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Association of Gastrointestinal Illnesses and Environmental Factors in a Kumiai Indian Community in Baja California, Mexico[1]

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INTRODUCTION

Every country must make choices about how best to use economic resources for health. The severe limitations in developing countries require that resource allocation choices lead to the most health for the money (Evans, Hall, and Warford 1981). The present study was conducted to assess the morbidity status in the Kumiai Indian community of San Antonio Necua, located south of Tecate in Baja California, Mexico, and to determine whether there is an association with environmental health factors.

The planning and evaluation of public health activities and health facilities require knowledge of the extent of morbidity in the population. Morbidity data are essential to attempt to control disease. The most important issues in less-developed countries often involve control of known hazards, such as air pollution, drinking water contamination, sewage and solid waste disposal, vectors, and diet.

In 1996, "Building a Kumiai Environmental Strategy: A Border 21 Project" (Wilken-Robertson 1996) identified the water quality needs of the Kumiai communities of Baja California. The report identified water quality concerns in five different communities and suggested that improvements be made to water used for domestic purposes in San Antonio Necua. Many members of the community had stated that the water tastes like manure and urine and that the water quality was causing illnesses in newborns (Wilken-Robertson 1996).

Instituto de Culturas Nativas de Baja California (CUNA) made efforts to contact non-governmental organizations (NGOs) to assist in providing technical expertise to help this community. Among those NGOs was Aqualink Water Systems, a volunteer group dedicated to providing technical assistance to villages in Baja California that are developing small water and wastewater treatment systems. The group was asked to help San Antonio Necua assess its needs for water system improvements, and in March 1997 it began working with the community.

San Antonio Necua obtains its drinking water from a stream whose water is piped approximately 3 kilometers from the mountains to two concrete storage reservoirs. The water is then distributed to homes. Data on the quality of water used for domestic purposes obtained since January 1996 had consistently shown the presence of fecal coliform bacteria (Wilken-Robertson 1996). The presence of total and fecal coliform bacteria in untreated surface water is common and an indicator of disease-causing organisms in the water (Salvato 1992). This type of contaminated water must be treated before consumption.

After an evaluation of the water system, Aqualink Water Systems made the following suggestions to improve the community's water supply (Coates Hedberg 1998):

- Treat source water with filtration and disinfection
- Rehabilitate an existing abandoned well
- Drill a new well

It was suggested that the best alternative was to rehabilitate an existing abandoned well. However, the community was concerned about changing their water supply from its current source to well

water that has a high level of total dissolved solids. When the alternative was suggested to treat the source water with chlorine for disinfection, community members became concerned this might also change the water's taste. Thus, the community opted not to make improvements or changes to the current water system, discounting the fact that it may be a cause of illness. This dilemma prompted the idea of evaluating the community's overall gastrointestinal illnesses and their association with drinking water.

The study examined the association of the community's gastrointestinal illnesses with a number of environmental health factors. The project was intended to answer the following question directly and empirically: Is there an excessive number of gastrointestinal illnesses related to environmental factors in the community?

The process began with an initial visit with the president of the community to discuss the plans for the study. The president was given information on the purpose and basis for the study, what the process consisted of, and what type of questions the researchers hoped to answer. The president consented to the study. The next step was to attend a meeting and propose the study to the community for its approval. After fielding questions, the majority of the community agreed to participate for a small stipend. Upon the researchers' request, the president selected five community members *(promotors)* to assist in gathering data for the study and they were introduced to the community. A meeting with the *promotors* explained their roles and provided training on gathering the data. Data collection began soon after. Each participant in the study was read an informed consent form, which they signed.

The study was carried out for four weeks during the months of September and October 1998 on the San Antonio Necua reservation, which is located in the northeastern part of Valle de Guadalupe. Approximately 42 families live there and the total population is 164.

After the study was completed, the results were presented to the community and additional information was provided to assess the need for environmental health improvements. It is hoped that the study will also assist public health workers in implementing future environmental health evaluations of communities in less-developed countries.

METHODOLOGY

This project was an observational prospective study in which participating individuals were followed for a period of four weeks. The information obtained was focused on environmental health aspects, including drinking water supply, sewage waste disposal, solid waste disposal, the presence of rodents in the home, where food was purchased, as well as personal characteristics such as gender, age, occupation, and illness.

Data Collection

Two sets of data were collected from participating families. One set of data was obtained from an initial Environmental Health Assessment Enrollment Questionnaire, which included questions about each household and personal data about the individual participant. The second set of data was collected from Daily Illness Questionnaires, which were administered over four weeks. These questionnaires are variations of those that had been used previously in three studies by the U.S. Environmental Protection Agency (EPA), one study by the Centers for Disease Control and Prevention, and one by an EPA-funded study in Quebec, Canada (Payment, et al. 1991; EPA 1998a).

In order to collect the data, a *promotor* method was implemented. A *promotor* is a person within a community recruited to assist participation in health programs. Using the contracted *promotors* provided consistency of data collection and ease of participation.

Data Analysis

All participating households were initially visited on September 12 or 13, 1998. An interview with the adults (18 years of age and older) in each household was carried out to complete the initial Environmental Health Assessment Enrollment Questionnaire and explain how the daily illness health data would be collected. Illness data was gathered from September 13, 1998, through October 10, 1998.

For the purpose of statistical analyses, an episode of highly credible gastrointestinal illness (HCGI) involved at least one of the following combinations (Payment, et al. 1991):

- Vomiting or diarrhea with or without confinement to bed, consultation with a doctor, or hospitalization
- Nausea or diarrhea combined with abdominal cramps with or without absence from school or work, confinement to bed, consultation with a doctor, or hospitalization

An incident of diarrhea is classified as three or more bowel movements in a 24-hour period. Episodes with plausible etiologies apart from the one under study, such as pregnancy, were excluded from data analysis.

RESULTS

Community Participants

All 42 families living in San Antonio Necua during the month of September 1998 were asked to participate in this study. Of these, 29 families, for a total study population of 114 people or 70% of the community, participated. When requesting participation, a geographical factor was observed within the community for those families who live primarily in the north section of the community—those families declined to participate.

Characteristics of the Families

Table 1 provides the general characteristics of the families within the study group. The mean age of the population studied is 24. When residents of the community reach the age of 14, they typically stop attending school and begin working. More than three quarters of the population (76.3%) had lived in the community all their life. Of the women surveyed, only two (3.6%) were pregnant. None of the participants use day care facilities to watch their children; family members are used when needed. Most of the married women do

not work and stay home. Just less than half (44.1%) the population has a job. Only 27% of those who work do so outside the community. The average workweek is Monday through Saturday.

Table 1. Personal Information from Data Obtained during the Survey of Community Participants on September 12 and 13, 1998 (N = 114 Persons)

Variable	Number of People	Percent of People
Age in years		
0–5	19	16.7
6–14	21	18.4
15–44	56	49.1
45+	18	15.8
Gender		
Male	58	50.9
Female	56	49.1
Years lived in community		
Life	87	76.3
1 to 3	12	10.5
4 or more	15	13.2
Occupation		
Housewife	23	20.2
Student	20	17.5
Children at home	18	15.8
Rancher	15	13.2
Fish cannery	14	12.3
Road construction work	11	9.6
Teacher	4	3.5
No work	3	2.6
Winery worker	2	1.8
Janitor	1	0.9
Pump mechanic	1	0.9
Store manager	1	0.9
Truck driver	1	0.9
Work location		
Inside community (includes students)	42	36.8
Outside community	31	27.2
Don't work (includes children at home and housewives)	41	36.0

Source: Authors

Less than 25% of participants indicated that they drink alcohol and less than 20% smoke tobacco (from data obtained from those who are older than age 13). More than 80% use herbal remedies, which are typically made into teas.

The community has a central local health clinic where a doctor provides clinical services once per week. The most common illnesses in the community are diabetes, tuberculosis, and gastrointestinal illness. At the time of the survey, 10% of the participants had been diagnosed with an existing illness. More than 5% were diagnosed with diabetes—a great concern among the community's elders.

Characteristics of the Households

There are 26 homes in the community that house the 29 families who participated in the study. The community is spread out into four different clusters over 15,474 acres. The mean number of people living in the home is 4.9 with a standard deviation of 1.6. The mean number of rooms in the houses within the community is 3.7 with a standard deviation of 1.5.

All participants claim to drink the water supplied in the community and do not purchase bottled or hauled water. None of the participants treat their water prior to consumption. However, at times they need to pick out dirt, debris, and worms (mosquito larvae). The median number of glasses of water consumed per person is 5.0 per day, the mean is 6.1 glasses with a standard deviation of 4.3.

Water is delivered via gravity (there are no water pumps) to San Antonio Necua by pipeline. The community has a water distribution system that allows accessibility to all households. Some households do not have water plumbed into their homes and may instead have a hose tap on site or use a nearby hose tap. However, during warmer times of the year due to increased water use or decreased availability of source water, only 28% of the community receives a constant flow of water. Those who reside on the south side of the community have a constant water supply in comparison to other locations of the community. The homes on the south side of the community are first to receive water from the water source.

Approximately 50% of the community has home water storage in buckets or has water piped to their kitchen sink. Some residents have a water supply piped to their homes' kitchen sinks while others haul water via buckets to store in 55-gallon containers within their house. Storage of drinking water is not related to water availability. Of those who have water available sometimes, 58.5% have water supplied to their kitchen faucet. Of those who have water available all the time, only 37.5% have water supplied to their kitchen faucet.

Containers stored inside the house are sometimes covered; some homes have a scoop to dip into the water to collect for use. Some households have smaller containers with special taps on covered buckets for drinking water. Used water from the homes' sinks and showers is drained by pipe to the outside of the home for washing and cleaning.

Seven homes have septic tanks servicing 28.9% of the participating population. The outhouses are typically used for a year, then the waste is covered and the housing is moved over a new hole. It was observed during the survey that none of the outhouse vent pipes were screened. None of those surveyed indicated that they use lime or any other covering material or mechanism to prevent odor and control vectors in the outhouses.

Twenty-nine percent of the population, or eight homes, indicated that they have problems with rats entering their dwellings. Most indicated that the rats enter through the roof and scavenge for food and water. The majority of the community (89%) indicated that they burn their garbage on a daily basis as a method of trash elimination. The remaining population, 11%, discard their trash near the river that flows adjacent to the community.

Crowding in households was determined by dividing the number of people by the total number of rooms in the household (Olaiz 1987). Overcrowding is defined as more than two individuals per room. By this criteria, overcrowding is present in five households (24%), affecting 27 people. Only two of the houses in the community do not have electricity, affecting 5% of the population. Three households (12%) do not have refrigeration, affecting 7.9% of the population. Those who do not have refrigeration indicated that they shop for food on a daily basis.

Forty-one percent of the participants are the primary cook in the household. The cook is usually a woman who is either the wife or an elder in the household. More than 75% of meat and dairy products are purchased at the community's local store, which participants use because of its convenience and the belief that the prices are discounted. Forty-eight percent of the population purchases produce outside the community; some of the residents grow some fruits and vegetables at their homes. The most common foods for typical daily meals are eggs, beans, tortillas, potatoes, chicken soup, and rice. Some of the interviewees mentioned that they reuse food cooked in the morning for another meal later in the day.

Health Problems in San Antonio Necua

The *promotors* gathered the four-week daily illness questionnaires from the participating families. These questionnaires (given to all participants) requested information about their health and symptoms related to acute gastrointestinal diseases, as well as other illness symptoms such as fever, headache, and cough. The data in Table 2 show the number of days of symptoms experienced by the population during the four-week study. Thirty-seven percent of the community had at least one day of diarrhea during the study. Additionally, 45 people (39.5%) indicated they visually observed worms in their stool.

Table 3 indicates the number of days of highly credible gastrointestinal illness (HCGI). During weeks one, two, and four, more than 17% of the population had at least one day of HCGI. During week one, four people had HCGI for more than four days. In week three, only 13% of the population had one day of HCGI.

During the entire four weeks of the study, 44.6% of the population had one case of HCGI. Only one person had a case of HCGI every week. Tuesday showed the highest average number of cases of HCGI—7.5 people—during the four-week period. Saturday and Sunday had the lowest percent of ongoing HCGI cases on average.

Table 4 and Figure 1 depict the number of cases of onset of HCGI by days of the week. Tuesday showed the highest average number of cases of onset of HCGI (25.0%) during the four-week period. The end of the week, Friday and Saturday, had the lowest percent of HCGI case onset.

Table 2. Daily Illness Data Gathered during the Survey of the Community Participants between September 13, 1998, and October 10, 1998, (N = 112 persons; data do not include those pregnant)

Variable	Number of people and percent by number of days of illness											
	None		One day		Two days		Three days		More than four days	
	#	%	#	%	#	%	#	%	#	%
Cold or flu with cough present	48	42.9	13	11.6	7	6.3	10	8.9	34	30.5
Headache	66	58.9	18	16.1	8	7.1	9	8.0	11	9.9
Diarrhea	71	63.4	16	14.3	11	9.8	6	5.4	8	7.2
Abdominal cramps	81	72.3	13	11.6	7	6.3	8	7.1	3	2.7
Nausea	93	83.0	10	8.9	2	1.8	4	3.6	3	2.7
Fever	94	83.9	9	8.0	6	5.4	2	1.8	1	0.9
Vomiting	97	86.6	10	8.9	1	0.9	2	1.8	2	1.8

Source: Authors

Table 3. Daily Illness Data on Number of Days of HCGI by Week from Data Gathered during Survey of the Community Participants between September 13, 1998, and October 10, 1998, (N = 112 persons; data do not include those pregnant)

| Week no. | Number of people and percent with HCGI by number of days of illness | | | | | | | | | | | |
	None		One day		Two days		Three days		More than four days	
	#	%	#	%	#	%	#	%	#	%
1	92	82.1	8	7.1	3	2.7	5	4.5	4	3.6
2	92	82.1	13	11.6	5	4.5	1	0.9	1	0.9
3	98	87.5	7	6.3	4	3.6	2	1.8	1	0.9
4	93	83.0	15	13.4	2	1.8	1	0.9	1	0.9
Mean	94	83.7	11	9.6	4	3.2	2	2.0	2	1.6

Source: Authors

Table 4. New Cases of HCGI By Onset Day and Week from Data Gathered during Survey of the Community Participants between September 13, 1998, and October 10, 1998, (N = 112 persons; data do not include those pregnant)

	Number of people and percent with new cases of HCGI by onset day and week													
	Sun.		Mon.		Tues.		Wed.		Thurs.		Fri.		Sat.	
Week no.	#	%	#	%	#	%	#	%	#	%	#	%	#	%
1	4	16.7	7	29.2	3	13	2	8.33	3	12.5	3	12.5	2	8.33
2	1	4.8	4	19.0	7	33	2	9.52	3	14.3	1	4.76	3	14.30
3	2	13.3	1	6.7	4	27	5	33.30	3	20.0	0	0.00	0	0.00
4	1	5.0	5	25.0	6	30	2	10.00	4	20.0	1	5.00	1	5.00
Daily total number	8	10.0	17	21.3	20	25	11	13.80	13	16.3	5	6.25	6	7.50
Daily mean	2.0		4.25		5.00		2.75		3.25		1.25		1.50	

Source: Authors

Figure 1. Day of Onset of HCGI illness
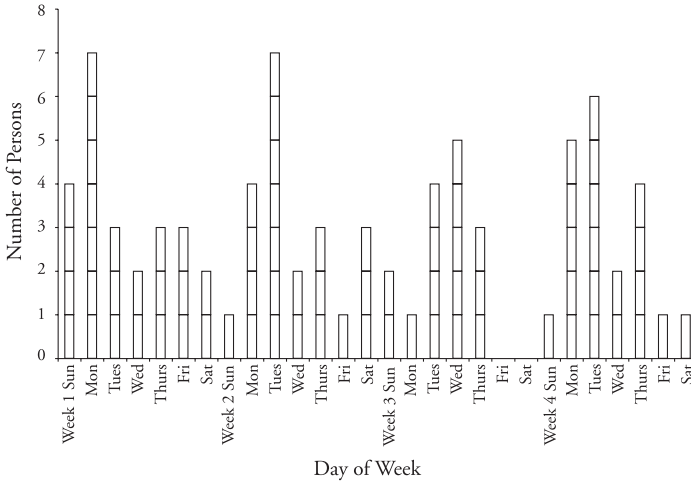
Source: Authors

Table 5 depicts the length of HCGI cases per person. More than 35% of HCGI cases occurred for more than one day. Approximately 8% had an HCGI case for more than four days. More than 40% of those who had an HCGI case for three days had a fever.

Table 5. Length of HCGI Cases By Week and Day from Data Gathered during Survey of the Community Participants between September 13, 1998, and October 10, 1998, (N = 112 persons; data do not include those pregnant)

Variable	Number of people and percent by length of HGCI cases							
	One day		Two days		Three days		More than four days	
	#	%	#	%	#	%	#	%
All HCGI cases	50	64.90	14	18.20	7	9.09	6	7.79
HCGI cases with fever	5	45.50	1	9.10	3	27.30	2	1.82
Percent of HCGI with fever of all cases		10.00		7.14		42.90		33.30

Source: Authors

Twenty-three percent of the people who had an illness visited a doctor. Most of the community indicated that when they are sick with diarrhea they visit the local community clinic for antidiarrheal medicine.

Personal Information and HCGI Cases

Table 6 depicts the univariate analysis of personal information and cases of HCGI. Those older than 13 who indicated they were smokers showed a statistically significant inverse relationship to cases of HCGI compared to those who did not smoke (χ^2 = 5.121, p = 0.024, Odds Ratio = 0.223). According to the data obtained, there was a decrease in the number of HCGI cases in the age group 6 through 14 in comparison to the other age groups.

Those who had not lived in the community all their lives had a significantly higher number of HCGI cases compared to those who had (χ^2 = 3.911, p = 0.048, Odds Ratio = 2.447). Of those who had not lived in the community all their lives, there was no significant difference in how many years they had been there and cases of HCGI. Those who work within the community did not have a significant difference in HCGI compared to those who work outside the community.

Although no statistical significance was shown between drinking less than eight and more than eight glasses of water per day, there was an increase in HCGI cases for those who drank more glasses of water (χ^2 = 1.360, p = 0.243, Odds Ratio = 0.618).

Household Information and HCGI Cases

Table 7 shows the univariate analysis of water supply and cases of HCGI. Tap water availability and storage showed no significant difference relative to HCGI cases.

Table 8 shows the univariate analysis of household sanitation characteristics and cases of HCGI. No significant relationship was shown between the type of sewage facility used, garbage disposal, crowding, location of the home within the community, electricity, or refrigeration. Significance was shown between those who live in homes with reported rodent problems and cases of HCGI

Table 6. Univariate Analysis of HCGI from Data Gathered during Survey of the Community Participants between September 13, 1998, and October 10, 1998, and Personal Information (N = 112 persons; data do not include those pregnant)

Variable	Cases of HCGI				χ^2	p value	Odds ratio	95% CI
	At least one case		None					
	#	%	#	%				
Drink alcohol (>13 years)					0.022	0.881	0.921	0.311–2.724
Yes	8	47.1	9	52.9				
No	28	49.1	29	50.9				
Smoke (>13 years)					5.121	0.024	0.223	0.311–2.724
Yes	3	21.4	11	78.6				
No	33	55.0	27	45.0				
Age in groups in years					2.879	0.411	N/A	N/A
0–5	9	47.4	10	52.6				
6–14	6	28.6	15	71.4				
15–44	27	50.0	27	50.0				
45+	8	44.4	10	55.6				
Gender					1.211	0.271	1.522	0.719–3.219
Female	27	50.0	27	50.0				
Male	23	39.7	35	60.3				
Use herbal remedies					0.212	0.645	1.260	0.471–3.371
Yes	42	45.7	50	54.3				
No	8	40.0	12	60.0				

Source: Authors

Table 7. Univariate Analysis of HCGI from Data Gathered during Survey of the Community Participants between September 13, 1998, and October 10, 1998, and Water Supply (N = 112 persons; data do not include those pregnant)

Variable	Cases of HCGI				χ^2	p value	Odds ratio	95% CI
	At least one case		None					
	#	%	#	%				
Tap water available 100% of time					0.127	0.721	0.859	0.372–1.983
Yes	13	41.9	18	58.1				
No	37	45.7	44	54.3				
Water storage					0.002	0.967	1.016	0.482–2.141
Kitchen tap	26	44.8	32	55.2				
Bucket	24	44.4	30	55.6				

Source: Authors

Table 8. Univariate Analysis of HCGI from Data Gathered during Survey of the Community between September 13, 1998, and October 10, 1998, and Household Sanitation Characteristics (N = 112 persons; data do not include those pregnant)

Variable	Cases of HCGI				χ^2	p value	Odds ratio	95% CI
	At least one case		None					
	#	%	#	%				
Sewage facility					0.014	0.904	1.052	0.461–2.402
Outhouse	36	45.0	44	55.0				
Septic	14	43.8	18	55.3				
Garbage disposal					1.781	0.182	2.360	0.117–1.539
Do not burn	7	63.6	4	36.4				
Burn	43	42.6	58	57.4				
Rodent problem in home					6.830	0.009	3.017	1.297–7.017
Yes	21	63.6	12	36.4				
No	29	36.7	50	63.3				
Crowded (>1 person/room)					1.841	0.175	0.537	0.217–1.328
Yes	9	33.3	18	66.7				
No	41	48.2	44	51.8				
Location of home					0.109	0.947	N/Aa	N/A
South side	11	42.3	15	57.7				
East side	15	44.1	19	55.9				
West side	24	46.2	28	53.8				
Electricity in home					0.074	0.786	0.797	0.154–4.129
Yes	47	44.3	59	55.7				
No	3	50.0	3	50.0				
Refrigeration available					0.507	0.477	1.679	0.398–7.078
Yes	47	45.6	56	54.4				
No	3	33.3	6	66.7				

aN/A = not applicable

Source: Authors

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(χ^2 = 6.830, p = 0.009, Odds Ratio = 3.017, 95% CI = 1.297–7.017). Although no significant relationship was shown, those who did not burn their garbage had an increase in numbers of HCGI cases (χ^2 = 1.781, p = 0.182, Odds Ratio = 2.36, 95% CI = 0.117–1.539). In addition, although no significance was found based on the location of the homes, HCGI cases increased in increments of 2% from south side to east side to west side.

The homes that had at least two people with a case of HCGI had a higher incidence of rodent problems; however, this was determined to be statistically insignificant. Those who have rodent problems and stay within the community during the day also had increased HCGI incidence; this too, though, was determined to be statistically insignificant. It was further shown that for those who have rodent problems and at least one case of HCGI, drinking water storage was not statistically significant. Forty-six percent of those who live on the west side of the community have rodent problems. One south-side home indicated rodent problems, as did one east side home. All those who indicated they had rodent problems on the south and east sides of the community had at least one case of HCGI (100%). Of those who live on the west side of the community and indicated they had rodent problems, 46.2% had at least one case of HCGI; the comparable figure for the east side was 44.1%, and for the south side it was 42.3%.

There was no significant relationship found between cases of HCGI and where dairy products, meat, and produce were purchased, or who cooks the food for the household.

Characteristics of the Water Supply

Samples of water for laboratory analysis were taken from one location within the distribution system. Table 9 indicates the water quality results of these samples.

Table 9. Water Quality Characteristics Gathered during Survey of the Community between September 13, 1998, and October 10, 1998

Date	Total coliform	Fecal coliform	HPC	Turbidity	TDS	Color
9/13/98	900	17	540	0.37	315.0	<20
9/20/98	900	30	Lab error	0.73	337.5	<25
9/27/98	500	8	170	0.76	346.0	<15
10/4/98	110	30	460	0.88	359.0	<15
10/11/98	140	8	125	0.82	249.0	<10

Source: Authors

DISCUSSION

Gastrointestinal Illnesses

During the study of San Antonio Necua, 50 people of the 112-person study population (44.6%) had at least one case of HCGI. The number of gastrointestinal illnesses in the community was present at a frequency high enough to test statistically the postulated hypotheses.

The incidence of diarrheal cases in the community from September 13, 1998, to October 10, 1998, was 366 per 1,000 people and the incidence of HCGI cases was 446 per 1,000. The reported incidence for diarrheal diseases found in Latin America in 1990, according to the Global Health Statistics, was 978 per 1,000 for all ages, and for ages older than 14, the rate was 300 per 1,000 (Murray and Lopez 1996). A study by Olaiz (1987) showed the prevalence rate (new cases over a two-week period) of diarrhea in communities in Tijuana, Mexico, to be 298 per 1,000 in 1987. The Olaiz study was carried out in rural communities within Mexico with a similarly high risk of gastrointestinal illnesses.

The incidence rate of diarrheal diseases in 35 established market economies surveyed in 1990 was 209 per 1,000 for all ages, and for those older than 4 years, the rate was 100 per 1,000. San Antonio Necua has a rate similar to those of developing communities.

Personal Information and HCGI Cases

Those older than 13 who indicated they smoke had a statistically significant inverse relationship with cases of HCGI (Table 6). This relationship may be consistent with recent findings from studies being performed in the United States. Since 1982, studies have shown a strong negative association between smoking and colitis (Thomas, et al. 1996), which has led to a search for the active ingredient responsible for the relationship. Nicotine is currently under investigation to determine whether it has a therapeutic role in the treatment of ulcerative colitis (Thomas, et al. 1996), a gastrointestinal condition that is a form of inflammatory bowel disease.

More than three quarters of the community's population (76.3%) have lived there all their lives, as is common within Indian groups. Most of the children marry outside San Antonio Necua and bring their spouses into the community. Those who indicated they have not lived in the community all their lives had a significant increase in number of cases of HCGI. An evaluation was performed to determine whether there was an association with newer community residents being more susceptible to illnesses. Since the range of years living in the community was from 1 to 32, further analysis was performed and concluded that length of time living in the community had no statistical significance in incidence of HCGI. Thus, a person who was not born in the community was determined to be more likely to incur gastrointestinal illnesses regardless of how long he or she had lived in the community.

During each of the four weeks, Tuesday was found to have the highest percent of onset HCGI cases and Monday ranked second highest, with ratings of 25.0% and 21.3% respectively (Table 4). The most common gastrointestinal illnesses have an incubation period of 24 hours to 48 hours (Seenland and Savitz 1997). Most of the families are home on Sundays all day because of the six-day workweek. Based on a 24-hour to 48-hour incubation period, an

HCGI case exposed on Sunday most likely had a day of onset of Monday or Tuesday. This indicates that the source of the gastrointestinal illness may be coming from the home.

Sixty-five percent of all HCGI cases had a duration period of one day (Table 3). The most common food-borne illnesses last 24 hours. Seventeen percent of all HCGI cases had a duration of more than three days, and of those, 38 percent were associated with fever (Table 5). The presence of fever is common in longer-duration food-borne illnesses.

Household Sanitation Characteristics and HCGI Cases

Those who indicated they had rodent problems had a significant increase in cases of HCGI (p < 0.05), as shown in Table 8. This finding was reinforced by the consistency of the effect across different ages, sexes, home locations, and occupations. This study suggests there is a significant association with the presence of rodents in the homes and gastrointestinal illness among the residents.

Water Quality Characteristics

The criteria for filtration avoidance in the United States requires that fecal coliform bacteria number be less than 20 per 100 milliliter (ml) and that turbidity is less than 1 Nephelometric Turbidity Unit. It also requires implementation of a watershed control program. The water supplied to the community met the criteria for filtration avoidance for turbidity; however, two samples showed fecal coliform bacteria at 30 per 100 ml. Although the source water on average met the qualifications for filtration avoidance, disinfection is necessary to achieve 99.9% inactivation of *Giardia lamblia*. The regulations are based on the assumption that all water systems that use surface water sources may be at risk, at least to some degree, from contamination by protozoan cysts and enteric viruses. *Giardia lamblia* is a protozoan that causes gastrointestinal illnesses and is most resistant to disinfection, thereby making it difficult to inactivate (Fulton, et. al 1992). When steps are taken to assure *Giardia* removal, a more complete level of control is thought to be achieved over the full

range of waterborne pathogens. In order to meet a 99.9% inactivation (3 Log Inactivation), a certain amount of disinfection and time in contact before consumption is required. Filtration should be considered if fecal coliform bacteria levels continue to be greater than 20 per 100 ml. Chlorination provides an inexpensive method of ensuring the bacteriological quality of water.

According to this study, no significant association was found between the consumption, availability, or storage of drinking water and gastrointestinal illnesses in the community. However, because community members all consumed the same water, the study was not able to determine specifically whether the drinking water was causing gastrointestinal illnesses.

SOURCES OF BIAS

Possible sources of bias need to be considered, the main one being reporting bias. Although the data was gathered from each household by the same person and training was provided, there is the possibility that the *promotors* misrecorded information. However, there was no significant increase in reporting of HCGI from any one *promotor*.

The participants who were aware of the study objectives and perceive that there is a problem within the community may have exaggerated their morbidity. Also, underreporting may have occurred for school children between the ages of 6 and 13 due to lack of communication and oversight between child and parent.

However, symptoms such as vomiting, diarrhea, and abdominal cramping are not subjective nor open to interpretation. Over the four-week study period the reported gastrointestinal illnesses were fairly constant, arguing against any such bias.

RECOMMENDATIONS

The intent of this study was to gather gastrointestinal illness and household information from the community and evaluate the association with existing environmental health factors. It was determined that there was a significant association of gastrointestinal illnesses

with the presence of rodents (p=0.009). Food in the home may become contaminated by rodent feces and urine, or by the rodent mechanically carrying and transferring disease organisms.

It was recommended that the community make efforts to reduce the number of rodents by eliminating the rodents' supply of food and water. Storage of food and water inside homes should be in tightly covered containers. The community should also implement control measures for breeding outside the home, such as minimizing access to garbage by using a sealed container and eliminating standing water near homes (Salvato 1992).

Although there was no significant association between gastrointestinal illness and the community drinking water, based on the presence of the low levels of fecal coliform bacteria, it is recommended that the community chlorinate their drinking water supply. Disinfection of the source water will assist in inactivation of pathogenic microorganisms.

ENDNOTE

[1] This chapter is an abridged version of Kathleen Coates Hedberg's Master's thesis for the Department of Public Health at San Diego State University in San Diego, California.

REFERENCES

American Public Health Association, American Water Works Association, and Water Environmental Federation. 1992. *Standard Methods for the Examination of Water and Wastewater, 18th ed.* Washington, D.C.: American Public Health Association, American Water Works Association, and Water Environmental Federation.

Coates Hedberg, Kathleen. 1998. Letter to Chief Bernebe, Aqualink Evaluation of San Antonio Necua Community Water System. Unpublished.

Evans J. R., K. L. Hall, and J. Warford. 1981. "Health care in the developing world: Problems of scarcity and choice." *New England Journal of Medicine* 305:1117–1127.

Fulton, G. P., E. A. Bryant, and G. C. Budd. 1992. *Disinfection Alternatives for Safe Drinking Water.* New York: Van Nostrand Reinhold.

Hedberg, K. M. C. 1999. "Association of Gastrointestinal Illnesses and Environmental Factors in a Kumiai Indian Community in Baja California, Mexico." Master's thesis, Department of Public Health, San Diego State University, San Diego, California.

Murray, C. J. L., and A. D. Lopez. 1996. *Global Health Statistics: A Compendium of Incidence, Prevalence, and Mortality Estimates for Over 200 Conditions.* Cambridge, Mass.: Harvard University Press.

Olaiz, G. A. 1987. "Water stored in 200 liter drums and health effects in low socioeconomic groups in Tijuana." Master's thesis, Department of Public Health, San Diego State University, San Diego, California.

Payment, P., L. Richardson, R. Dewar, M. Edwardes, E. Franco, and J. Siemiatycki. 1991. "A randomized trial to evaluate the risk of gastrointestinal disease due to consumption of drinking water meeting current microbiological standards." *American Journal of Public Health* 81(6):703–708.

Salvato, J. A. 1992. *Environmental Engineering and Sanitation, 4th ed.* New York: John Wiley and Sons.

Saul, H. 1996. "Year of the rat." *New Scientist* 152:32–37.

Seenland, K., and D. A. Savitz. 1997. *Topics in Environmental Epidemiology.* New York: Oxford University Press.

Thomas, G. A. O., J. Rhodes, and J. Green. 1996. "Nicotine and gastrointestinal disease." *Quarterly Journal of Medicine: Monthly Journal of the Association of Physicians* 89(7):485–488.

U.S. Environmental Protection Agency. 1998a. "Waterborne disease studies and national estimate of waterborne disease occurrence." *Federal Register* 63(154).

Wilken-Robertson, Michael, ed. 1996. *Water Quality in the Kumiai Communities of Baja California. Building a Kumeyaay Environmental Strategy: A Border XXI Project.* Ensenada: Instituto de Culturas Nativas de Baja California and the Campo Environmental Protection Agency.

Wilken-Robertson, M. 1998. *Sustainable development in the indigenous communities of Baja California.* Ensenada, B.C.: Instituto de Culturas Nativas de Baja California and the Council for Environmental Cooperation.