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Prevalence of Chronic Kidney Insufficiency in the Communities of “La Isla” and “Candelaria”, Chichigalpa

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Summary

Chronic Renal Insufficiency (CRI) is a pathology that is found in every country in the world. For many countries in Europe, Asia, and the Americas; this phenomenon is the consequence of increased longevity and the accompanying increase of chronic illnesses such as diabetes, mellitus, and arterial hypertension due to aging. In Central America, evidence has come to light pointing towards a different epidemiological factor. The majority of the patients attended at local hospitals and health clinics with CRI are young, male, and employed in agriculture.

This prevalence study (based on a sample of inhabitants from La Isla and Candelaria of the Chichigalpa municipality) considers a wide range of aspects related to the health, occupations, and habits of the people. Samples were taken from the participants for creatine and urine tests in order to know the state of renal function.

The results indicate around 40% of the population has some level of renal damage. Additionally, the men show more instances of decreased renal function in terms of frequency and severity. The male to female ratio was 12:1 for levels 1 and 2 of the disease and 22:1 for irreversible levels. 11 to 12% of the population has irreversible renal damage not associated with known risk factors (such as diabetes mellitus and arterial hypertension) though some have consumed alcohol and tobacco in the past. The study also found a relationship with labor-related factors such as agricultural work and exposure to pesticides.

These results help us understand the magnitude of the problem. However, in order to be able to approach it from a preventative point of view, it is necessary to investigate deeper into the causality of the illness.

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Introduction

Chronic Renal Insufficiency (CRI) has, in the last few years, been declared a public health problem on a global level due to the sustained increase shown in the number of patients that require renal replacement therapy (RRT). As a result of this treatment, we are presented with an aging population and an increase in the number of patients with chronic illnesses such as diabetes and arterial hypertension. Latin America has not escaped this epidemic. In fact, evidence has been produced that indicates this phenomenon is occurring in many countries in the region. However, in Central America, differences exist in the epidemiology of this illness. The majority of cases that require RRT are among people that live at sea level altitude, particularly men younger than 40 years old, and without prior history of diabetes or hypertension.

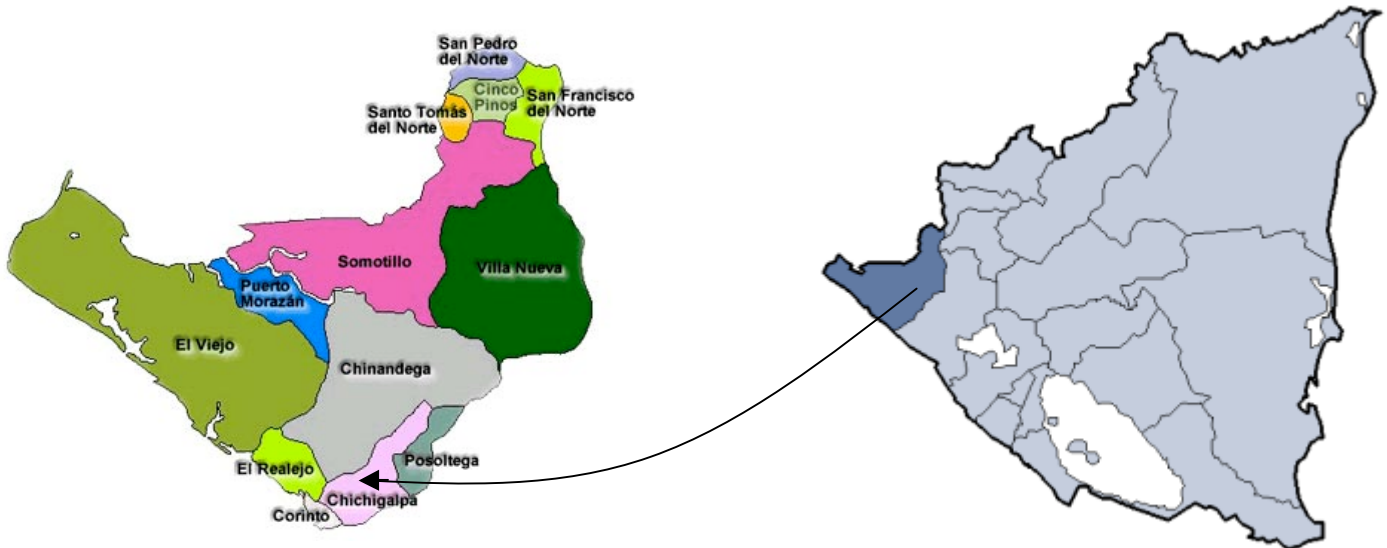
The evidence in Nicaragua, although not conclusive, points towards a high prevalence of the disease reflected in the data on mortality. Official statistics produced by the Ministry of Health show that the departments of Leon and Chinandega have the highest rate of CRI mortality in the country (5 and 4 for every 10,000 inhabitants respectively). This represents between 4 to 5 times higher than the national rate for this year (1.09 for every 10,000 inhabitants). The incident rate for every municipality in these departments is not the same. In Chinandega, the highest mortality is found in the municipality of Chichigalpa while the lowest is Villanueva (13 and 0.4 for every 10,000 inhabitants, respectively).

In very few countries in the world, and none in our subcontinent, has there been a published population study that demonstrated the pattern of incidence and the degree of gravity imposed by CRI. This fact enormously limits the health sector, the government, and society in general to confront and prevent this epidemic. In Chichigalpa, studies exist that focus on the active work population but provide no information on the number of affected within the general community.

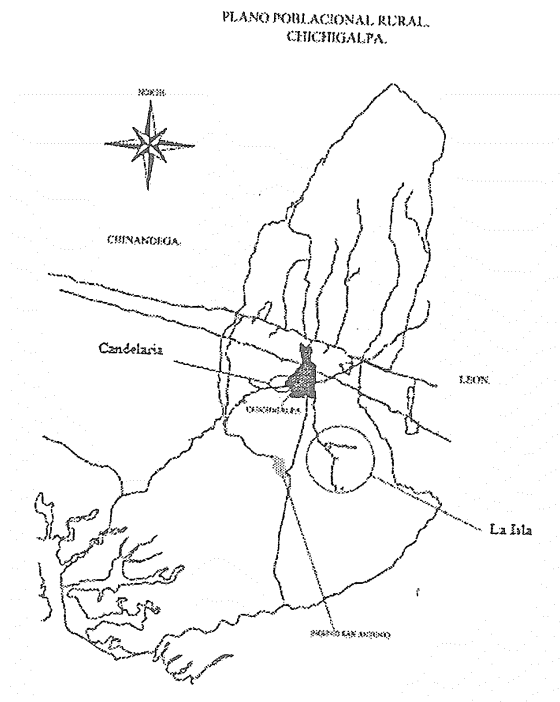
This study aims to raise awareness about the prevalence of this disease. In recent years, this area of the country has seen the mortality and morbidity associated with this pathology increase so rapidly that it has become a social as well as a health issue.

Characteristics of the Terrain

Chichigalpa is one of 13 municipalities in the Department of Chinandega in Northwest Nicaragua. It is located at an average altitude of 76 meters above sea level and has a tropical climate with an average temperature of 27 degrees Celsius. The population is 44,796 (INEC 2005), of which 76% live in urban areas. 45% of the population is younger than 20 years old and 47% are between 20 and 60 years old.



Historically, since 1851, Chichigalpa has focused on producing sugar-based products such as honey and sweets. This industry reached its peak around 1890; the year Ingenio San Antonio was founded. From 1904 to 1990, Chichigalpa emphasized cotton production and opened the first processing plant in Nicaragua. Also, on a smaller scale, the region produced plantains and bananas for exportation.



The community, La Isla, is one of five sectors of Guanacastal Sur, which is situated 3 kilometers Southwest of Chichigalpa. The other four communities are Países Bajos, Los González, Santana and El Triunfo. The people primarily rely on agriculture; largely on the cultivation of sugar cane and to a lesser extent on the cultivation of basic grains for personal consumption. According to data supplied by the Ministry of Health, the 15 years and older population of La Isla is approximately 1016 inhabitants and 176 households.

Candelaria is a recently established neighborhood. Prior to the year 2000, the workers of Ingenio San Antonio and their families had lived on land located within the boundary limits of the company's property. The community was resettled outside the company's property limits on land that is located on the very southern end of Chichigalpa, adjacent to Ingenio San Antonio. According to data by the Ministry of Health, there are 1909 people in 776 households in Candelaria.

Methodology

Population Census

Since there are various sources reporting different population data, it was necessary to carry out a census prior to the study and visit every household. Our census shows that the population of 20 to 60 years in age is 408 people in La Isla and 538 people in Candelaria. In the cases where it was impossible to obtain the necessary information from the inhabitants of a household, the information was provided by the residents of the neighboring household.

Sample

This study produced a sample of the residents of both sexes between the ages of 20 to 60 years in five communities from the municipality of Chichigalpa that make up La Isla (188 persons: 46%) and the neighborhood of Candelaria (212 persons: 40%).

Sample Calculation

The sample size was calculated with 95% accuracy. The prevalence was expected to be 35% based on previous findings in studies carried out in Western Nicaragua. The sample was calculated using the microcomputer program EPI INFO version 6, which is used for handling epidemiologic data.

Sample Collection

The samples were attained by visiting every household in La Isla and every other household in Candelaria. In every case, one person in each family (within the age range of the study) was selected through a random drawing, surveyed, and reported in the census. If the person selected was not available, a follow-up visit was made until the subject was successfully interviewed. In cases where the selected person refused to participate, the random drawing was repeated using the same methodology. If the second person refused, it was then considered a refusal to participate by the household.

No response

There was a 6% rate of refusals to participate in La Isla and 12.5 % in Candelaria. In three households, none of the inhabitants were in the selected age range of the study. Four households were found to be vacated after visiting them on at least four occasions. There was one household in La Isla that refused to take part in the survey (of which no family members were known to be suffering from CRI). In Candelaria, 24 people refused to be surveyed, 8 of which stated they were suffering from CRI. The two reasons given for refusing to participate were: fear of knowing the results of the exams without proper medical assistance available; and fear of retaliation by the company, Ingenio San Antonio.

Table 1
Prevalence Study Participation by Category and Community, 2008

Community	Refusals	Vacant Houses	Out of age range	Surveyed	Sample Size
La Isla					
(n)	9	0	2	175	188
%	4.8	0.0	1.1	94.1	100.0
Candelaria					
(n)	24	4	1	203	212
%	10.3	1.7	0.4	87.5	100.0

Due to the design of collecting the samples from one person for each house (as well as taking into account the refusal rate) the number of participants in the study was different from the initial calculation. There was a final survey of 175 people in La Isla (93% of the sample and 43% of the population) and 202 in Candelaria (95% of the sample and 37.5% of the population).

Georeference

The spatial location of each house was plotted simultaneous to the gathering of information for the census.

Procedures for collecting information

Personnel

The study was conducted by 26 medical students and 6 clinical laboratory students. The students were supervised by 2 doctors and 2 medical technicians. Each individual participated in a training workshop and completed survey test training before conducting the survey in the field. All students possessed UNAN-Leon identification cards.

Time Period

In order to ensure a high level of participation, information for the census was collected during the weekends over a two month time period. Additional time was made to revisit people who were previously unavailable or refused to participate during the first visit.

Obtaining the Information

In every household selected, the reason for the visit was explained before completing the census. Every member of the household was included in the census; giving basic personal information, occupation, and any known illnesses. A random drawing proceeded with all household residents between the age range of 20 to 60 years, whether or not they were present at the time of the visit. If the person selected was present at the time, the consent form was then read requesting their signature if they agreed to participate. After signing the consent form, they filled out the survey giving descriptive personal data, employment history, residential history, medical history, current or past exposure to household or work-related chemicals, hydration habits, and consumption of alcohol, drugs and medicines. After the questionnaire, a 20ml blood sample was taken. This blood sample was collected in one 9ml tube with EDTA and two 9ml tubes without an anticoagulant. At the same time, the subjects were requested to supply urine and feces samples. If the selected individual was not present at the household, the researchers asked when the individual would return and revisited the household to complete the questionnaire and take the samples as described above.

Handling the biological samples

Urine and Feces Samples

The urine sample was separated down to 5ml in order to carry out a chemical physical and microscopic exam in the field. Another 20ml of urine was preserved under congelment in order to quantify the number of metals and pesticides in the metabolites. The feces sample was analyzed by a copro-parasitologic exam in the field.

Blood Samples

The blood sample with anticoagulant was refrigerated immediately. The sample without anticoagulant was submitted to centrifuge after a half hour and separated in two tubes. One tube contained 1 ml in order to determine the creatine level. The other tube had the addition of serum to store for later use in quantifying the metals and pesticides in their metabolites. The blood sample with serum and the urine sample were kept refrigerated at 8 degrees Celsius while in the field, and later refrigerated at -25 degrees Celsius in sample banks at the *Laboratorio de Contaminantes* at CISTA. After extracting the samples, the 1 ml tube that was used to determine the creatine level was transported to the *Centro Nacional de Diagnostico y Referencia (CNDR)* where they were processed by means of the Jaffe method in a Combas Integra 400 system. Additionally, to measure the hematocrit, samples were taken with capillary tubes with heparin.

Calculation of Renal Function

Renal function calculations were done by using the Glomerular Filtration Rate (GFR) according to the formula Modification of Diet in Renal Disease (MDRD) recommended by the National Kidney Council. The MDRD formula is $GFR (mL/min/1.73 m^2) = 186 \times (Scr)^{-1.154} \times (Age)^{-0.203} \times (0.742 \text{ if female}) \times (1.212 \text{ if African-American})$ (conventional units). To produce a calculated base, the creatine was first measured. The results placed the renal function in six categories, as set by Q/DOKI norms from the National Kidney Council.

Category	GFR (ml/1.72 m ² sc/minute)	Severity of Damage	Prognostic
Normal Level 0	> 90 ml without proteinuria or hematuria	No renal damage	
Level 1	> 90 ml with hematuria or proteinuria	Incipient kidney damage- does not affect kidney function	Reversible
Level 2	> 60 ml	Light kidney damage	Reversible
Level 3	30 to 60 ml	Moderate kidney damage	Irreversible
Level 4	15 50 30 ml	Severe kidney damage	Irreversible
Level 5	< 15 ml	Failed kidney	Requires Kidney Transplant

The urine, creatine, hematocrit and feces exams were revealed to the participants by members of the research team during the second community visit. During the second visit, blood samples were taken again to confirm the incidence of CRI as determined by the National Kidney Council. The results of the contaminants in the blood and urine are still pending processing. As these results are obtained, they will be delivered to every participant following the same procedure as before.

Patient Follow-up

Some patients were found with some acute diseases. These patients, depending on the illness, were attended to immediately or referred to a nearby health clinic.

Data Analysis

The data analysis was completed through frequency distribution and the use of descriptive statistics from the various demographics, history, exposure, and effects. The prevalence of the kidney disease was analyzed based on a global perspective, taking into account the five levels of CRI and prognostics of the disease (normal, reversible and irreversible). The variables listed above were also analyzed in comparing other exposed groups and taking into account the different occupational and environmental risk factors.

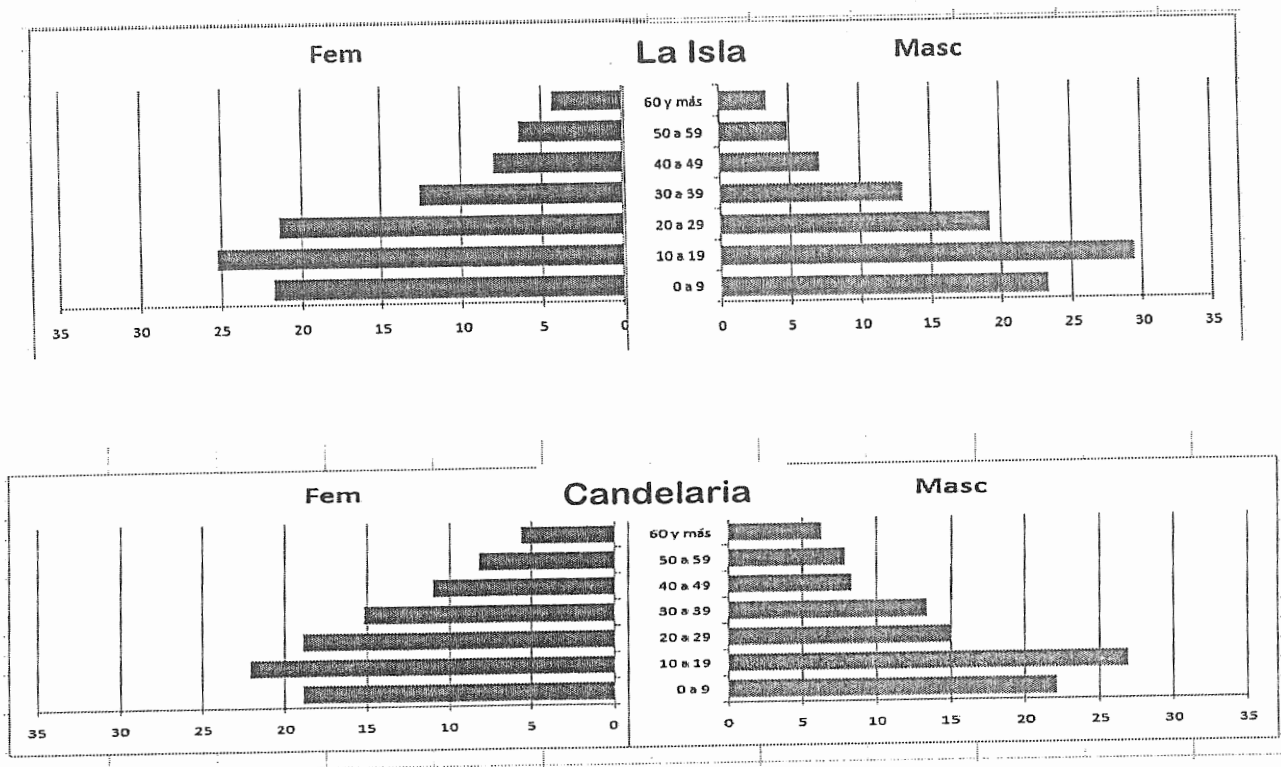
Results

Census

General Characteristics of the population

The distribution of the populace according to sex in each community corresponds with the national population. In respect to age, 50% of the population of La Isla is younger than 30 years while Candelaria has 45% under 30 years. Although both communities have begun a transitional demographic change, they maintain similarities in the population curve until 19 years of age. From there the weighted percentage for each age group gradually decreases until finally reaching 3% in La Isla and 6% in Candelaria in the group of 50 to 60 years of age.

Population Pyramid for La Isla and Candelaria, Chichigalpa, 2008



Employment

The official age of employment is 16 years and older, which makes up 58% of the populace in La Isla and 55% in Candelaria. Both are the same among males and females. Participation in productive activities is greater among men than women (4:1 in La Isla and 2:1 in Candelaria). The principal sources of employment for men in both communities are work in agriculture and livestock, followed by the production of basic goods. Employment among women is relatively

low, only 14% of the women in La Isla and 20% in Candelaria work outside of the home. In both communities, the main sources of employment for women are making and selling food and work in other households.

The economic inactivity rate is 60% in La Isla and 66% in Candelaria and varies between the sexes in both communities. Among men in both communities, this segment is principally made up of pensioners from the illness. Among women, most are housewives.

The unemployment rate is low, 3% in La Isla and 1% in Candelaria. Mainly men are affected by the disease (Table 2). Included among the unemployed are people that, despite suffering from advanced levels of CRI, do not have pensions as a result of having the disease. Some have not reported their illness to Social Security and others have early kidney damage and are not contracted out to work by Ingenio San Antonio or their associated businesses. This segment of the population is not recognized by Social Security and lacks other opportunities to earn an income (Table 2).

Table 2
Population over 16 years old by occupation, sex and community, La Isla and Candelaria, 2008

Productive Participation		La Isla			Candelaria		
		Male	Female	Total	Male	Female	Total
Population	(n)	439	435	874	543	534	1077
Eligible to Work Population (>16 years)	(n)	192	254	446	252	338	590
	% of General Population	43.7	58.4	51	46.4	63.3	54.8
Economically Active Population	(n)	128	35	163	127	67	194
	%	66.7	13.8	36.5	50.4	19.8	32.9
Agriculture-Livestock	(n)	69	7	76	61	6	67
	%	35.9	2.8	17	24.2	1.8	11.4
Manufacturing	(n)	53	1	54	48	14	62
	%	27.6	0.4	12.1	19	4.1	10.5
Services	(n)	6	27	33	18	47	65
	%	3.1	10.6	7.4	7.1	13.9	11
Economically Inactive Population	(n)	61	216	267	121	269	390
	%	26.6	85	59.8	47	79.6	66.1
Retired, Housewives, students	(n)	17	215	232	67	268	335
	%	8.9	84.6	52	26.6	79.3	56.8
Pensioner from Disease	(n)	34	1	35	54	1	55
	%	17.7	0.4	7.8	21.4	0.3	9.3
Unemployed	(n)	13	3	16	4	2	6
	%	6.8	1.2	3.6	1.6	0.6	1.0

State of Health

Overall, the most common illness in both communities, according to the survey, is CRI; which affects 11% of the residents. The percentage is higher among men than women with a rate of 6:1. 23% of the men in La Isla and 15% in Candelaria suffer from the disease. Among women, the

rate is also higher in La Isla with 5% affected compared to 2% in Candelaria (Table 3).

The most common pathologies known by the residents in both communities are arterial hypertension (AHT) and urinary tract infection (UTI). The prevalence of diabetes mellitus is low in both communities though it is higher in Candelaria (Table 3).

Table 3
Morbidity According to Survey, La Isla and Candelaria, 2008

Disease/ illness	La Isla			Candelaria		
	Male	Female	Total	Male	Female	Total
(n)	439	435	874	543	534	1077
CRI	22.8	4.6	13.7	15.5	1.9	8.7
AHT	4.6	4.1	4.3	1.7	5.4	3.5
UTI	0.2	0.2	0.2	2.0	3.6	2.8
Arthritis	0.7	0.9	0.8	1.1	2.4	1.8
Asthma	0.7	0.9	0.8	1.1	1.3	1.2
Diabetes	0	0.9	0.5	0.9	1.7	1.3
Anemia	0.7	0.9	0.8	0.9	0	0.5
Gastritis	0	0.5	0.2	0.9	0.9	0.9
Uric Acid	0.2	0	0.1	0.9	0.9	0.9
Heart Disease	0.7	0.2	0.5	0.2	0.9	0.6
Other Illnesses	1.1	1.4	1.3	4.1	3.6	3.8

Prevalence Study

Characteristics of Surveyed Population

Of the 175 persons that participated in La Isla, 31 % were men. And of the 202 surveyed in Candelaria, 37 % were men. In respect to age, the mean age was 35 ±11 years in La Isla and 39 ±11 years in Candelaria. Table 4 shows the distribution for sex and age in each community. In general, the surveyed participants were predominately young; 66% in La Isla were under 40 and 54% in Candelaria were under 40 (Table 4)

Table 4
Survey of Sex and Age, La Isla and Candelaria, 2008

Age		La Isla			Candelaria		
		Male	Female	Total	Male	Female	Total
20 to 29	(n)	18	48	66	14	32	46
	%	32.7	40	37.7	18.9	25	22.8
30 to 39	(n)	13	37	50	23	40	63
	%	23.6	30.8	28.6	31.1	31.2	31.2
40 to 49	(n)	15	20	35	14	35	49
	%	27.3	16.7	20	18.9	27.3	24.3
50 to 60	(n)	9	15	24	23	21	44
	%	16.4	12.5	13.7	31.1	16.4	21.8
Total	(n)	55	120	175	74	128	202

Living Conditions

In respect to education, 11% are illiterate and 34% have less than 6 years of schooling. Only 16% have 11 years or more of schooling. In La Isla ,education level among participants was less than in Candelaria in all aspects with an exception in illiteracy and incompleteness of primary school (Annex 1).

Water and sanitation services are also less available in La Isla than in Candelaria. La Isla does not have potable water and the majority of the population (98%) receives water from wells which they treat with a home system. Because sewer systems do not exist, latrines are the most common method of disposing of human excrement. In Candelaria, an urban community, the majority (98%) are supplied with water through a potable water distribution network which they do not need to purify. However, despite being within the urban limits of Chichigalpa, less than a third of the surveyed have access to sanitation services connected to a sewer system (Annex 2).

Poverty affects at least three quarters of the population of La Isla and Candelaria. According to the survey, 81% of the residents of La Isla live in extreme poverty on less than \$1 (C\$ 20) a day. In Candelaria, this economic level includes 73% of the residents. Those not classified as “poor” (making more than \$2 a day) amounts to 18% of the residents in La Isla and 25% in Candelaria (Table 5).

Table 5
Income per Day, La Isla and Candelaria, 2008

Income per Day	La Isla	Candelaria
(n)	171	200
Less than \$1		
(n)	138	145
%	80.7	72.5
Less than \$2		
(n)	2	4
%	1.2	2.0
More than \$2		
(n)	31	51
%	18.1	25.5

Candelaria is a community comprised of immigrants. 85% of the residents (male and female) have lived there for less than ten years. La Isla, for its part, has had a more stable population. 75% of the residents have lived in La Isla for more than 15 years, with an increase among women with more than 10 years of uninterrupted residency (Table 6).

Table 6
Years of Residency in the Community by Sex, La Isla and Candelaria, 2008

# Years Living in the Community	La Isla			Candelaria		
	Male	Female	Total	Male	Female	Total
(n)	55	120	175	74	128	202
< 5						
(n)	7	14	21	14	21	35
%	12.7	11.7	12	18.9	16.4	17.3
5 to 9						
(n)	3	8	11	46	96	142
%	5.5	6.7	6.3	62.2	75	70.3
10 to 14						
(n)	2	13	15	3	6	9
%	3.6	10.8	8.6	4.1	4.7	4.5
15 to 19						
(n)	2	13	15	2	2	4
%	3.6	10.8	8.6	2.7	1.6	2
> 20						
(n)	41	72	113	9	3	12
%	74.5	60	64.6	12.2	2.3	5.9

Chronic Renal Insufficiency

Overall, 56% to 58% of the population in each community has normal kidney function. The remaining percentage of the populations in both communities have some degree of CRI. 30% have level 1 and 2 (reversible kidney damage) and 11% have level 3 and 4 (irreversible kidney damage). Although the percentage of persons with low to intermediate level CRI is similar in both communities, the population of persons in La Isla that require a kidney transplant (level 5 or failed kidney) is double the population needing transplants is in Candelaria (Table 7).

Table 7
Prevalence of CRI, La Isla and Candelaria, 2008

CRI Level		La Isla (n) 175	Candelaria (n) 202
No CRI	(n)	99	118
	%	56.6	58.4
CRI	Level 1-2 (n)	53	61
	%	30.3	30.2
	Level 3-4 (n)	19	21
	%	10.9	10.4
Failed Kidney	(n)	4	2
	%	2.3	1

Community Analysis

La Isla

CRI and Sex

The men in La Isla suffer disproportionately from CRI when compared to the women. While men are found to be divided almost equally in thirds within the prevalence of CRI and its severity, the women have an overall lower prevalence rate and only 4% are found to have irreversible kidney damage (Table 8).

Table 8
Prevalence of Kidney Damage by Sex, La Isla, 2008

CRI Level	Men	Women	Total
(n)	55	120	175
Normal			
(n)	17	82	99
%	30.9	68.3	56.6
Reversible			
(n)	20	33	53
%	36.4	27.5	30.3
Irreversible			
(n)	18	5	23
%	32.7	4.2	13.1

CRI and Age in Men and Women

In all age groups, we find persons with varying degrees at which the kidney function has been affected. Different symptoms are manifested depending upon the sex. As men get older, the proportional rate of irreversible kidney damage increases with an exception for the oldest age group. The highest proportion of irreversible kidney damage is in the age group of 40 to 49 years. No man over 49 years has a normally functioning kidney. Women, on the other hand, show a more linear pattern. The percentage of women with kidney damage increases with age. With the exception of women between 30 to 39 years, the tendency of irreversible damage is consistently greater with older age (Table 9).

Table 9
Prevalence of Kidney Damage by Age and Sex, La Isla 2008

Age	Males				Females			
	(n)	Normal	Reversible	Irreversible	(n)	Normal	Reversible	Irreversible
20 to 29	(n) 18	8	7	3	48	38	9	1
	%	44.4	38.9	16.7		79.2	18.8	2.1
30 to 39	(n) 13	6	4	3	37	25	12	0
	%	46.2	30.8	23.1		67.6	32.4	0
40 to 49	(n) 15	3	3	9	20	11	7	2
	%	20	20	60		55	35	10
50 to 60	(n) 9	0	6	3	15	8	5	2
	%	0	66.7	33.3		53.3	33.3	13.3

CRI and Occupation

The majority of men are employed in the agricultural sector, while most women are housewives taking care of the domestic work and the children. As shown in table 10, there is a high rate of irreversible kidney damage among men in every occupational category, while for women it is predominately among those classified as the economically inactive population (EIP) whom are housewives (5.1%) (Table 10).

Table 10
Kidney Damage Distribution by Occupation

Principal Activity	Male				Female			
	(n)	Total Normal	Reversible	Irreversible	Total Normal	Reversible	Irreversible	
	(n) 55	17	20	18	120	82	33	5
Agriculture/ Livestock	(n) 34	10	14	10	10	7	3	0
	% 100	29.4	41.2	29.4	100	70	30	0
Production of Goods (Manufacturing/ Construction)	(n) 6	3	1	2	3	1	2	0
	% 100	50	16.7	33.3	100	33.3	66.7	0
Service Industry (Transportation & Trade)	(n) 3	1	1	1	10	7	3	0
	% 100	33.3	33.3	33.3	100	70	30	0
EIP	(n) 4	1	1	2	96	66	25	5
	% 100	25	25	50	100	68.8	26	5.2
Unemployed	(n) 8	2	3	3	1	1	0	0
	% 100	25	37.5	37.5	100	100	0	0

Irreversible Kidney Damage Risk Factors

The family and personal history of diseases shows an association with irreversible kidney damage and a history of diabetes and urolithiasis (OR > 3), although the value of the probability (p) was not significant. Personal habits showed a connection from past consumption of tobacco and alcohol (OR > 3 with p < 0.005). In respect to occupational risks, a history of working in sugar cane fields, fainting at work, and working in cotton fields has shown a relation with irreversible kidney damage (OR: 4.5, 3.9, and 2.2) with values of p less than 0.005 (Table 11).

Table 11
Associated Risks to Irreversible Kidney Damage

Variable	Prevalence	P	Odds Ratio	IC 95%
Family Medical History				
Arterial Hypertension	10.5	0.340	0.684	0.312- 1.498
Diabetes	19	0.562	1.608	0.602- 4.297
Kidney Diseases	13.2	0.807	1.106	0.491- 2.494
CRI	12.2	0.907	0.949	0.394- 2.283
Personal Medical History				
Diabetes	40	0.239	3.360	1.064- 10.608
Urolithiasis	37.5	0.107	3.257	1.211- 8.760
Arthritis	16	0.331	1.502	0.663- 3.399
AHT	10	0.556	0.739	0.265- 2.058
Malaria	10.1	0.395	0.697	0.300- 1.620
Urinary Tract Infections	81.1	0.039	2.776	0.982- 7.846
Habits				
Past Consumption of Tobacco	38.9	0.002	3.816	1.816- 8.016
Past Consumption of Alcohol	32	0.007	3.200	1.517- 6.750
Current Consumption of Alcohol	21.1	0.471	1.729	0.657- 4.548
Current Consumption of Tobacco	19	0.610	1.544	0.508- 5.497
Past Consumption of Drugs	33.3	0.855	2.606	0.502- 13.532
Current Consumption of Drugs	13.1			
Medicine Consumption				
Analgesic/ Anti-inflammatory	10.4	0.411	0.712	0.315- 1.610
Other Nephrotoxic Medicines	16.7	1.000	1.333	0.353- 5.041
Nephrotoxic Antibiotics	12.9	1.000	1.011	0.368- 2.779
Occupational Risks				
Past Sugar Cane Work	23.4	0.000	4.582	1.781- 11.786
Fainting at Work	34.6	0.001	3.914	1.866- 8.209
Past Cotton Work	22.2	0.036	2.222	1.048- 4.711
Mixing/ Applying Pesticides	22.5	0.055	2.105	0.986- 4.497
Current Agriculture Work	19.6	0.105	1.87	0.877- 3.988
Past Banana/ Plantain Work	25	0.127	2.221	0.973- 5.067
Packaging Bananas	25	0.414	2.038	0.704- 5.896
Strenuous Work	11.5	0.573	0.799	0.366- 1.748
Child Labor	15.7	0.625	1.257	0.499-3.169
Thirsty during work	14	0.658	1.196	0.540-2.647
Intoxication of Pesticides	15.4	1.000	1.223	0.321- 4.667
Others				
Residency > 10 years in Community	12.8	0.968	0.834	0.309- 2.256

Candelaria

CRI and Sex

There are more men affected with irreversible CRI in number and severity than the women: a ratio of 22 men for every women affected. 65% of men have some degree of kidney damage and approximately a third have level 3 to 5. Among women, less than 1% have irreversible kidney damage (Table 12).

Table 12
Prevalence of Kidney Damage by Prognostic and Sex, Candelaria, 2008

Degree of CRI (n)	Male	Female	Total
(n)	74	128	202
Normal			
(n)	26	92	118
%	35.1	71.9	58.4
Reversible			
(n)	26	35	61
%	35.1	27.3	30.2
Irreversible			
(n)	22	1	23
%	29.7	0.8	22

CRI and Age

There is not a consistent pattern in respect to men's age and the proportional rate for each degree of kidney function. The majority (71%) of the younger population (20 to 29) does not have any kidney damage and there were no cases of irreversible kidney damage. Among the age group of 30 to 39 years and 50 to 59 years, the category of reversible kidney damage was the largest. Among the age group of 40 to 49 years, the highest proportion (43%) of the surveyed had irreversible damage to their kidneys.

Among women the pattern is different. The age group found with the highest percentage of kidney damage is that between 40 to 49 years. However, the only woman with irreversible kidney damage is younger than 30 years (Table 13).

Table 13
Prevalence of CRI by Age Group and Sex, Candelaria, 2008

Age	Male				Female			
	Total	Normal	Reversible	Irreversible	Total	Normal	Reversible	Irreversible
(n) 20 to 29	14	10	4	0	32	23	8	1
%		71.4	28.6	0		71.9	25	3.1
(n) 30 to 39	23	6	9	8	40	31	9	0
%		26.1	39.1	34.8		77.5	22.5	0
(n) 40 to 49	14	4	4	6	35	20	15	0
%		28.6	28.6	42.9		57.1	42.9	0
(n) 50 to 60	23	6	9	8	21	18	3	0
%		26.1	39.1	34.8		85.7	14.3	0
(n) Total	74	26	26	22	128	92	35	1
%		35.1	35.1	29.7		71.9	27.3	0.8

CRI and Occupation

Among people affected by reversible kidney damage, there is a diverse distribution of occupation for both sexes in Candelaria. Men and women with irreversible kidney damage mainly work in the agricultural sector. There are also men who are economically inactive and pensioners (Table 14).

Table 14
Prevalence of Kidney Disease by Occupation and Sex, Candelaria 2008

Principal Activity	Male CRI Level				Female CRI Level			
	Level 1-2	Level 3-4	Kidney Failure	Total	Level 1-2	Level 3-4	Kidney Failure	Total
Agriculture/ Livestock (n) %	11 64.7	6 35.3	0 0	17 100	1 50	1 50	0 0	2 100
Manufacturing (n) %	5 100	0 0	0 0	5 100	1 100	0 0	0 0	1 100
Transportation/ Supply (n) %	1 100	0 0	0 0	1 100	0 0	0 0	0 0	0 0
Other Service Activities (n) %	0 0	1 100	0 0	1 100	6 100	0 0	0 0	6 100
PEI (n) %	8 44	9 50	1 6	18 100	26 100	0 0	0 0	26 100
Unemployed (n) %	1 16.7	4 66.7	1 16.7	6 100	0 0	0 0	0 0	0 0
Total (n) %	26 54.2	20 41.7	2 4.2	48 100	35 97.2	1 2.8	0 0	36 100

Irreversible Kidney Damage Risk Factors

There was no statistic ($p < 0.05$) or clinical ($OR > 1$) relation found between family and personal health history and incidence of irreversible CRI. Nor was any relation found with known consumption of medicines such as nephrotoxins. Among those with unhealthy habits, there was a statistical relation of past tobacco use ($p = 0.005$) and current alcohol use ($p = 0.049$).

In relation to occupational history, a statistically significant relationship was found between working in sugar cane fields and the mixing or applying of pesticides ($p= 0.000$) and CRI. Slightly less strong relationships were found with working in the cultivation of bananas/plantains ($p= 0.001$), agricultural work ($p= 0.031$), and consuming more water than normal while at work ($p= 0.001$). However, the latter displayed an OR of less than 1 ($OR < 1$). There was no clinical or statistical relation found with those residing in the same place for over ten years or with those working in the same occupation (Table 15).

Table 15
Analysis of irreversible CRI and Associated Risks, Candelaria, 2008

Variable	Prevalence	P	Odds Ratio	IC 95%
Family Medical History				
CRI	13.5	0.436	1.404	0.600- 3.285
Kidney Diseases	12.4	0.699	1.164	0.539- 2.512
Arterial Hypertension	10.7	0.747	0.881	0.408- 1.903
Diabetes	14	0.754	1.297	0.545- 3.088
Personal Medical History				
Malaria	9.2	0.339	0.682	0.309- 1.504
AHT	14.5	0.387	1.425	0.640- 3.173
Urolithiasis	20	0.509	1.860	0.623- 5.552
Arthritis	13.7	0.543	1.295	0.565- 2.969
Diabetes	16.7	0.906	1.500	0.398- 5.659
Urinary Tract Infections	73.9	0.279	1.782	0.734- 4.325
Habits				
Past Consumption of Tobacco	31.8	0.005	3.580	1.657- 7.731
Current Consumption of Alcohol	22.2	0.049	2.459	1.129- 5.358
Past Consumption of Alcohol	18.9	0.190	1.951	0.865- 4.401
Current Consumption of Tobacco	18.2	0.296	1.807	0.770- 4.240
Past Consumption of Drugs	16.7	1.000	1.485	0.238- 9.275
Current Consumption of Drugs	11.4	-	-	-
Medicine Consumption				
Analgesic/ Anti-inflammatory	8.1	0.140	0.549	0.244- 1.238
Nephrotoxic Antibiotics	7	0.273	0.543	0.166- 1.712
Other Nephrotoxic Medicines	20	0.742	1.771	0.481- 6.522
Occupational Risks				
Past Sugar Cane Work	34.5	0.000	12.695	4.520- 35.659
Mixing/ Applying Pesticides	40	0.000	4.800	2.329- 9.892
Thirsty during work	3.3	0.001	0.182	0.056- 0.596
Past Banana/ Plantain Work	36.4	0.028	3.656	1.500- 8.907
Current Agriculture Work	26.3	0.031	2.675	1.120- 6.392
Strenuous Work	6.3	0.070	0.432	0.167- 1.118
Child Labor	18.4	0.448	1.288	0.594- 3.240
Past Cotton Work	17.4	0.539	1.638	0.611- 4.396
Fainting at Work	6.7	0.555	0.540	0.133- 2.183
Packaging Bananas	25	0.944	2.250	0.394- 12.851
Intoxication of Pesticides	13.3	1.000	1.187	0.307- 4.588
Others				
Residency > 10 years in Community	12.4	0.451	2.050	0.505- 8.328
Same Occupation > 10 years	6.1	0.891	1.394	0.361- 5.384

All those interviewed were asked if they suffered from kidney disease. Among those who responded positively, only one person in La Isla had a normal Glomerular Filtration Rate. In Candelaria, everyone had some degree of kidney damage. Of those reporting that they did not suffer from kidney disease, the study revealed these participants, in fact, did have some degree of kidney damage (in La Isla, 41% and in Candelaria, 39%). In both communities, 10% of those who reported no kidney disease were found to have irreversible kidney damage (Table 16).

Table 16
Percentage of People with Kidney Damage According to their Knowledge

Community	CRI Prognostic	Previous Knowledge of CRI	
		No	Yes
La Isla	Normal (n)	98	1
	%	59	11.1
	Reversible (n)	51	2
	%	30.7	22.2
	Irreversible (n)	17	6
%	10.2	66.7	
Total (n)	166	9	
%	100	100	
Candelaria	Normal (n)	118	0
	%	60.8	0
	Reversible (n)	56	5
	%	28.9	62.5
	Irreversible (n)	20	3
%	10.3	37.5	
Total (n)	194	8	
%	100	100	

Discussion

This is the first community study, independent from their employment, which covers men and women between the ages of 20 to 60 years in La Isla and Candelaria. Although community research studies have been conducted before in this municipality, none had clearly defined their survey sampling methods. They also have only focused on the male population with biased selection; a practice that inevitably skews the results [12].

Based upon the results obtained in this study, it is clear we are confronting an epidemic with a prevalence rate that exceeds data of other community research done in the same Western zone of Nicaragua (only comparable to data from Chichigalpa) [6]. Although we see with this study the same epidemiological pattern in the research by Torres and collaborators, other communities in Western Nicaragua have greater prevalence figures. The affected population is predominately the male population (68% of all levels), with a high rate of terminal cases in males between the ages of 20 to 29 years (34.4%). As with other previous studies, the majority of cases are in rural areas [6].

Validity

The principal strength of this study is that it is based in the community with the same possibility of participation given to men and women, independent of their occupations. The inclusion of the female population allows us to understand the magnitude of the problem in this group and to also make comparisons of the sexes. In this study, the sampled participants were made of a more comprehensive and inclusive group than just those who voluntarily wanted to participate. Only individuals whom were randomly selected took part in the study. The total percentage of respondents who refused to participate was 6% in La Isla and 12% in Candelaria, which is small enough to not affect the sample's representation. According to data referring to the participating respondents previous knowledge of CRI (Table 16); if these refusing individuals were included, it would possibly maintain or increase the rate of prevalence but not lower it.

The second strength of this study is that the prevalence rate uses the 5 levels of CRI as proposed by the National Kidney Council (NKC). This allows a comparison to be made with population studies in the Unites States [10], Japan [8] and China [7]. The classification of two CRI levels in two separate groups, reversible (level 1 and 2) and irreversible (level 3 and 4), permits us to establish different prognostics within the studied population. This will be useful for monitoring and prevention programs.

The principal limitation of this study might be related with the type of study that it is. With a prevalence study, one runs the risk of certain biases: a selective bias could have been present by the participants' self-selection or by the intentional selection on the part of the researcher. However, the conclusion of kidney damage was dependent on the blood samples that was analyzed a week after the information was collected. These samples were sent codified to the laboratory without presumptive diagnoses. Meanwhile, the surveyed population was selected by chance through a drawing by each family member in every household visited, regardless if they were present at the time of the visit.

Those who refused to participate in the study could have contributed to any directional change in the prevalence. However, the percentage of those who chose not to participate was low and their demographic traits reflects, to some degree, that of the studied population. The main reason non-participants provided for not wanting to participate was the fear of learning that they have CRI.

This demonstrates a possibility of underestimating the illness. If these individuals were included, it would possibly maintain or increase the rate of prevalence but not lower it.

Since the answers were based on the memory of the respondents, another bias that could have been present in this study is perception of who was affected and was not affected by CRI due primarily to the question about exposure to pesticides. This information could be influenced by previous knowledge of the CRI problem, which has very important social and economic implications in this municipality. The population believes that CRI is caused by the contamination of the environment by pesticides. However, less than 5% of the surveyed acknowledged being sick. The lack of public health care among the surveyed population and the consequent lack of knowledge of their healthy or sick condition (coupled with the fact that the survey was completed previous to revealing the laboratory results) reduces the probability that those found to be sick mentioned greater exposure to pesticides than those whom were not found to be sick.

CRI and Sex

Although the study confirmed that the disease predominately affects men, women are also falling ill. The female prevalence of CRI is low. However, we see CRI in the final stages (above all in Candelaria) which would indicate that women are also susceptible to the disease and, therefore, breaking the image that the disease exclusively affects men [12-15]. It is important to note that most cases among women fall into the first two levels of CRI and still represent a higher proportion than the study of five communities done in 2007 by Torres and collaborators. [6]. This result is important because, in the first two levels of CRI, specific actions can be taken to help correct the kidney pathologies or systemic existence and thus prevent the progression of the disease. The women are a vulnerable group if they do not receive appropriate attention.

CRI and Age

An analysis of cases in the irreversible stage of the disease are found disproportionately among men between the age of 20 to 29 years. Meanwhile, the incidences of irreversible cases among women coincide with the data from other studies done in Central America and report patients in younger age groups in kidney transplant therapy [13, 14]. Our results show that cases of irreversible damage are found among men between 20 to 29 years and among women between 40 to 49 years. There was not a consistent propensity in cases within both groups of men and women. The cases of men increase in respect to age, while there was not a single case found among women between the ages of 30 to 39 years. This does not correspond with what has been seen in other countries where an increase in age is related to a reduction in kidney function [5, 11, 16]. This propensity speaks in favor of a rapid progression of the illness with consequent mortality. And it concurs with findings in a preliminary study that is being researched about the mortality of CRI in the 24 years of the municipality's registry. The highest rate of mortality is found among men with 40 to 49 years [17]. In cases among women, we find a gap in the age group of 30 to 39 years, but then see renal damage reappearing in cases of women over 40. This finding could be due to some type of exposure that is modifying the effect. Or, it could be a product of chance.

CRI and Location

The prevalence rate of irreversible damage in Candelaria is similar to the rate in La Isla. This data coincides with reports in other Central American countries and with results from other communities in Western Nicaragua where the prevalence is greater in rural areas [6, 13-15].

CRI and Occupation

In exploring the behavior of kidney function in La Isla (in relation to the occupation of the individual and the severity of the disease), we find that there is a greater proportion of kidney damage among men that work in agriculture. This greatest proportion is followed by those who work in manufacturing, trade, construction, and the unemployed. The majority of individuals with irreversible kidney damage were found to pertain to three subgroups: current agriculture workers, current construction workers, and the unemployed.

Given the scarce number of women who work outside the home, it was not strange to find that the majority who have reversible or irreversible kidney damage fall within the category of EIP. Those who do work outside the home with reversible kidney damage were found to work in the agricultural sector, similar to men who are affected.

CRI and Risk Factors

The relation between irreversible CRI and associated risk factors, although different for La Isla and Candelaria, did not coincide with the same pattern that has been reported in studies in other parts of the world (including Latin America). Of the nine personal and family pathologies most cited by respondents, 7 could be related as cause, direct effect, or through the medications that are required to control the development of CRI. However, we only found a relation between the presence of diabetes mellitus and Urolithiasis and irreversible CRI. In the United States, Europe, and the most developed countries in Latin America; diabetes and hypertension are the most important risk factors in the development of CRI. The results from this study verify what has been affirmed for Central America, that these illnesses do not have a central role in CRI according to the Latin America Nephrology Association [2, 5, 18, 19]. There is a strong correlation between past tobacco and alcohol use and irreversible CRI. Although, to be conclusive, it would be necessary to know the quantity consumed to establish if there is a direct proportional relation between the amount consumed and the degree of kidney damage.

Other work related risk factors (particularly agricultural work in sugar cane, cotton, banana/plantain, exposure to pesticides) result in a prevalence ratio risk greater than 3. La Isla and Candelaria have a prevalence ratio of 4 for those who have worked with sugar cane.

Of the nine personal and family pathologies most cited by respondents, 7 could be related as cause, direct effect or through the medications that are required to control the development of CRI. Given that this is a descriptive study, we cannot establish if the disease is a cause or consequence of other chronic pathologies. Kidney disease is a silent condition, similar to hypertension or diabetes. The population most affected is among men. This population seldom seeks medical attention and is not subject to medical checkups. Although we cannot estimate the extent of chronic pathologies in connection with CRI, the prevalence of these chronic illnesses (Hypertension 23% and 27% and Diabetes 2.9% and 6% in La Isla and Candelaria, respectively) are lower than the rate for kidney disease. This points towards another causal mechanism.

With respect to a relation with nephrotoxic medicines, the descriptive data of chi-square distribution and its p value show no relation between the use of these medicines and the occurrence of kidney damage. Despite that, it will be necessary to calculate the ingested quantity of medicines in order to know if high doses have any influence and/or if the medicines are casual factors or a contributant. This constitutes a gap in the determination of causality.

In respect to occupational factors, there is extensive consideration as to whether working in sugar cane fields is the risk factor most important in the development of kidney disease. The question has been raised if other factors contribute significantly to the problem; such as the consumption of liquor [20-22]. This factor does not seem significant in this population.

The workers affected by the disease claim that the illness is a product of the use of pesticides which are probably nephrotoxic. It should be noted that they are not currently utilizing it in sugar cane cultivation. Unfortunately, there exists gaps of information in the history of nephrotoxic pesticide use in this sector and the workers do not remember (or did not know) the names of the pesticides that they used.

In conclusion, it is evident that we are in the presence of a Chronic Renal Insufficiency epidemic in the communities of La Isla and Candelaria. While prominent among young men, this disease is also affecting women. The impact that this disease has on the personal health of the residents also influences the living conditions. The consequence of mainly affecting young, productive men seriously compromises the economic security, food supply, and the possibilities of family and community development.

Although this data clearly indicates and warns about the magnitude of this disease, the necessity of doing an analytical study with a variable analysis needs to be considered. Such a study might examine, in greater detail, the risk factors and establish the extent these factors have in the stages of the disease with irreversible damage. It is also necessary to evaluate the effect of potential variables of confusion, modifiers of effect, or of interaction in the progression of kidney damage. The causality study would contribute substantially to reducing the disease and establishing prevention and health promotion programs.

Conclusion and Recommendations

Chronic Renal Insufficiency represents an epidemic for the communities of La Isla and Candelaria in the municipality of Chichigalpa. Already, it affects a large percentage of the population.

Results show that the men are the most vulnerable to the disease. This is significant since families traditionally depend on males for economic and other forms of stability. Many inhabitants are currently affected at the initial stages of the disease. There exists, at the early stages, an opportunity to intervene that could result in reversing the disease (or, at minimum, improving the kidney function of those affected). This would greatly impact the socio-economic conditions among the studied population.

In order to successfully implement appropriate preventive measures, besides just controlling the chronic disease from those who suffer it, it is necessary to promote a healthy lifestyle that counters the habitual use of tobacco and alcohol and promote sufficient consumption of safe drinking water. Additional in-depth studies will be required in order to assess the impact of each of the many risk factors. Above all, there is a need for study of environmental and occupational risk factors that (according to our results) may be connected with the occurrence of CRI in agricultural work and pesticide exposure.

Annexes

Annex 1

Educational Level of Surveyed Participants, La Isla and Candelaria

Education Level		La Isla	Candelaria	Total
None	(n)	27	15	42
	%	15.4	17.4	11.1
Some Primary	(n)	73	56	129
	%	41.7	27.7	34.2
Completed Primary	(n)	33	42	75
	%	18.9	20.8	19.9
Some High School	(n)	26	43	69
	%	14.9	21.3	18.3
Completed High School	(n)	9	23	32
	%	5.1	11.4	8.5
Advanced Studies	(n)	7	23	30
	%	4	11.4	8
Total	(n)	175	202	377

Annex 2

Access to Basic Services, La Isla and Candelaria, 2008

Access to water and Sanitation services		La Isla	Candelaria
Drinking Water	(n)	174	202
Well	(n)	170	1
	%	97.7	0.5
Potable	(n)	1	198
	%	0.6	98
Other	(n)	3	3
	%	1.7	1.5
Excrement Disposal	(n)	175	198
Latrine	(n)	168	139
	%	96	70.2
Toilet	(n)	4	59
	%	2.3	29.8
Open Spaces	(n)	3	0
	%	1.7	0
Treatment of Drinking Water	(n)	175	201
Yes	(n)	130	35
	%	74.3	19.4
No	(n)	45	164
	%	25.7	81.6