Heeding the Message? Determinants of Risk Behaviours for West Nile Virus

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ABSTRACT

Objectives: West Nile virus (WNv) emerged in North America in 1999, with the first incursion causing an outbreak of meningoencephalitis in the New York City area which resulted in seven deaths. In the face of WNv, public health professionals recommend various personal protective behaviours (PPBs) that either reduce the risk of mosquito bites (e.g., wearing protective clothing and/or insect repellent when outside at dusk or dawn) or eliminate mosquito breeding sites (e.g., preventing opportunities for standing water to stagnate; cleaning out eavestroughs regularly). This paper evaluates the uptake of the public health message in a WNv hot spot (2002) in order to assess the determinants of the likelihood of undertaking personal protective behaviours to reduce the risk of illness from WNv.

Methods: A telephone survey was administered to a random sample of adults (n=1650) living in the L6L and L6K Forward Sortation Areas of Oakville, Ontario, Canada.

Results: While close to 100% of survey respondents were aware of WNv and approximately 80% recalled receiving information from the public health department regarding the virus, levels of reported personal protective behaviours were relatively low. Through a multivariable modeling process, a range of determinants emerged to explain outcome levels.

Discussion: The message about public education in the face of emerging health threats is clear; that is, that public education is key. But we cannot end the public health presence there – public health researchers must evaluate the uptake of the message.

Key words: West Nile virus; risk reduction behavior; public health

La traduction du résumé se trouve à la fin de l'article.

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West Nile virus (WNv) emerged on the North America scene in 1999, causing an outbreak of meningoencephalitis in the New York City area which resulted in seven deaths.[1,2] Of the total 123 non-fatal cases detected in the USA in 1999-2001, the median age of patients was 65 years, with a range from 5 to 90 years; 60% were over 60 years of age; 63% were females.[3] With respect to fatalities (n=18), the median age was 75 years, with a range from 44 to 90 years; 90% were aged 60 years or above; and 44% were males.[3] Since this first North American outbreak, the incidence of WNv infection has been increasing annually.[4-6] As of 2005, there were 2,470 human cases of WNv infection reported to CDC for 2004.[5] In Canada, 1,335 human cases were reported in 2003.[6] In Canada, the increase in human cases has coincided with the spread of the disease westward across the country. In 2002, the Province of Ontario in central Canada contained over 90% of confirmed human cases; one year later, the majority of human cases were confirmed in the western Prairie provinces.[7]

The virus is transmitted to humans by infected mosquitoes. *Culex pipiens*, an urban-dwelling mosquito, is an important vector that breeds in underground standing water found in city drains and catch basins. During a long, hot summer, these water sources become even richer in the rotting organic material that *Culex* needs for survival; concomitantly, these climatic conditions can also lead to a decline in mosquito predators (e.g., frogs).

Public health professionals recommend various personal protective behaviours (PPBs) that either reduce the risk of mosquito bites or eliminate mosquito breeding sites. It is often difficult, however, to get populations to heed public health risk messages. We know, for example, the risks associated with tobacco consumption, yet over 21% of the Canadian adult population continues to smoke cigarettes on a daily basis (www.healthcanada.ca). This translates also to new emerging health risks,[8,9] including (re-)emerging infectious diseases such as West Nile virus. Adams et al.[10] report that of the 17 confirmed cases of WNv infection in Connecticut in 2002, only 3 reported having used any PPBs.[10] *Risk communication*, defined as "a science based approach for communicating effectively in high concern situations"[11, p.382] is key in these circumstances.

The implementation of a household-based seroprevalence survey in Oakville, Ontario (Figure 1), where a large outbreak of West Nile virus occurred in the summer of 2002, allowed us to assess the uptake of risk behaviour messages disseminated by public health agencies. Survey data are used to explore attitudes, risk perceptions, and prevention behaviours undertaken. Adams et al.[10] used survey data to explore knowledge, attitudes and behaviours around West Nile virus in Connecticut, where an outbreak had occurred in 2002. The majority (77%) of these respondents (n=1791) sometimes or always used at least one PPB, while only 15% never used any PPBs. These reported levels of risk reduction must be contextualized, however, by the fact that this area had a 15-year track record of public health messaging because of Lyme disease. In contrast, the present study was performed soon after the first introduction of WN virus into Canada, in a region where public health messaging about protection against insects was novel.

Oakville is located in the region of Halton, characterized by the highest incidence of reported clinical West Nile virus infection in Ontario in 2002. Sixty cases (58 confirmed and 2 probable) occurred in a population of approximately 400,000 with onset during the months of August and September 2002 (Figure 2). A peak in dead crow sitings in Halton (600 per week) occurred five weeks before the peak in human cases. Within this region, the greatest spatial concentration of cases occurred in south Oakville, in the L6L and L6K forward sortation areas (FSAs; i.e, the first three digits of the postal code) (Figure 1). We hypothesized that, given a short duration of intense dissemination of the risk message by the public health department, there would be high levels of awareness of WN virus in the population as well as a relatively high level of uptake of the risk reduction message.

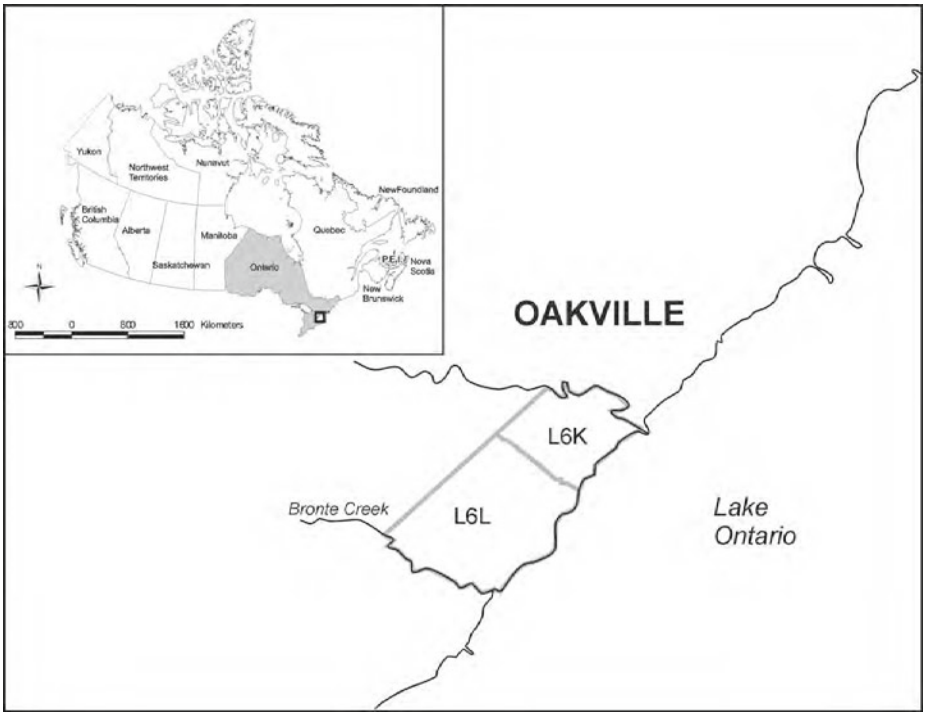

Figure 1. Map of Oakville, Ontario; L6L and L6K forward sortation areas

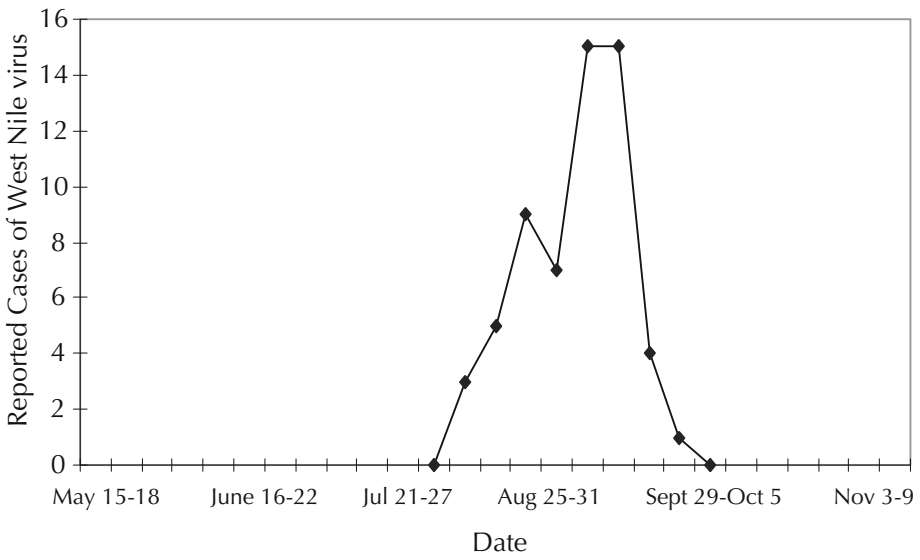

Figure 2. Reported West Nile virus cases in Halton Region, 2002

METHODS

The survey was conducted in March-April 2003. Households in the L6L and L6K Forward Sortation Areas (FSAs) were selected from a population of 30,467 (2001 census) using random digit dialing. Within households, one randomly selected adult (18+ years) was invited to participate. Given that pediatric neuroinvasive disease is rare, children were excluded from the study.[2] The average income for the population over 15 years of age was $42,827 (compared to $29,261 in Canada and $30,876 in Ontario). Thus, this is a middle- to high-income area.

The survey (available from the authors upon request) consisted of questions related to socio-demographic information; information about exposures to mosquitoes, including home environment, potential water reservoirs, and exposures to birds; as well as PPBs. Research staff made home visits to obtain blood. Single serum samples were collected from March 23 to June 5, 2003 (note: specimen collections were interrupted from March 29 to April 16 because of the outbreak of severe acute respiratory syndrome (i.e., SARS). Respondents were unaware of their serologic status at the time of the telephone interview, thus reducing the possibility of recall bias. The seroprevalence determined in this stage of the study was 3% in the general population (for more details, see

TABLE I

Sample Characteristics

Characteristic	Survey Respondents (%) (n=1650)	2001 Census Population Age 18+ Years (n=30,467)
Sex		
Female	827 (50)	16,015 (53)
Age (years)		
15-24	31 (2)	4045 (13)
25-44	404 (24)	10,740 (34)
45-64	679 (41)	9465(30)
≥65	531 (32)	7510 (24)
Education		
Completed high school	1519 (92)	27,040 (93)

TABLE II

Summary of Univariate and Multivariable Models: 2+ Personal Protective Behaviours

Characteristic	Odds Ratio (95% confidence interval), P value	Adjusted Odds Ratio (95% confidence interval), P value
Demographic		
Female	2.050 (1.676-2.507), 0.000	1.805 (1.462-2.227), 0.000
Outdoor exposures		
Time spent outside at dusk or dawn	0.929* (0.858-1.006), 0.070	
Mean time spent outside	0.958* (0.927-0.989), 0.009	0.967* (0.935-1.000), 0.049
Personal behaviour		
Worried about WNv	1.706 (1.355-2.149), 0.000	1.590 (1.252-2.019), 0.000
Worried more about WNv than getting sick from pesticide use	1.293 (0.986-1.696), 0.063	
Source reduction behaviour		
Check/clean gutters if necessary	1.20 (0.959-1.500), 0.110	
Collections of water present on property at all times	1.21 (0.977-1.500), 0.081	
Drain items that may collect water	1.339 (1.076-1.500), 0.009	

* Odds of practising 2 or more protective behaviours per hour spent outdoors

ref. 12). The ethics review board at McMaster University approved the study.

Initially, 1,500 individuals completed the survey, but not all consented to provide a blood sample. As a result, an additional 150 individuals were surveyed. Of the 1,650 total, 1,505 respondents consented to provide a blood sample. No statistically significant differences were found between the two groups on key demographic characteristics; the two groups were therefore pooled for subsequent analysis.

Respondents had an average age of 55.6; 50% were female; and 93% had completed high school. In comparison with the population from which they were drawn, there were some discrepancies (Table I) vis-à-vis the sample. Those aged 18-24 (2%) and 25-44 (24%) were under-represented when compared to these age categories in the 2001 Census data (13% and 24%, respectively). Those aged 45-64 (41%) and 65 years and older (31%) were over-represented (30% and 34%, respectively).

To evaluate the practice of protective behaviours, we conducted a univariate analysis using the chi-square test and student's t-test to assess differences between those respondents who practiced two or more such behaviours versus others. Similarly, a univariate analysis was conducted to determine differences between respondents who wore mosquito repellent always or sometimes when outdoors for 30 minutes or more and those who rarely or never wore mosquito repellent. The following variables were considered for analysis: checking/cleaning gutters, collections of water present on property, draining items that collect water, worried about WNv, worried more about WNv than pesticide use, gender, mean time spent outdoors at dusk or dawn, mean time spent outdoors total, highest level of formal education completed, and frequency mosquitoes seen in the home. Multivariable analysis using logistic regression was performed using a backwards, stepwise method, initially selecting variables for inclusion in the model if $p<0.20$.

RESULTS

The majority (79%) of the 1,650 respondents lived in single-family homes and most of these (74%) were characterized by an open deck or unscreened porch. Further, while 1,507 (60%) of respondents reported having screens on doors and windows that lead to the outside, 394 (24%) of these reported tears in the screens. Three hundred and forty-seven (21%) respondents found mosquitoes in the home once per week or more during the period of reporting.

Of respondents, 80% reported remembering receiving information in the summer of 2002 about how to avoid mosquito bites, and 73% reported that they obtained their information about West Nile virus from the media (e.g., ref. 13). Virtually all respondents (99%) were aware of WNv before the survey and that the disease is transmitted through mosquito bites.

Approximately three quarters (78%) of respondents were somewhat or very worried about becoming sick with West Nile virus, compared with 59% who were very or somewhat worried about becoming sick from the pesticides used to kill mosquitoes. When asked what worried them more, 56% reported they were more worried about getting sick from West Nile virus, 22% more worried about health impacts of pesticide use, and 18% concerned about the health effects of both. Nearly two thirds of respondents (65%) rarely or never wore insect repellent when outdoors for 30 minutes or more, and half (50%) rarely or never wore long-sleeved shirts and/or long pants when out at dusk or dawn for 30 minutes or more. When remaining respondents who had responded negatively to the above noted questions were asked what else they did to avoid being bitten, over half (51%) reported they did nothing.

Sixty-one percent of respondents practised two or more PPBs, including avoiding areas where mosquitoes are likely to be, avoiding going outdoors altogether, wearing long sleeves/long pants when outdoors, and using mosquito repellent when outdoors for 30 minutes or more. Results of the univariate analysis to assess characteristics of those respondents who practised two or more personal protective behaviours between July 1st, 2002 and September 30th, 2002 are shown in Table II. Being female,

mean time spent outdoors at dusk or dawn, total time spent outdoors, being worried about West Nile virus, being worried more about WNv than getting sick from pesticide use, having gutters checked and/or cleaned, collections of water present on property, and draining items that collect water on property were all associated at the *a priori* cut-off level of 0.2 with practising 2 or more personal protective behaviours. Being female, mean time spent outdoors during a typical day, and being worried about WN virus were retained in the final multivariate model for protective measures (Table II).

Results of the univariate analysis to assess the characteristics of those respondents who wore mosquito repellent when outdoors for 30 minutes or more between July 1st, 2002 and September 30th, 2002 are shown in Table III. Being female, having completed high school, frequency of mosquitos seen in the home, time spent outdoors at dawn or dusk, total time spent outdoors, being worried about WN virus and being worried more about WN virus than getting sick from pesticide use were all associated at the *a priori* cut-point of 0.2 with use of mosquito repellent when outdoors for 30 minutes or more.

Being female, frequency of mosquitos in the home, time spent outdoors and being worried about West Nile virus were retained in the final multivariate model for use of mosquito repellent model (Table III).

TABLE III

Summary of Univariate and Multivariable Models: Mosquito Repellent Use

Characteristic	Odds Ratio (95% confidence interval), P value	Adjusted Odds Ratio (95% confidence interval), P value
Demographic		
Female	1.388 (1.133-1.700), 0.002	1.349 (1.087-1.674), 0.007
Completed high school	1.327 (0.903-1.949), 0.148	
Indoor exposure		
Frequency mosquitoes seen in the home (once/week vs. less)	1.474 (1.156-1.878), 0.002	1.418 (1.101-1.825), 0.007
Outdoor exposure		
Time spent outside at dusk or dawn	1.107* (1.021-1.201), 0.014	
Mean time spent outside	1.042* (1.008-1.077), 0.016	1.047* (1.011-1.084), 0.010
Personal behaviour		
Worried about WNv	1.954 (1.508-2.531), 0.000	1.812 (1.387-2.369), 0.000
Worried more about WNv than getting sick from pesticide use	1.348 (1.019-1.779), 0.036	

* Odds of using repellent per hour spent outdoors

DISCUSSION AND CONCLUSION

Levels of awareness (99.9%) and worry (78%) about WNv in south Oakville in the summer of 2003 were both high in the wake of the outbreak experienced. And yet, the uptake of the public health message – which 80% of respondents reported receiving – was relatively modest. However, a little more than half (61%) of respondents did report undertaking two or more personal protective behaviours.

The key determinants of PPBs that emerged from the multivariable analyses were: being female, being worried about West Nile virus, indoor exposure (mosquito repellent use model only) and outdoor exposure. With respect to the latter, the direction of relationship changes between the models. That is, for two or more PPBs, less time spent outdoors meant increased likelihood of use of two or more PPBs. While this might seem counterintuitive at first, it is consistent with the risk perception literature that indicates that familiarity with a risk decreases one's concern.[11,14] However, those who spend more time outdoors generally were more likely to report using mosquito repellent (Table III).

It is difficult to find comparative data in the literature to determine whether or not this is a 'typical' response. A study in a similar community in Connecticut that had also experienced an outbreak in the previous summer[10] showed that 57% of respondents wore repellent on skin or clothes and 59% sometimes or always used at least two protective behaviours. With respect to the determinants of these behaviours, Adams et al.[10] discovered a similar picture: using insect repellent was significantly associated with being less than 50 years old, being worried about getting WNv, and spending time outdoors in the evening. Using 2+ PPBs was associated with being female and being worried about getting WNv. Herrington,[15] in a national US survey of 1,750 adults, found that the most robust predictor of behavioural action to prevent mosquito bites was worry about being bitten by an infected mosquito (OR 7.3; 95% CI = 4.3-12.2).

Of our sample, 80% reported receiving information the previous summer about how to prevent WNv, and yet the uptake of the message was relatively modest. There are several potential explanations for this. First, the data are based on self-report and could be biased toward a socially-desirable response. Second, 73% of respondents reported receiving their WN virus information from the media, yet the media has been criticized for lack of accurate reporting of environmental health risk issues in general[16] and WN virus in particular.[17] Third, the message was not delivered clearly and/or not well understood. This seems unlikely, though, as indicated by the relatively high socio-economic status of the study population as well as the fact that indeed 78% reported at least one PPB. Fourth, the risk was simply not seen as such by the general population. Given the high levels of awareness and concern, however, this explanation is not likely.

Covello et al.[11] critiqued the risk communication strategy used in the 1999 New York outbreak. They suggest that the risk communication strategy failed in that case for a number of reasons, including lack of consultation with key stakeholders about the perception of the risk; the full range of communication channels not being exploited; too many messages being contained in risk communication materials; and materials produced containing inadequate repetition/visualization.

These results have important implications for the public health response to emerging public health threats. It appears likely that WN virus has become endemic in North America, with seasonal recurrences. Indeed, a representative of the Public Health Agency of Canada is quoted in the media as saying: "West Nile virus has become part of the scenery."[18]

Although the risk has been low in Ontario in the summers since the major Oakville outbreak, due to changing weather and other climatic factors, the scares continue: the summer of 2005 saw 95 confirmed human cases of the virus in the province. And the experience has much to teach us about emerging health threats. The take-home message from public and other health officials is consistent: public education is key.[3,12,19] And further, not only is it important to disseminate the message, it is essential to evaluate its uptake to ensure the message is heeded.

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RÉSUMÉ

Objectifs : Le virus du Nil occidental (VNO) est apparu en Amérique du Nord en 1999, sa première incursion ayant causé une flambée de méningo-encéphalite qui a fait sept morts dans la région de New York. Pour lutter contre le VNO, les professionnels de la santé publique recommandent diverses mesures de protection individuelle qui réduisent le risque de morsures de moustiques (porter des vêtements de protection, s'enduire d'insecticide lorsqu'on est dehors au lever ou au coucher du soleil) ou qui éliminent les gîtes à larves de moustiques (empêcher la formation d'eaux stagnantes, nettoyer périodiquement les gouttières). Nous évaluons ici l'acceptation du message de santé publique dans une zone sensible au VNO (2002) afin d'évaluer les déterminants de la probabilité de prendre des mesures de protection individuelle pour réduire le risque de contracter le VNO.

Méthode : Une enquête téléphonique a été administrée à un échantillon aléatoire d'adultes (n=1 650) vivant dans les régions de tri d'acheminement L6L et L6K d'Oakville (Ontario), au Canada.

Résultats : Près de 100 % des répondants au sondage avaient entendu parler du VNO, et environ 80 % se souvenaient d'avoir reçu de l'information des services de santé publique à propos du virus, mais les niveaux déclarés de mesures de protection individuelle étaient relativement faibles. Un exercice de modélisation multivariée a mis au jour divers déterminants possibles de ces résultats.

Discussion : Le message est clair : l'important est de sensibiliser le public aux menaces émergentes pour la santé. Mais le rôle des services de santé publique ne s'arrête pas là. Les chercheurs en santé publique doivent aussi évaluer l'acceptation du message.

Mots clés : virus du Nil occidental; comportement à moindre risque; santé publique