

3) No noticeable differences were observed between chewers and controls with respect to general behavior and spontaneous social performance. Both groups showed similar attitudes toward the testing situation, particularly regarding participation and cooperation.

4) The initial assessment indicated that chewers tended to obtain lower scores in all of the eight tests used to evaluate higher cognitive functions such as attention, memory, abstract reasoning, and learning. The chewers' poorer performance was still evident after allowing for factors such as age, education, and place of residence which could have influenced the results.

5) Breaking down the chewers' group according to different degrees of chronic chewing showed that the scores tended to get worse with more years of chewing and suggested that short-term effects of coca chewing did not play a significant role in these results.

6) The results of a second study, conducted two years later, tended to confirm the validity of our testing procedures, in that several of the same subjects obtained similar scores on the same tests. This second study, however, was designed to evaluate learning progress under controlled laboratory conditions. Here again, as expected, both past chewers (abstaining at the time of the study) and chewers who continued to practice the habit obtained poorer results than the controls. These poorer results were obtained with regard to both the overall score and the rate of improvement in three separate testing trials.

7) A more detailed examination of the results indicated that the tests most responsible for the overall differences were those calling for a higher level of abstract thinking—as opposed to those merely requiring manual dexterity.

8) When allowance was made for the subjects' level of education, it was observed that literate controls scored much better than illiterate ones, whereas among chewers such a difference did not exist. In other words, it would seem that the chewers had lost certain abilities learned or developed at school which the controls had retained. Again, these tendencies were made clear by tests requiring more elaborate abstract thinking, the manual tests yielding similar results regardless of whether the subjects were literate or illiterate.

The most logical interpretation of these findings is that chronic coca chewing produces lasting brain function changes that manifest themselves as a cognitive deficit. Such a deficit is not readily perceived under normal living conditions that currently prevail in the Andes. Specifically, most adult chewers carry on a rather simple, monotonous life with little opportunity for change and little intellectual challenge.

The fact that the capacity for abstraction and the ability to grasp and learn principles behind concrete phenomena seem particularly affected makes the chewers' "subliminal" deficit a matter of great social concern. Indeed, it may be said that by interfering with such functions, coca chewing reinforces a state of individual and social stagnation, impairs creativity, decreases initiative, and may prevent large sectors of the

Andean population from taking full advantage of available opportunities.

In conclusion, of all the harmful effects attributed to coca chewing, the impairment of cognitive functions may well prove to be the most significant. For by rendering people less able to seek change, it may strongly contribute to perpetuation of the present unfavorable social conditions that foster so many other important health problems in the Andean population.

SUMMARY

Coca-leaf chewing, a prevalent habit in the Andean highlands of Peru and Bolivia, constitutes an important public health problem. In fact, the numbers of people involved make it one of the major narcotics problems in the world.

It should also be noted, however, that differences between coca-leaf chewing in the high Andes and cocaine use in urban settings are comparable to the differences between opium smoking in South-East Asia and heroin addiction in industrial societies. That is, coca-leaf chewing involves an orderly, moderate, and socially accepted use of narcotics that cannot be equated with the usually individualistic, anarchic, and more symptomatic problem of cocaine abuse.

There are some indications that coca-leaf chewing is associated with malnutrition, anemia, and liver damage. But the evidence would seem insufficient to attribute a primary role to the practice, especially if other significant factors such as poverty, an unbalanced diet, alcohol abuse, and parasitic diseases are not considered. There is also some evidence associating the habit with a poor overall state of health—and on the other hand with certain kinds of nutritional benefits, and with increased ability to go without food when working conditions demand it.

Perhaps more significantly, studies performed at McGill University have provided considerable evidence that chronic coca-leaf chewing causes lasting brain fuction changes that manifest themselves as a cognitive deficit. This deficit is not readily perceived under normal Andean living conditions, since the lives of most chewers there are rather simple and monotonous, with little opportunity for change and little intellectual challenge.

The fact that the chewers' capacity for abstraction and for grasping and learning basic principles seems particularly affected is a matter of great social concern. For by interfering with these functions, coca-leaf chewing reinforces a state of individual and social stagnation, impairs creativity, and decreases initiative. Moreover, by rendering people less able to seek change or take full advantage of available opportunites, the habit may strongly contribute to perpetuation of the present unfavorable social conditions that foster so many other important health problems in the Andean population.

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