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Medicinal Plant Use and Knowledge for Monteverde Residents Based on Age and Education

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ABSTRACT

Approximately 80% of the world population relies on medicinal plants from the forest, home gardens, or market as a primary form of healthcare (Alcorn 1995). However, increased development and deforestation in recent years may be compromising the practice of natural medicine among the inhabitants of many developing countries. Interviews with 33 residents of Monteverde, Cost Rica examine both the current level of knowledge concerning natural medicine and its practice based upon age and educational level. Statistically significant positive linear relationships were found between both utilization and knowledge of medicinal plants and age. Knowledge and utilization of medicinal plants decreased weakly with increasing educational level; however age may be a confounding variable, as education was correlated with age. Despite the lower number of natural treatments cited by the youngest participants, the practice of natural medicine is indeed still prevalent among residents of Monteverde, demonstrated by the average number of ailments for which participants used medicinal plants, 11 out of 16. As the species of plants cited are mostly exotics or garden-variety natives, the results of this study do not have strong implications for conservation. Nevertheless, considering the lack of affordability of pharmaceutical products, it is fortunate that medicinal plant knowledge has survived in this community.

RESUMEN

Aproximadamente 80% de la población del mundo usa plantas medicinales del bosque, los jardines, o el mercado para mantener salud (Alcorn 1995). Sin embargo, el desarrollo y la deforestación en los últimos años pueden influir la práctica de medicina natural entre los habitantes de muchos países en desarrollo. Entrevisté 33 residentes de Monteverde, Costa Rica para examinar el nivel del conocimiento sobre medicina natural y su práctica con respecto a edad y nivel de educación. Hay relaciones lineales, positivas y estadísticamente significativas entre ambos la utilización y el conocimiento de plantas medicinales y la edad de la persona. El conocimiento y la utilización de plantas medicinales disminuyeron débilmente con niveles de educación más altas; sin embargo la edad puede ser una variable que confunde, porque la educación estuvo asociada con la edad. A pesar del número más bajo de tratamientos naturales citados por los participantes más jóvenes, la práctica de la medicina natural es todavía predominante entre residentes de Monteverde, debido a el número de enfermedades para lo cuál los participantes usaron plantas medicinales. La mayoría de las especies de plantas citadas es exótica, por lo cual los resultados de este estudio no tienen implicaciones importantes para la conservación. Por los precios elevados de los productos farmacéuticos en el mercado, afortunadamente el conocimiento de medicina natural ha sobrevivido en esta comunidad.

INTRODUCTION:

Utilitarian arguments for conservation of tropical forests emphasize that species must be preserved because of their realized or potential utility to humans (Alcorn 1995). Indeed, forty two percent of the world's top selling drugs are derived from natural sources, and pharmaceuticals from genetic resources are valued at \$75-150 billion annually (Kate and

Laird 1999). Bioprospecting companies such as the Instituto Nacional de Biodiversidad (INBio) are attempting to find novel chemical compounds, genes, macro and micro organisms and other valuable natural products to create new medicines and consumer products (Sittenfield et al. 1994). For example, the use of rosy periwinkle (*Catharanthus roseus*) for treating childhood leukemia and Hodgkin's disease illustrates the pharmaceutical potential of tropical forests and the need for their conservation (Balick 1997). *Artemisia annua*, an herbal remedy used in China for almost 2000 years has proven effective against resistant strains of malaria (Balick 1997).

Pursuit of miracle drugs to treat cancer, neurological disorders, and infectious diseases is the developed world's view of the medicinal value of tropical conservation. However, according to the World Health Organization over one-third of the world population, primarily in developing countries, lacks access to essential medicines. Moreover, of the six billion people in the world, only about one billion utilize manufactured pharmaceuticals to maintain health and treat illnesses (Alcorn 1995.). The remaining 5 billion obtain medicines from the forest, home gardens, or local market. In Belize up to 75% of the primary health care is provided by traditional healers using medicinal plants (Balick 1997). As habitat destruction increases in developing countries, availability of natural resources for medicinal application is greatly diminished.

Furthermore, the influence of industrialized nations may contribute to a loss of culture, tradition, and knowledge of medicinal plants and natural remedies. A study among the native inhabitants of the Atlantic Forest in Caicaras, Brazil (Begossi et al. 2004) documented patterns of medicinal plant uses based on age. Caicaras depended predominantly on small-scale agriculture until the last 20 years when tourism increased

dramatically. Through interviews researchers found the greatest amount of medicinal plant knowledge among older individuals (aged 40 and over) in the population, indicating that information is being lost.

There is evidence that development may lead to the loss of traditional knowledge. A study among communities in Sierra de Manantlan of western Mexico (Benz et. al 2000) revealed that knowledge of medicinal plant uses was lower among more modernized communities. Reduced knowledge and use of medicinal plants was associated with the loss of indigenous languages and reduced community remoteness, as well as the presence of indoor plumbing and modern medical infrastructure.

Many generations of the historically remote town of Monteverde, Cost Rica have relied on natural remedies from local forest, farms and gardens to treat minor illnesses from headaches and gastrointestinal problems to asthma and insomnia (Libman 1999). In the past lack of access to pharmacies and medical infrastructure may have contributed to dependence upon natural medicine. Yet, as modern institutions become more common and encroachment upon the forests increases, the vertical transmission of biological knowledge from one generation to the next is uncertain. The presence of more expensive manufactured drugs as medical alternatives as well as the discouragement of natural medical practice from Western thought may influence younger individuals. Since the average annual income for 2000 in Costa Rica was U.S.\$4,062 per capita, increased dependence upon more expensive pharmaceutical products would have prominent economic implications (Estado de la Nacion 2006). This study examines the current level of medicinal plant knowledge and use for Monteverde residents based upon age and education.

MATERIALS AND METHODS

Study Site

Monteverde, Puntarenas province, Costa Rica was chosen for its rich biodiversity, proximity to tropical lower montane wet forest, history of natural medical practices, and increased development in the last 20 years. This is essential to the study in that rapid development may contribute to cultural differences between generations. Until the mid 1980s Monteverde's economy was based on small single-family farms. Electricity has only been installed in some parts within the last 10 years. However, ecotourism has eclipsed agriculture as the principal source of income for the town (Nadkarni, 2000). In only two decades Monteverde has become a world-renowned destination for tourists, receiving an estimated 120,000-150,000 visitors (M. Hidalgo, President of Local Tourism Board) to 200,000 visitors annually (Key to Costa Rica, 2006). Data were collected from October 24 to November 15, 2006. Interviews of local residents were conducted in the homes of participants, in local businesses, and in the center of Santa Elena, Costa Rica.

Selection of Participants

Recruitment of the thirty-three participants was based upon convenience sampling with restrictions on place of origin and age. Only persons over the age of 20 and raised in Monteverde or the adjacent towns of Guacimal, Las Juntas, and Tilaran were asked to participate in this study. Because the transmission of biological and medicinal knowledge is in part a social construct, it may be influenced by family values and tradition as well as socioeconomic status (Cox 1997) To help control for these potentially confounding variables, efforts were made to interview several members within the same family.

Conduction of Interviews

Participants were interviewed in Spanish, in-person without the aid of a recording device. Interviews were based on a standard questionnaire (Appendix 1), which consists of several questions regarding the interviewees' backgrounds as well as their use and knowledge of natural treatments for 16 common ailments. Participants were told at the start of each interview that questions concerned practices in the treatment of common illnesses rather than use and awareness of medicinal plants to avoid potentially biased answers. Utilization and knowledge were measured as the number of ailments out of a possible 16 for which the participants stated using or naming a natural treatment. It is important to note that this study does not concern itself with the number of medicinal plants used or known; if participants cited more than one medicinal plant for an ailment, it was counted as only one treatment. To qualify as a natural remedy, the treatment must be available in a form not manufactured by pharmaceutical companies. This included all plants and agricultural products.

Price Determination for Pharmaceutical Drugs

In order to quantify the economic burden of purchasing manufactured pharmaceuticals, prices of common medicines were collected at Farmacia Vitosi, one of only two pharmacies in the Monteverde region. Prices were converted from Costa Rican colones to U.S. dollars and adjusted for 12 pills. The recommended dose for each medicine is two pills every four to six hours.

RESULTS

Use and Knowledge of Medicinal Plants Based on Age

A significant positive linear relationship exists for age and utilization of medicinal

plants (regression, $R^2 = 0.355$, $p < 0.001$, $n = 33$; figure 1 A) as well as for age and knowledge of medicinal plants (regression, $R^2 = 0.322$, $p < 0.001$, $n = 33$; figure 1 B). However when data points from participants aged 20-23 ($n = 5$) were removed from the analysis, the trends become much less apparent and the results for both utilization and knowledge are no longer statistically significant (regression, $R^2 = 0.099$, $p = 0.108$, $n = 27$ and $R^2 = 0.069$, $p = 0.185$, $n = 27$, respectively; figure 2).

Interestingly, females stated using medicinal plants more often than males (t-Test, $t = 3.04$, $df = 32$, $p < 0.005$); also they were able to name more natural remedies (t-Test, $t = 3.48$, $df = 32$, $p < 0.005$). Visually, the majority of points representing female participants lie above the best fit line, while many points representing male participants lie below the line (Figure 1). The mean female age was 43.47 ± 14 , while the mean male age was 34.43 ± 14 .

Use and Knowledge of Medicinal Plants Based on Educational Level

There is a negative linear trend between educational level and use of medicinal plants, however the results are not statistically significant (regression, $R^2 = 0.099$, $P = 0.074$, $n = 33$; figure 3 A). Similarly, there is a negative linear relationship between educational level and knowledge of natural medicine (regression, $R^2 = 0.088$, $P = 0.095$, $n = 33$; figure 3 B). Age and educational level were inversely related (linear regression test, $R^2 = 0.361$, $P\text{-value} < 0.001$). Conversations with interviewees and other residents of Monteverde indicate that the majority of younger individuals tend to be more highly educated than their parents and grandparents. For example, the average educational levels were 11.9 years \pm 3.5 for the 20-29 year old interviewees, 9.1 years \pm 4.0 for the 30-39 year olds, and 6.4 years \pm 5.1 for participants 40 years and over.

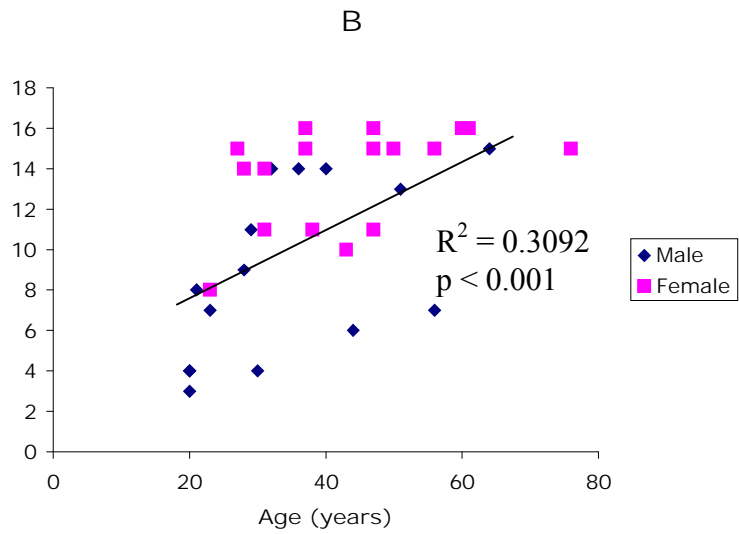
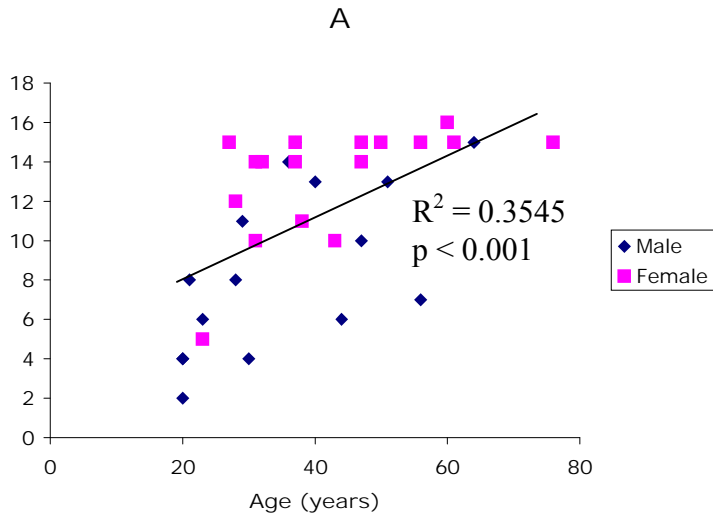


Figure 1. A. Use of Medicinal Plants Based on Age. Participants were asked what they use to treat 16 common ailments. "Treatments" measures the number of ailments for which participants used natural remedies. B. Knowledge of Medicinal Plants Based on Age. Participants were asked to name a medicinal plant or natural remedy for 16 different ailments. Both use and knowledge of medicinal plants increase with age. Males interviewed tended to be of younger ages, while the age of females has a more even distribution.

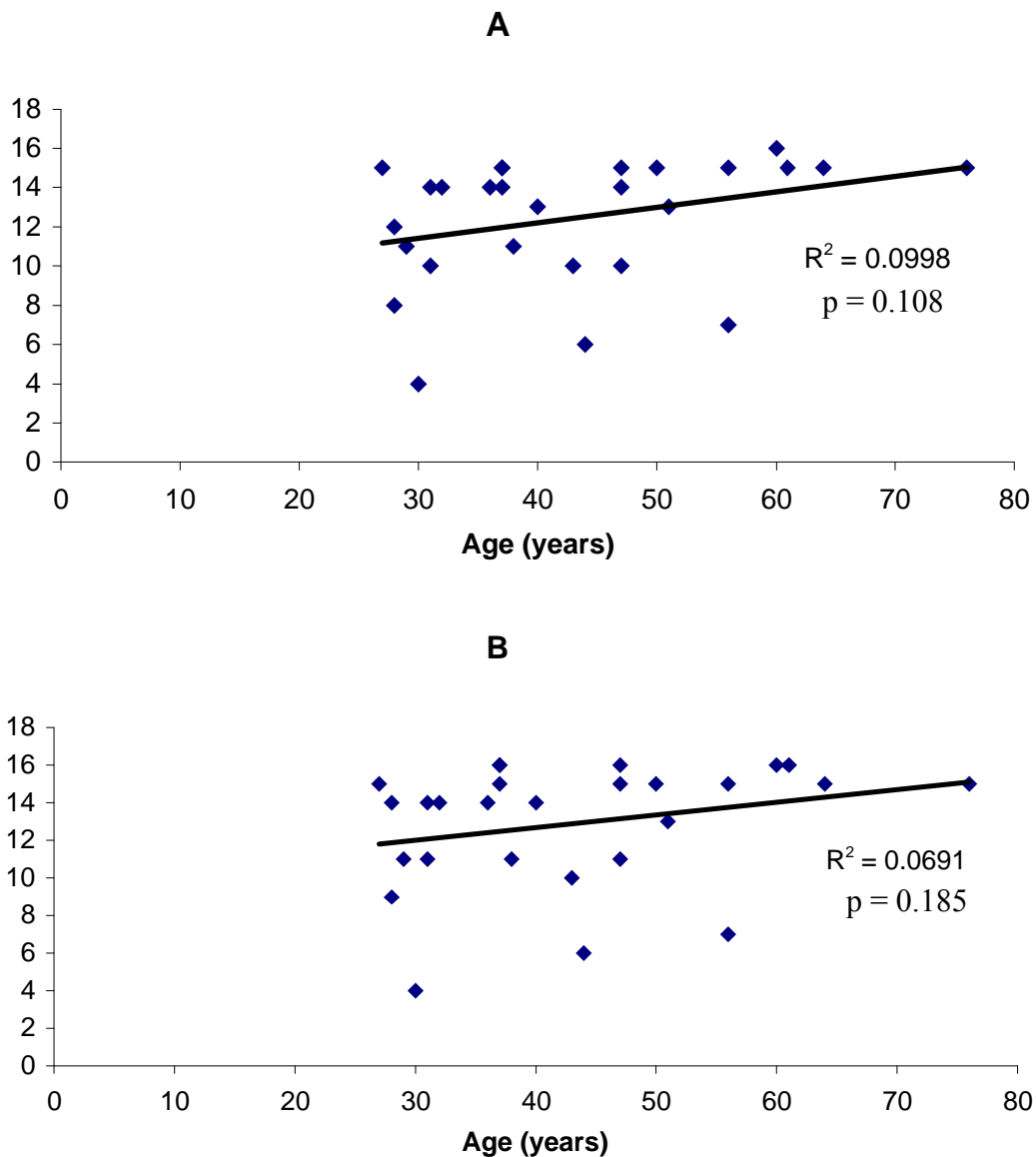


Figure 2. A. Use of Medicinal Plants Based on Age (27-76 years). Data from the 20-26 year old group was removed, revealing a weaker relationship between age and number of natural remedies used to treat the 16 ailments. B. Knowledge of Medicinal Plants Based on Age (27-76 years). Data from the 20-26 year old group was removed, revealing a weaker relationship between age and number of known natural treatments for the 16 ailments.

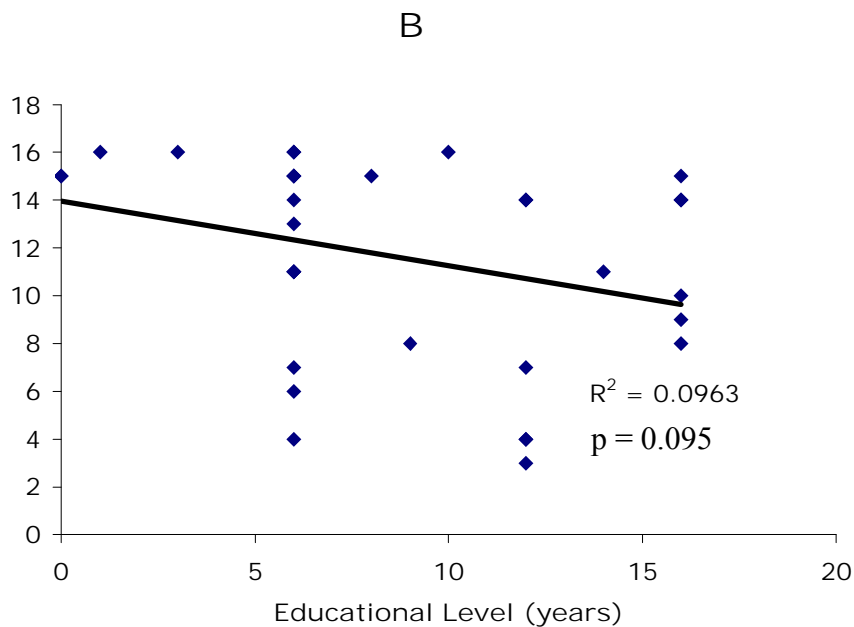
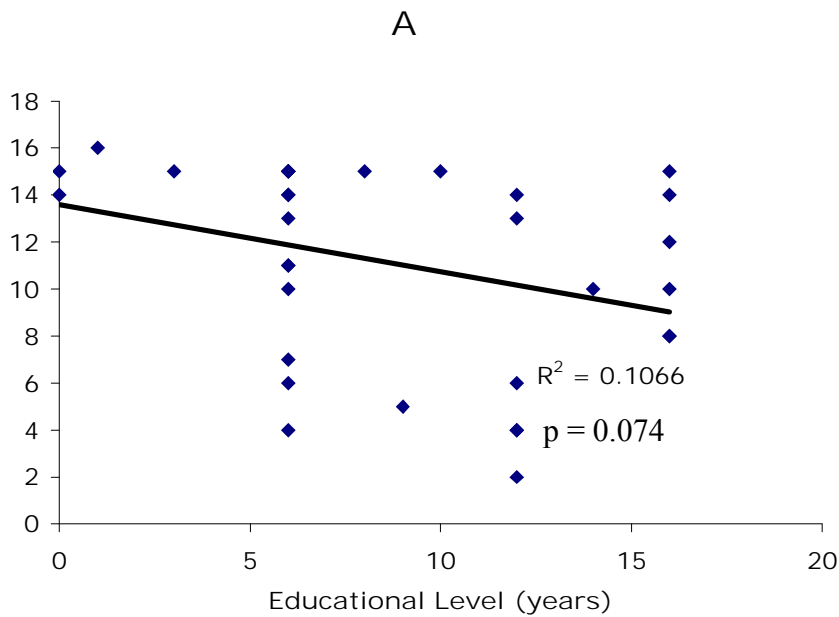


Figure 3. A. Use of Medicinal Plants Based on Educational Level. Participants were asked what they use to treat 16 common ailments. "Treatments" measures the number of ailments for which participants used natural remedies. B. Knowledge of Medicinal Plants Based on Educational Level. Participants were asked to name a medicinal plant or natural remedy for 16 different ailments. Both use and knowledge of medicinal plants decrease weakly with increased educational level.

General Observations

All interviewees used and were able to cite medicinal plants for at least 2 ailments out of a possible 16, with the average number of natural treatments used and known being 11.06 and 11.58, respectively. Table 2 summarizes the most frequently cited medicinal plants and their indications. Only 45% of the plants listed are native to the Neotropics, while the majority are introduced. Many species are cultivated in gardens and prefer disturbed habitats (Bernhardt 2004). All of the participants acknowledged family members, including parents, grandparents, aunts, uncles, cousins, and in-laws as the source of cited natural remedies. Younger participants aged 20-23 (n = 5) were often more hesitant in responding to the questions and expressed doubt when citing a medicinal plant. Two stated that other family members such as parents or grandparents prepared teas and other treatments, which the participants were unable to identify. When asked what he used to treat sore throats, one 20 year old shrugged and stated that he did not know. At that time that interviewee's mother interjected, "I make llanten tea for you." She laughed and said to me, "He drinks it; he just doesn't know what it is."

Use of natural medicine varied little with knowledge of natural medicine, indicating that if participants knew of the natural remedy, they most likely used it as part of their healthcare routine. The vast majority of interviewees (n = 30) expressed a preference for natural medicine over pharmaceutical products, with only one participant (aged 30) preferring pharmaceutical drugs and two participants (aged 20 and 28) expressing no preference. The most frequently cited reason for favouring natural medicine was reduced secondary effects (n = 24). One participant (aged 76) complained that when she took acetaminophen for a headache, it provoked stomach pains, or if she used decongestants

she became drowsy and lethargic. Participants (n = 21) claimed that natural remedies, especially teas prepared from dried medicinal plants, were as effective in relieving their symptoms without side effects. Many interviewees (n = 11) acknowledged the high cost of manufactured medicine as a deterrent from its use. One interviewee (aged 28) who preferred natural medicine in conjunction with pharmaceutical medicine stated that if she was ill and had money, she went to the pharmacy, but if she did not have money, she went to her grandmother's garden. Table 1 displays the prices of several common medicines used to treat cold and flu symptoms as well as stomach problems. The pharmaceutical drugs ranged in price from U.S.\$2.80 to U.S.\$8.40 for 12 pills. Tradition and custom were also consistently mentioned (n = 7) as influencing healthcare choices.

Table 1. Common Pharmaceutical Products, Indications and Prices collected at Pharmacy Vitosi located in the center of Santa Elena, Costa Rica

Medicine	Use	Price (for 12 pills)
Pseudophedrine	Nasal decongestant	\$8.40
Panadol	Colds, flu, sore throat, fever, cough	\$4.80
Tapsin	Colds, flu, sore throat, fever, cough	\$3.00
Aceatminophene	Headaches	\$2.40
Comtrex	Colds, flu	\$5.00
Lomotil	Stomach problems, diarrhea	\$7.20

Table 2. Common Medicinal Plants Cited by Monteverde Residents.

Common Spanish/English Name	Scientific Name (Family)	Origin	Medicinal Use
Ajo/Garlic	<i>Allium sativum</i> (Liliaceae)	Europe	Intestinal parasites, antibacterial, antiviral
Apazote/Wormseed	<i>Chenopodiaceae ambrosioides</i> (Chenopodiaceae)	Neotropics	Parasites
China	<i>Impatiens walleriana</i> (Balsaminaceae)	Africa	Antibiotic, relieves itching of insect bites
Canela/Cinnamon	<i>Cinnamomum zeylaanicum nees</i> (Lauraceae)	Asia	Stomach problems, nausea, diarrhea
Coco/Coconut	<i>Cocos nucifera</i> (Arecaceae)	Neotropics	Parasites
Dormilona/Mimosa	<i>Mimosa pudica</i> (Mimosaceae)	Neotropics	Sedative, pain reliever, dental pain
Guajava/Guava	<i>Psidium guajava</i> (Myrtaceae)	Neotropics	Diarrhea, bleeding gums
Hierbabuena/mint	<i>Mentha citrata, M. crispera, M. piperita</i> (Labiatae)	Europe	Calms nerves, antibacterial, stomach problems
Jingibre/Ginger	<i>Zingiber officinale</i> (Zingiberaceae)	Asia	Antibacterial, natural stimulant, sore throats, colds and flu, digestion
Juanilama	<i>Lippia alba</i> (Verbenaceae)	Neotropics	Digestion, relaxant, colds, flu
Limon/Lemon	<i>Citrus spp.</i> (Rutaceae)	Asia	Colds, flu, sore throat
Llanten/Plantain	<i>Plantago mayor</i> (Poaceae)	Unknown, cosmopolitan	Colds, flu, sore throat, cough
Manzanilla/Chamomile	<i>Matricaria chamomilla</i> and <i>Anthemis nobilis</i> (Compositae)	Europe	Mild calmativ, relaxant, digestive stimulant
Menta/Mint	<i>Mentha rotundifolia</i> (Lamiaceae)	Neotropics	Vomiting, antibacterial, calms nerves
Oregano	<i>Lippia graveolens</i> (Verbenaceae) and <i>Origanum vulgare</i> (Lamiaceae)	Neotropics and Europe, respectively	Stomach problems, colds, cough, flu
Papaya	<i>Carica papaya</i> (Caricaceae)	Neotropics	Digestion, stomach problems
Romero/Rosemary	<i>Rosemarinus officinalis</i> (Lamiaceae)	Europe	Stomach problems, digestion
Ruda/Common Rue	<i>Ruta graveolens L.</i> (Rutaceae)	Europe	Ear infections, inner ear pain
Sábila/Aloe Vera	<i>Aloe vera</i> (Liliaceae)	Africa	Burns, insect bites, gastritis
Tilo	<i>Justicia pectoralis</i> (Acanthaceae)	Neotropics	Mild sedative
Zacate de Limon/Lemon Grass	<i>Cymbopogon citratus</i> (Poaceae)	Asia	Colds and flu, pain reliever, inflammation, relaxant

DISCUSSIONS

Results of the study demonstrate an increase in use and knowledge of medicinal plants with increasing age. The results agree with the study by Begossi et al. (2004), in which the highest levels of medicinal plant knowledge were found among the older members of the population. The potential cause of the positive relationship between age and knowledge or use of natural medicine may be explained in part by increased development. Older individuals were raised in an environment much different than that of their children and grandchildren. One 40 year old resident of Monteverde stated that during his early childhood, there was no electricity in the town and people had to purchase supplies from neighbouring Guacimal or Las Juntas, which was a two-day journey on horseback. Many interviewees over the age of 40 were delivered at home by midwives, because the nearest hospital was in Puntarenas. This sharply contrasts the Monteverde of today with modern clinical facilities and several fulltime physicians.

Yet, the trend becomes much weaker when the data for the 20-23 year olds were removed. It appears that the lack of use and awareness of natural medicine is mainly among the youngest interviewees, while adults in their late 20s and 30s generally exhibited a breadth of knowledge comparable to older individuals. A possible hypothesis is that adults in their early 20s are less likely to have children than adults in their late 20s and beyond. It could be that knowledge of natural remedies is gained when individuals bear the responsibility of caring for the health of their families. This may be the critical point where they develop an interest in healthcare and begin to ask older family member for advice in treating common illnesses. Furthermore, conversations with locals and observations of family dynamics indicate that it is common in Monteverde for children to

live with parents until marriage, regardless of age. If the 20-23 year old interviewees are living with their parents, then it is possible that they are unknowingly using natural remedies, which may have caused inaccurate responses for use. In this case, there may have been a large gap between use and knowledge. The interviews in which the participants stated that other family members prepared remedies for them support this hypothesis. Treatments prepared by other family members could explain why these interviewees were unable to cite using specific medicinal plants. The extensive preference of natural medicine over pharmaceutical products, regardless of measured practice or awareness, is also consistent.

It appears that females were generally more knowledgeable and more likely to cite using natural medicines than males, which is consistent with the study conducted by Begossi et al. (2004). They found that the greatest knowledge tended to be among women, many of them housewives, with a mean age of 46 years. Traditional gender roles may explain this trend, as it is typically women who care for ill family members. Yet, many men identified uses for a substantial number of medicinal plants and there was less variation in knowledge among males than females in the Begossi study. However, the observed relationship in my study may be confounded by age, as females had a higher mean age than males.

The trend between educational level and use and knowledge of medicinal plants may become significant with a larger sample size. However age potentially confounds the relationship, as educational level and age were inversely related among study subjects. An even distribution of participants from all ages and educational backgrounds is necessary to determine whether the negative linear trend between educational level and

practice and awareness of natural medicine is substantial. This is difficult due to characteristics of the study site; the conversations with residents of Monteverde indicate that the trend between age and educational level is typical of the town and not a result of sampling methods. The older generations simply did not have the same opportunities to attend school as their children and grandchildren have had; many were required to contribute to their families' livelihood at early ages.

Overall the data suggest that age significantly influences practice and awareness of natural medicine, however a substantial amount of knowledge remains among younger individuals in their late 20s and early 30s. It seems, therefore, that strong cultural traditions can coexist with increased development. A comparative analysis of the medicinal plant knowledge possessed by traditional healers in more isolated Amazon versus in the more developed Andes, revealed that healers in the Andes possessed a greater degree of biological, medical, and taxonomic knowledge, despite higher modernization and lower biodiversity in the region (Vandebroek 2004). Determination of ethnobotanical knowledge among Tzeltal Maya children in 1968 and again in 1999 showed no difference in the number of plant species that children aged nine to twelve could correctly identify, despite increased modernization in the 30 years between studies (Zarger and Stepp 2004).

The practice of natural medicine is indeed still prevalent among residents of Monteverde, demonstrated by the generally high number of ailments for which participants cited using natural remedies. As the species of plants utilized are mostly exotics or garden-variety natives, the results of this study do not have strong environmental implications. Although conservation of tropical forest is paramount for a

variety of other reasons, it does not play a prominent role in the preservation of traditional medicinal knowledge among Monteverde residents. Nevertheless, the social implications of the study are immense. Considering the lack of affordability of pharmaceutical drugs, it is fortunate that medicinal plant knowledge has survived through land development, increased populations, and the tourism explosion. As mentioned before, the average annual per capita income in Costa Rica is less than U.S. \$5,000; thus many families may only be able to budget \$10 or \$20 per month on healthcare. From the list of prices for common manufactured medicines (Table 1), the economic burden of purchasing these products is obvious. Contrastingly, most of the medicinal plants cited can be grown in gardens practically for free. This study reveals a situation where culture, tradition, and nature contribute to improved quality of life for people in the community. Future studies should examine the wealth of knowledge among locals concerning exclusively native plant species.

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APPENDIX

Cuestionario

Nombre:

¿Cuántos años tiene usted?

¿Dónde nació usted?

¿Dónde fue criado/a?

¿Cuántas generaciones de su familia han vivido en Monteverde?

¿Cuál nivel de educación ha completado usted? ¿Colegio, universidad, etcétera?

¿Cuál especialidad de estudio tuvo?

¿Cuál es su ocupación?

¿Cuándo le duele la cabeza que hace usted para aliviar el dolor?

¿Dónde aprendió este remedio? ¿Quién se lo recomendó a usted?

...para la gripe o resfriados

...para alergias, asma, o problemas con respiración

...para la garganta irritada

...para la tos

...para dolor de estómago o diarrea

...para náuseas o vómitos

...para dolor de las muelas

...para picaduras de los insectos (Que usa como un repelente o para aliviar el dolor)

...para parásitos

...para insomnio, falta sueño

...para tratar nervios o para relajar

...para tratar letargo/para tener más energía

...para infecciones de los oídos y para dolor de los oídos

...para visión y la salud de los ojos

...para quemaduras

¿Usted sabe de cualquier remedio natural para dolor de la cabeza?

...para la gripe o resfriados

...para alergias, asma, o problemas con respiración

...para la garganta irritada

...para la tos

...para dolor de estómago o diarrea

...para náuseas o vómitos

...para dolor de las muelas

...para picaduras de los insectos (Que usa como un repelente o para aliviar el dolor)

...para parásitos

...para insomnio, falta sueño

...para tratar nervios o para relajar

...para tratar letargo/para tener más energía

...para infecciones de los oídos y para dolor de los oídos

...para visión y la salud de los ojos

...para quemaduras

¿Generalmente, usted prefiere medicamentos de la farmacia o medicina natural?
¿Por qué?

¿Cuándo usted visita los doctores para tratar algunas de estas enfermedades, que le recomiendan ellos?