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Yard flooding by irrigation canals increased the risk of West Nile disease in El Paso, Texas

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Abstract

Purpose—To investigate the effects of use of water from irrigation canals to flood residential yards on the risk of West Nile disease in El Paso, Texas.

Methods—West Nile disease confirmed cases in 2009–2010 were compared with a random sample of 50 residents of the county according to access to and use of water from irrigation canals by subjects or their neighbors, as well as geo-referenced closest distance between their home address and the nearest irrigation canal. A windshield survey of 600 meters around the study subjects' home address recorded the presence of irrigation canals. The distance from the residence of 182 confirmed cases of West Nile disease reported in 2003–2010 to canals was compared to that of the centroids of 182 blocks selected at random.

Results—Cases were more likely than controls to report their neighbors flooded their yards with water from canals. Irrigation canals were more often observed in neighborhoods of cases than of controls. Using the set of addresses of 182 confirmed cases and 182 hypothetical controls the authors found a statistically significant inverse relation with risk of West Nile disease.

Conclusions—Flooding of yards with water from canals increased the risk of West Nile disease.

Keywords

West Nile Virus; Irrigation; Epidemics; Case-Controls Studies

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MeSH Keywords

West Nile encephalitis; Irrigation; Case-Controls Studies; Arboviral encephalitides; Housing Characteristics; United States; Epidemiologic Studies; Risk Factors

Although the epidemic of the mosquito-borne West Nile (WN) has declined (1), certain areas in the Western US continue to experience relatively high levels of occurrence of WN disease. *Culex tarsalis* is the main vector of WN disease in the Western US (2–3), and is known to thrive in agricultural irrigated areas (4). Associations between crop production, percent of land irrigated and risk of WN were found using ecologic geospatial studies (5–11). In several US cities and towns, aqueducts, originally built for crop irrigation, became engulfed by urban growth. Residents living next to those aqueducts or irrigation canals claim natural (i.e. riparian) rights to water from these canals and for convenience and economy use water from canals to flood their residential yards. This study tested the hypotheses that: a) distance to irrigation canals was inversely related to the risk of WN disease and b) within proximity to the irrigation canals persons who flood their yards with water from canals or who report that their neighbors do so, were at increased WN disease risk.

MATERIALS AND METHODS

We conducted a cumulative (“epidemic”) unmatched case-control study (12, p. 125) of 48 new WNV cases reported and investigated by the City of El Paso Department of Public Health from 2009–2010 among residents of El Paso County, Texas, who met the definition of confirmed cases (13). The authors conducted the study in October–November of 2010, as part of an ongoing field epidemic investigation. Controls were subjects randomly selected among El Paso County residents who reportedly had not had WN disease. They were chosen based on a random selection of 50 blocks each with probability proportional to population size. Once a block was randomly selected a household was systematically selected starting at a predetermined point and by visiting consecutive households until a study subject from the block was selected and consented to participate in the study. Within each household a subject was selected using the next birthday method (14). An attempt was made to contact and interview all cases and randomly selected controls and to obtain a blood sample to test for serological evidence of past WN viral infection. Information on decedent cases and from those unable to respond due to severe illness was obtained from next-of-kin respondents. Structured interviews collected information on demographic characteristics, time spent in occupational and recreational outdoor activities, use of mosquito repellent, medical history, income and education, and access to water from canals by the participants and/or their neighbors and the practice of flooding yards with water from canals. Questions for cases were framed to recall the period before the onset of WN disease. Study participants were unaware of the main study hypothesis. Data was entered into an application developed in Epi-Info 3.5 (Epi Info; CDC, Atlanta, GA) (15).

Internal Review Board approval was obtained from the UT HSC Committee for the Protection of Human Subjects (HSC-SPH-06-0115). In addition, the ongoing epidemic investigation on WN disease is in compliance with Texas law (State of Texas Health and Safety Code) which provides state and local health departments with the authority to carry out outbreak investigations to protect the public health (Chapters 81, 121, 161 of Texas Health and Safety Code). All the investigators that contacted study subjects participants or had access to identified information worked as paid employees or volunteers for the City of El Paso Department of Public Health. All study subjects voluntarily agreed to participate in

the study and signed informed consent forms. All records were kept confidential in compliance with state and federal laws.

The investigators also drove approximately 600 meters around the residence of the study participant to observe whether irrigation canals or ditches were present using a windshield screen survey method (16). In addition, a database with the exact location of the irrigation canals was joined to layers with geo-coded residence of cases and controls, and the Euclidean distance to the nearest canal was calculated using ArcGIS v.10 (ESRI Inc., Redlands, CA). The main exposure variables were the self reported use of water from canals for flood irrigation by the study participants or neighbors (yes/no), presence or absence of irrigation canals or ditches within a three-block distance or about 600 meter radius of the subjects' address, and the distance to irrigation canals from geo-referenced data. Most *Culex tarsalis* female mosquitoes, the main vector of WN in the Western US, although capable of flying long distances, when released in a riparian habitat most times stay within a 1 kilometer of their release point (17). Therefore, the 600 meters drive seemed relevant and a feasible range to cover for the resources available to our epidemic field investigation team. ArcGIS calculated distance to nearest canal was categorized using the tertiles of its distribution among the controls. The analyses controlled for age (0–44, 45+ years), gender, ethnicity, and income via stratified and logistic regression.

To assess the degree of misclassification of disease status of the cumulative case-control study also referred as actual case-control study, the sera specimens were tested for WN viral antibody as well as for Eastern equine encephalitis, dengue (types 1–4), yellow fever, and Saint Louis encephalitis using the hemagglutination inhibition test in serial two-fold dilutions of 1:20 to 1:5120, at a pH 6.6 with 4 U of antigen and a 1:200 dilution of goose erythrocytes, as described previously (18) at the University of Texas Medical Branch at Galveston, Texas.

For the descriptive epidemiology, we used WN disease case reports from 2003–2010 of confirmed cases, calculated age adjusted rates to the 2000 US Census population. Standardized rate ratios and their 95% confidence intervals (CI) were determined using normal approximation methods (11). Smoothed rates of reported WN disease during the 8-year period were computed at the zip code tabulation area level using a two-dimensional median-based smoothing algorithm developed by the National Cancer Institute (19). A spatial scan statistic (SaTScan v 9.1, IMS Inc., Silver Spring, Md.) based on the Poisson distribution was used to identify spatial clustering (20). The spatial scan statistic has been presented in detail elsewhere (21). In brief, it evaluates whether the rates of WN disease were the same in a select group of census tracts and the remaining over a scanning window without prior assumption of its size. The Poisson distribution is used to estimate the expected number of cases as a function of rate (number of cases/number of persons at risk) for each location (scanning window) in a permutation test over all possible geo-referenced windows (i.e., Monte-Carlo hypothesis testing). Most likely clusters (i.e., primary) and secondary clusters are identified using a likelihood ratio test. This purely spatial cluster analysis was run using the maximum spatial cluster size (M) of <50% of the population to evaluate clusters of any size and with M<25%. This geo-spatial cluster analysis only used the case reports from 2003–2010 and population counts of the 121 census tracts in El Paso County, Texas.

The coordinates of the addresses of all confirmed reported cases of WNV in El Paso County in 2003–2010 were compared to those from the centroids of a random sample of as many blocks as cases reported, as if the authors had actually selected and interviewed a hypothetical subject living in each of those blocks. These blocks were also selected with probability proportional to size of the blocks. Again, the distance to the nearest irrigation canal was

estimated as described above, and its distribution among controls used to create categories and calculate odds ratios (OR), 95% CI and test for trends. We refer to this study as the case-hypothetical control study. A p value < 0.05 (two-sided test) was considered statistically significant. These analyses were carried out using SAS 9.2 (SAS Institute, Cary NC).

RESULTS

In 2003–2010, 182 confirmed cases of WN disease were reported for an age-adjusted incidence rate of 3.5 cases per 100,000 person-years. Eighteen (or 9.9%) of the 182 confirmed WN disease cases were known to be deceased at the time of report. Cases of WN fever were reported since 2004, and 24 (16%) fell into this category, the rest were considered neuroinvasive. Incidence of WN disease increased 30-times between those in the 0–9 years of age and those in the 70+ years age group; the age-adjusted rate ratio was higher among males than females [Rate Ratio (RR)=1.8, 95% CI: 1.4, 2.4]. Hispanics had a higher age-adjusted rate of WN disease than non-Hispanics (RR= 1.8, 95% CI: 1.2, 2.7). WN disease occurred every year from late June to early November, peaking in August.

A striking pattern emerged regarding the spatial distribution of cases of WN disease with most cases occurring in close proximity to the irrigation canal system as shown in the spot map of Figure 1a. Those living in zip code tabulation areas with their centroids within 0.5 Km from the nearest irrigation canal had a 2.5-fold increased risk compared to those living ≥ 4.6 km away (RR=2.5, 95% CI=1.8,3.4). Thus, residents of zip code tabulation areas closer to irrigation canals in the East side of the county were at higher risk as shown by age-adjusted smoothed rates in the area map of Figure 1b. Using the maximum spatial cluster size of $\leq 50\%$ of the total population, we found evidence of a statistical significant cluster which included 29 census tracts (or 23% of all tracts) that comprises 27% of the county's population and 90/182 (49%) of all cases (RR=2.5; $p<0.001$). Two secondary clusters were also identified near the Rio Grande, but none of these were statistically significant (Figure 2a). Also the use of a threshold of $\leq 25\%$ of the total population as scanning window identified a large cluster which included 23 of the same 29 census tracts found in the previous analysis with a $\leq 50\%$ population scanning window, and also identified three secondary clusters, one of them with statistically significant increased rates (Figure 2b).

Turning into the actual case-control study, we were able to locate and interview 39 of 48 cases (or 81.2%) that occurred in 2009–2010, and only one case subject refused to participate while eight cases were lost to follow-up. Blood sample specimens were obtained from 30 of the 39 cases (76.9%). A total of 119 attempts were made to include a randomly selected control, 43 selected persons were not at home, and 26 refused to take part in the study, thus the total non-response was 58.0%, while the refusal rate was 21.8%. The control series had slightly more female (28 or 56%), Hispanic (44 or 88%), and older (26 or 52% 45+ years) persons than expected in the general population which is comprised of 52% female, 81% Hispanic and 30% 45+ years, according to 2010 population estimates. Fifteen consenting controls refused to provide a blood sample (26.0%) and adequate samples could not be obtained from 4 subjects, leaving 31 specimens from controls for the validation study.

Hemagglutination inhibition testing of 29 serum samples from WN confirmed cases and showed a pattern of HI antibodies characteristic of a primary antibody response to flavivirus infections, with only two samples that showed secondary response, and one had a cross-reaction unable to interpret. Among the 29 cases, all serum samples reacted with flavivirus antigens, and 28 (96.6%) showed cross reaction to several flaviviruses, but with greater titers against WNV than to the other flaviviruses. The HI results of one the controls were uninterpretable due to cross-reaction, and 29 of the remaining 30 were negative for WN

antibody. Three controls (10 %) reacted with Saint Louis encephalitis virus only. Excluding those samples with equivocal serology, 27/28 WN cases, and 29/30 controls were correctly classified, for estimates of 96.4 (95% CI: 79.8, 99.8) sensitivity and 96.7 (95% CI: 80.9, 99.8) specificity of the working definition of cases and controls with respect to WN virus past infection status.

Two-by-two table analyses revealed modest and not statistically significant differences between cases and controls by age, gender, ethnicity, and no differences by income or education. However, cases were more likely to report having a medical diagnosis of diabetes, high blood pressure, stroke, or kidney disease prior to acquiring WN than the controls (OR=2.7, 95% CI: 1.2, 6.2). Only 9/39 cases (23.1%) and 5/45 controls reported occupations that required working outdoors (OR=2.7, 95% CI: 0.8, 8.9). There was no association between WN disease in relation to the amount of time spent in occupational outdoor activities. Also, there was no significantly elevated risk of WN disease according to time spent in outdoor leisure-time activities (sitting at the porch or yard, gardening, walking or jogging), in general, or at dusk.

Only 5% of cases of WN disease and 6% of their controls reported that they had water rights to irrigation canals (Table 1). Twenty-eight percent of the cases and 6% of the controls reported their neighbors had natural rights to water from the irrigation systems (OR=2.9, 95% CI: 0.9, 10.5). Those who reported seeing their neighbors using water from irrigation canals to flood their yards had almost a five fold increased risk of WN disease (OR=4.5, 95% CI: 1.2, 22.7). The results of the windshield survey showed that more persons affected with WN disease than controls lived within 600 meters of irrigation canals (OR=3.2, 95% CI: 1.2, 8.1). In more instances canals or ditches were observed within 600 meters of the subject's address than those when water from canals was used by cases and controls or their neighbors to flood their yards: 17/39 observed by study personnel versus 11/39 reported instances by cases and 10/50 observed by study personnel and 4/50 reported among controls.

Table 2 shows the results of geospatial analyses of the distribution of distance to irrigation canals using the two sets of data: The relation to distance to canals among the 48 cases of WN disease reported in 2009–2010 and the 50 controls according to the tertiles of the distribution of controls is shown in panel A, while in panel B the same analysis is presented using the cases reported in 2003–2010 and hypothetical controls compared by quintiles of the distribution of controls. Panel A shows that 50% of cases of WN disease reported in 2009–2010 lived within less than 901 feet from irrigation canals, whereas only one third of the controls lived within such distance from canals. We did not find evidence of an association between the risk of WN and distance from addresses to irrigation canals in this smaller sample, although cases who lived within one km had an increased risk by a factor of 2 (OR=2.0, 95% CI: 0.8, 5.2), although not statistically significant. However, panel B shows evidence of an association between risk of WN disease and closer distance to irrigation canals in the larger set of case reported in 2003–2010 compared to hypothetical controls (test for trend p -value<0.001), indicating that 43% of all cases of WN disease reported in 2003–2010 lived within 327 meters of canals, corresponding to the lowest quintile of distribution of the controls, while less than 8% of the cases lived at least 7,396 meters away from the canals, the upper quintile of the distribution of the controls. These results demonstrate that proximity to irrigation canals increased risk almost by a factor of six (OR=5.7, 95% CI: 2.8, 11.9) when the extremes of the distribution were compared.

Using the data from the actual case-control study, that collected data on use of water from canals, we assessed whether the effect of flooding residential yards was observed only within certain distance to canals. Indeed, as shown in Table 3, only persons who lived within closest distance to irrigation canals used water from canals to flood their yards. When the

relation between distance to irrigation canals and risk of WN disease was stratified according to use of water from irrigation canals to flood the yards (table 3, Panel A), the effect of distance was null in the domain of those who flood their yards with water from canals, since only those living next to canals had access to water from canals (extended Mantel-Haenszel test for trend χ^2 P-value=0.3). When the relation between yard flooding by irrigation canals and WN disease was stratified according to distance to canals, again only those living within the closest distance to canals had access to water from canals to flood their yards, in that stratum those who flooded their yards or have reportedly seen their neighbors flooding their yards had an increased risk of WN disease (OR=2.6, 95% CI: 0.7, 10.8). The weighted average of the effect of flooding yards with water from canals remained unchanged (Mantel-Haenszel OR=2.7, 95% CI: 0.7, 10.2).

We found that only 9% of the cases of WN disease reportedly used insect repellent sometimes, but none of them reported using repellents more frequently, while 14% of the controls used them sometimes or more frequently. The differences shown in table 3 were statistically significant (Fisher's exact test p -value=0.002). The comparison between none versus some use of mosquito repellents showed a statistically significant difference on the risk of WN disease (OR=3.5; 95% CI=1.0, 15.9).

Table 5 shows the results of the multivariate analysis of interview data indicating that the relation between proximity to irrigation canals and an increased risk of WN disease was not confounded by age, gender, income, education or history of medically diagnosed chronic diseases. Also the analysis indicates that there was a four-fold increased risk of WN disease among those who live in areas with irrigation canals (OR=4.1, 95% CI: 1.4, 12.3).

DISCUSSION

We tested the hypothesis that proximity to irrigation canals and use of water from canals to flood residential yards is a risk factor for WN disease in El Paso, Texas. The larger 2003–2010 case-control study showed that persons living closer to irrigation canals were at increased risk of WN, while the smaller 2009–2010 case-control study which obtained data through actual interviews provided insights into one postulated mechanism by which the closeness to canals operates: the use of water from canals to flood residential yards.

According to the El Paso County soil survey, the valleys by the Rio Grande have soils that tend to drain well except where layers of clay exist (22). These clay hardpans limit drainage and create mosquito breeding sites. The canopy along the irrigation canals attracts both passerine species (23) and common mockingbirds, grackles and doves often found positive for WNV throughout the Southwestern US (24). There are about 3,000 water users of the El Paso County Water Improvement District #1, the majority are owners of small tracts of land (less than 2 acres) that use the water for landscape irrigation. Water from irrigation canals is made available to those who have water rights and pay taxes to the water district. These small tract users receive water 1.5 to 2 times a month during full allocation years for a total of 8 to 10 irrigations during the irrigation season which usually runs from March to the end of September. In residential yards where clay hardpans, pockets and indentations in the ground exist, flooding will create ideal breeding sites for *Culex* mosquitoes, which prefer to lay their eggs in organically enriched, newly created water (25, 26). In 2010 the Vector Control Program of the City of El Paso sent to the Department of State Health Services Laboratory mosquito pools caught in 267 light traps. WNV was isolated from 12 (4.2%) of these pools and 11 (91.7%) were obtained from *Cx. tarsalis* specimens, all of them from traps set near canals (D. Soto, Vector Control Program, Environmental Services, City of El

Paso, 2011: Personal Communication). To sum up, the irrigation canals bring together birds, the main hosts of WN virus, mosquitoes and humans.

Our study presents new findings on the role of the use of agricultural irrigation for residential purposes in urban settings on the risk of WN disease. In the Texas Panhandle, playa-lakes (i.e., ponds) have been found associated with high levels of occurrence of WN disease (27), and studies conducted in Iowa (6) and Colorado (8) indicate that irrigation plays a role in the occurrence of WN disease in rural areas. Studies conducted in Southern California suggest that in urban settings *Cx. tarsalis* is more adapted to thrive along riparian corridors (2, 25). It is possible that flooding of yards with water from agricultural irrigation canals occurs in other settings in the Western US.

We also found that only 26% of the respondents in the control series reported that they used mosquito repellent sometimes while at outdoors, which is less than the 42%–60% prevalence of use found in surveys in other states (28–31).

Our study has strengths as well as limitations: the validation study provides reassurance regarding the correct classification of cases and controls and is consistent with reports of low occurrence of WNV in the general population (32–35). In El Paso, Texas, in 2009–2010, between June and December of each year, among 51,557 blood donations screened for WN, only 22 (0.04%) were confirmed as WN viremic (Kato, M and Pavia M: United Blood Services of El Paso, 2011: Personal Communication). The distance to irrigation canals is only a proxy measure of actual use of water to flood residential yards but seems to capture the exposure of interest at an ecological neighborhood level. However, we did not collect information on the address of neighbors who flooded their yards, as the assessment of the proximity to irrigation canals is only based on the address of cases and controls. Further research is planned in El Paso to document the transmission of WNV in the vicinity of the canals. The findings of the case-control study base on interviews allowed us to control for relevant covariates, but had limited statistical power (<80%) to detect associations of the order of < 5-fold increased risks, as some of the numbers presented in the tables are small. However, the comparison made using the larger case-hypothetic control study (n=182 cases) had enough statistical power, but lacked the richness of the information obtained from interview data.

In conclusion, we found evidence that living in close proximity to irrigation canals, the use of water from canals and the prevalent practice of flooding residential yards with water from canals in El Paso County, Texas, was a risk factor for WN disease. Furthermore, this study identified two other risk factors: those at high risk are older individuals with chronic conditions who do not use mosquito repellent. Interventions should target these populations within areas close to irrigation canals.

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Figure 1. Distribution of laboratory confirmed cases of West Nile disease, El Paso, Texas, 2003–2010. The urbanized areas are shown in solid gray, and the grid of irrigation canals and ditches is shown as gray lines

Panel A. Spot map by residence of cases. A non-filled circle represents 1 case.

Panel B. Smoothed age-adjusted rates by Zip Code Tabulation Area of the cases' addresses

Figure 2. Spot map depicting the spatial clustering of laboratory confirmed cases of West Nile by Census Tracts of residence of the cases

Panel A, results using a scanning window of $\leq 50\%$ of the total population. A large statistically significant cluster ($RR=2.5$, $P\text{-value}<0.001$), is depicted by spots in dark squares. Two, not statistically significant secondary clusters are depicted by crosses and stars. Cases not clustered are depicted as circled spots. The urbanized areas are shown in solid gray, and the grid of irrigation canals and ditches as gray lines.

Panel B shows results using a scanning window of $\leq 25\%$ of the total population. One large statistically significant cluster ($RR=2.4$, $P\text{-value}<0.001$) is depicted by dark square spots, and three small secondary clusters, one of them, number 1 (crosses in dark gray) was statistically significant ($RR=2.7$, $P5\text{ value}=0.04$). Cases not clustered are depicted as circled spots.

Self report of access to water from irrigation canals, and observed presence of such canals within 600 meters of home address of cases of WNV disease and controls, El Paso, Texas 2009–2010

Table 1

Characteristic	Cases		Controls		Odds Ratio (95% CI)
	Number	%	Number	%	
Study subjects had water rights from irrigation canals					
Yes	2	5.1	3	6.0	0.8 (0.1, 5.3)
No	37		47		1
Knew neighbors have access to waters rights					
Yes	11	28.2	6	12.0	2.9 (0.8,10.5)
No	28		44		1
Had seen neighbors flooding their yards with water from irrigation canals					
Yes	11	28.2	4	8.0	4.5 (1.2, 22.7)
No	28		46		1
Canals or ditches identified via windshield survey					
Yes	17	44.7	10	20.4	3.2 (1.2,8.1)
No	21		39		1

Distribution of distance to nearest irrigation canal according to geo-referenced data from the address of cases of WN disease and controls, El Paso, Texas

Table 2

A. Actual Case-Control Study (n=98) 2009–2010						
Distance of Residence to Irrigation Canals (in meters)	Cases*		Controls		Odds Ratio (95% CI)	
	Number	%	Number	%		
<901	24	50.0	17	34.0	2.0 (0.8, 5.2)	
901–5,289	12	25.0	16	32.0	1.1 (0.4, 3.0)	
5,290+	12	25.0	17	34.0	1	
Total	48		50			Trend P=0.14

B. Case Hypothetical -Control Study, (n=384) 2003–2010						
Distance of Residence to Irrigation Canals (in meters)	Cases		Controls		Odds Ratio (95% CI)	
	Number	%	Number	%		
<327	78	42.9	36	19.8	5.7 (2.8, 11.9)	
327–1,739	40	22.0	37	20.3	2.9 (1.3, 6.1)	
1,740–4,238	27	14.8	36	19.8	2.0 (0.9, 4.4)	
4,239–7,395	23	12.6	36	19.8	1.7 (0.7, 3.8)	
7,396+	14	7.7	37	20.3	1	
Total	182		182			Trend P<0.0001

* We used the home address of all cases found in case reports

Distribution of distance to nearest irrigation canal and use of water from canals to flood their yards by cases of WN disease and controls or their neighbors, El Paso, Texas 2009–2010

Table 3

A. Distance to canals stratified by use of water from canals to flood residential yards				
Distance to Canals	Cases*		Controls	
	Number	%	Number	Odds Ratio (95% CI)
Use water from canals to flood irrigate residential yards				
<901	11	100.0	5	Not calculable
901–5,289	0	0.0	0	Not calculable
5,290+	0	0.0	0	Not calculable
Subtotal	11		5	
Do not use water from canals to flood irrigate residential yards				
<901	10	35.7	12	2.0 (0.6, 6.8)
901–5,289	11	39.3	16	1.7 (0.5, 5.6)
5,290+	7	25.0	17	1
Subtotal	28		45	
Extended Test for Trend <i>P</i> -value=0.3				
B. Distance to canals stratified by use of water from canals to flood residential yards				
Use of water from irrigation canals to flood residential yards (self or neighbors)	Cases*		Controls	
	Number	%	Number	Odds Ratio (95% CI)
Living <901 meters of canals				
Yes	11	52.4	5	29.4
No	10		12	2.6 (0.7, 10.8)
Living 901–5,289 of canals				
Yes	0	0.0	0	0.0
No	11		16	--
Living 5,290+ of canals				
Yes	0	0.0	0	0.0
No	7		17	1
Total	39		50	Mantel-Haenszel OR 2.6 (0.7, 10.2)

* Only 39 cases were interviewed

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Use of mosquito repellent during the last summer among cases of WN disease and controls, El Paso, Texas 2009–2010

Table 4

Frequency of Mosquito Repellent Use	Cases		Controls		Odds Ratio (95% CI)
	Number	%	Number	%	
Never (0%)	40	90.9	37	74.0	3.5 (1.0,15.9)
Some times (25%)	4	9.1	6	12.0	
Half of the times (50%)	0	0.0	1	2.0	
Most of the times (75%)	0	0.0	2	4.0	
Always (100%)	0	0.0	4	8.0	
Fisher's Exact P=0.002					

Multivariate analysis of presence of irrigation canals within 600 meters of the home address of cases of WNV disease and controls, El Paso, Texas 2009–2010 (n=98)

Table 5

Model	Crude Odds Ratio (95% CI)	Multivariate Odds Ratio (95% CI)
Canals or ditches present as assessed by windshield survey		
Yes		4.1 (1.4, 12.3)
No	1	1
Age (yrs)		
<44	1	1
45+	2.0 (0.9, 4.6)	1.6 (0.5, 4.6)
Gender		
Male	1.9 (0.9, 4.3)	2.0 (0.7, 5.2)
Female	1	1
Ethnicity		
Hispanic	1	1
Non-Hispanic	2.2 (0.7, 6.5)	3.8 (1.0, 13.8)
Any chronic disease		
Yes	2.7 (1.2, 6.2)	2.0 (0.7, 5.9)
No	1	1
Household Income (dollars a year)		
<20,000	0.8 (0.4, 1.9)	0.5 (0.2, 1.4)
20,000+	1	1

Hosmer-Lemeshow χ^2 P=0.5