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Beyond the 'back yard': Lay knowledge about *Aedes aegypti* in northern Australia and its implications for policy and practice

Darlene McNaughton[a,*], Alan Clough[a], Petrina Johnson[a], Scott Ritchie[b], Scott O'Neill[c]

[a] School of Public Health, James Cook University, Cairns, Australia
[b] Tropical Population Health Services, Queensland Health, Cairns, Australia
[c] School of Biological Sciences, University of Queensland, Brisbane, Australia

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ABSTRACT

Controlling dengue fever in Australia and internationally, relies heavily upon the actions of residents as well as community education and awareness of the risks. Although it has been well established in medical anthropology that the success of health interventions is highly dependent upon a clear grasp of lay knowledge of disease, limited attention has been given to lay understandings of dengue fever and its vectors in the extant literature. We begin addressing this hiatus through an examination of north Queensland residents' knowledge of the breeding habitats of *Aedes aegypti* mosquitoes. Building on the insights of earlier social research, we use factor analysis to examine the results of a series of randomly selected telephone surveys and compare responses over time and between cities.

Our analysis confirms that many people assume that *Ae. aegypti* is ubiquitous in the landscape, that it lives and breeds *not only* around the home, but also in a variety of geographical spaces located beyond the suburban 'backyard', and beyond the control of local residents. Lay understandings appear to be placing people at risk from dengue, influencing the mosquito management practices of local residents and acting as a source of resistance to public health messages that focus on individual responsibility. A way forward through the provision of new information that challenges key assumptions is provided in the discussion. We argue that rather than dismissing lay understandings as ignorance, strategies, practices and policy based on a detailed understanding of this knowledge will mean that practitioners are better able to address these assumptions and will likely be more effective at educating the public of the risks posed by dengue.

1. Introduction

In recent decades, dengue fever has made a dramatic reappearance worldwide and is occurring in areas once thought to be free of the disease. Approximately 2.5 billion people worldwide, or 40% of the world's population, are thought to be at risk from the disease which is now endemic in more than 100 countries (Gubler, 2002; Halstead, 2007). Globally, an estimated 50–100 million cases occur each year, of which as many as 500,000 result in dengue haemorrhagic fever (DHF) and dengue shock syndrome (DSS) (Halstead, 2007). Dengue fever is now recognised internationally "as the most important arboviral disease of humans" (Gubler, 2002; Halstead, 2007; World Health Organization, 2000, 2002, 2004).

Dengue has a long history in north Queensland, Australia. Like malaria, it made sporadic appearances in the region from as early as 1879 (Black, 1972; Derrick, 1957; Douglas, 1994; Dyson, 1889; Hare, 1898; Kay et al., 1984; Spark et al., 1994; Spencer, 1994) with infection rates of up to 85% (1940–41 outbreak) in some parts of the region (Kay et al., 1984: 264; Queensland Government, 1942). From the 1950s to the early 1980s, dengue fever disappeared from the region for more than 26 years, due to the growing use of residual insecticides (including DDT) and introduction of reticulated water among other things (Kay et al., 1984: 264). At the time of writing there have been 3 fatalities from dengue fever and 27 outbreaks in the region since 1990 during which time all four serotypes have been recorded.

In Queensland, mosquito control is the responsibility of local government authorities. The increasing incidence of dengue in the region led to the development of Dengue Fever Management Plans in the early 1990s (see for example Queensland Health, 2005) and the creation of the Dengue Action Response Team (DART)—a

* Corresponding author at: School of Medicine and Public Health, James Cook University, PO Box 6811, Cairns, QLD 4870, Australia. Tel.: +61 7 4042 1559; fax: +61 7 4042 1675.
E-mail addresses: darlene.mcnaughton@jcu.edu.au (D. McNaughton), alan.clough@jcu.edu.au (A. Clough), petrina.johnson@jcu.edu.au (P. Johnson), scott_ritchie@qld.health.gov.au (S. Ritchie), soneill@uq.edu.au (S. O'Neill).

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skilled, specialist group that utilises house-to-house inspections and focuses on disease and vector surveillance, vector control and education (Montgomery and Ritchie, 2002; Ritchie, 2005; Ritchie et al., 2001).

Education campaigns have also been at the forefront of dengue prevention in north Queensland. For the most part, they have sought to alert the public both to the risk of dengue fever and to preventive measures, notably the identification and removal of potential breeding containers from around the suburban home. Evaluations of campaigns undertaken in the 1980s (Kay et al., 1984) and 1990s (Spark et al., 1994) suggest that while greater public awareness of the disease was achieved, this did not always translate into action—notably the removal of mosquito breeding sites.

At present, there is no vaccine for dengue fever. Reducing exposure to the mosquito vector through the use of repellent, insect screens and the removal of potential breeding sites, remain the most common forms of prevention. In northern Australia, dengue fever is vectored by the mosquito *Aedes aegypti*, a highly domesticated species that breeds in a variety of water-holding containers located in and around the home and other humanised buildings in suburban areas (i.e. offices, construction sites, vases in cemeteries) (Montgomery and Ritchie, 2002). The most common breeding sites are containers that have a straight edge for the mosquito to lay its eggs on, namely discarded items, old tyres, potted plant bases, vases, plastic tarpaulins, boats, blocked roofing gutters, buckets, pet bowls, watering cans and fallen palm tree fronds (Montgomery and Ritchie, 2002; Ritchie, 2005; Ritchie et al., 2001).

It is generally accepted then that the mosquito is not found and does not breed in creeks, swamps, lagoons, rivers or puddles of water. The type of houses in the region examined here range from low set brick or block homes to highset or two story 'Queenslander' style timber homes, as well as multi-story brick apartments. Yard sizes vary considerably in the region and have been deceasing in size in recent decades. The 2003–2004 average site area of new houses in was 735 sqm (ABS, 2005).

The female mosquitoes require a blood meal to provide protein for their eggs, and humans are their preferred source (Russell et al., 2005). Furthermore, *Ae. aegypti* do not fly far, with local studies suggesting 100–200 m at most (Russell et al., 2005). Critically, control of dengue fever and such a human-focused mosquito is heavily reliant upon the actions of residents and public awareness of the risks—where the mosquito breeds and how the disease is transmitted.

Anthropology's central contribution to knowledge in the last century has been in establishing that all "human knowledge is culturally and historically shaped and constituted" (Good, 1990) including people's understandings of disease, illness, cure and preventive measures (Kleinman et al., 1978; Koss, 1988; Scheper-Hughes and Lock, 1987). In recent years, these insights have led many to suggest that health interventions have been failing, in part, because they are based on a limited awareness of the complexity of lay understandings and the socio-political and cultural contexts in which this knowledge has emerged (Good, 1990: 26). These concerns have also been taken up in number of groundbreaking studies into public understandings of malaria and its vectors, which in several cases have led to improvements in public awareness and action (see for example Agyepong, 1992; Kamat, 2006; Williams and Jones, 2004; Winch et al., 1994, 1996).

The key lesson from these and other similar studies, is that it is essential to know how the disease and its vector is understood by the public if we are to communicate effectively and reduce the incidence of disease. Significantly, there only a few published accounts of lay knowledge of dengue fever (see for example Gordon, 1988, 1990; Kendall, 1998; Kendall et al., 1991; Koss, 1988; Suarez et al., 2005; van Benthem et al., 2002; Whiteford, 1997; Winch et al., 1991) and even fewer of the mosquito's that vector it (Kendall, 1998; Slosek, 1986; Suarez et al., 2005; Whiteford, 1997). As Suarez et al. (2005: 496) have argued ". . .we still do not know what dengue is culturally and what it means for individuals in their everyday lives" (see also Gubler and Meltzer, 1999; Slosek, 1986), while even less is known about lay understandings of mosquito vectors and how this may be effecting dengue control.

In recognition of this significant hiatus in the extant literature, anthropological research into lay understandings of dengue fever and its local vector *Ae. aegypti*, began in north Queensland in 2008. This research was part of a broader study – funded by the Foundation for the National Institutes of Health, through the Grand Challenges in Global Health Initiative – into community attitudes towards the use of the bacterial symbiont *Wolbachia* as a bio-control strategy for the elimination of dengue fever (www.eliminatedengue.com). Utilising an ethnographic research design it includes ongoing participant observation, focus groups (20) and in-depth, semi-structured interviews (50) with Cairns residents. The results of this research, reported elsewhere, (McNaughton, unpublished data) suggest that many people believed that *Ae. aegypti* were ubiquitous in the landscape—that they live and breed *not only* around the home, but also in a variety of geographical spaces located beyond the suburban 'backyard', and beyond the control of local residents. For many people, the logic of this thinking went as follows: no matter how much effort you go to at home, these mosquitoes are ubiquitous in the landscape, they breed around people's homes (your and others) and in the numerous freshwater swamps, creeks, puddles and palm fronds located in the 'bush'.

The aim of this paper is not to restate these findings however, but to examine them further, through an analysis of existing public health survey data from three randomly selected telephone surveys (n = 1200) and to address the question: "What do north Queensland residents know about the breeding habits and habitats of the *Ae. aegypti* mosquito?".

2. Methods

2.1. Setting

Townsville and Cairns are the largest cities in tropical northern Australia (Cairns 16°55′32″S, 145°46′31″E and Townsville 19°15′23″S, 146°49′6″E). The former is located in the dry tropics, has a population of 147,044 (Australian Government, 2006) and was established as a port in 1864 on the homelands ('Country') of the Bindal, Juru Wulgurukaba, and Nawagi Peoples. Cairns is located to the north of Townsville in the wet tropics. It has a population of 127,438 (Australian Government, 2006) and was founded as a port in 1876 on the homelands ('Country') of the Djabugay (west), Yirrganydji (north) and Gimuy Yidinji (south) Peoples. Both cities have distinct dry and wet seasons, with mosquitoes being particularly abundant and visible during the wetter months (November–March). Many residential suburbs in both cities are located near beaches, swamps, rivers and creeks and both cities have a highly mobile and growing population (Australian Government, 2006).[1]

2.2. Survey instrument

Data are available from randomly selected telephone interview surveys conducted in Cairns and Townsville in 2004 (n = 400), 2007 (n = 400) and 2008 (n = 400), developed by staff at the Trop-

[1] According to 2006 National Census, 50% of the population of Cairns were living at a different address in 2001, with many new residents arriving from cooler, southern states where dengue fever does not currently occur.

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Table 1
Sample characteristics—proportions in age and gender groups in three samples (400 people in each sample) in Cairns ($n = 200$) and Townsville ($n = 200$), far north Queensland.

Age group	2004				2007				2008			
	Cairns		Townsville		Cairns		Townsville		Cairns		Townsville	
	M*n* = 99	F*n* = 9101	M*n* = 9100	F*n* = 9100	M*n* = 9102	F*n* = 998	M*n* = 9102	F*n* = 998	M*n* = 999	F*n* = 9101	M*n* = 999	F *n* = 9101
18–25	15%	5%	17%	17%	13%	5%	17%	16%	10%	7%	16%	10%
26–35	18%	25%	22%	22%	24%	24%	21%	17%	18%	19%	17%	18%
36–45	22%	24%	20%	17%	23%	21%	18%	16%	23%	21%	24%	23%
46–55	26%	21%	17%	16%	20%	21%	17%	19%	21%	23%	17%	22%
56–65	10%	11%	13%	13%	12%	12%	17%	14%	16%	16%	14%	12%
66+	8%	15%	11%	15%	10%	15%	12%	16%	11%	15%	11%	16%
Total	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

ical Population Health Services (TPHS, Queensland Health) Cairns, north Queensland. To design the survey questions, consensus with key stakeholders and mosquito control experts about the principal environments where mosquitoes might be seen by the public to breed was achieved through a focus group held by TPHS staff (Schmidt 2008 pers. comm.).

In the telephone survey, participants were asked "Where dengue mosquitoes breed?" They were then asked if they believed ('yes', 'no', 'unsure') that dengue mosquitoes breed in the following environments:

- *rivers or creeks*—freshwater and/or estuarine water courses which can expand in size and volume depending on seasonal rainfall levels;
- *freshwater swamps*—shallow, freshwater land-locked water bodies with moderate to dense vegetation;
- *brackish or saltwater swamps*—shallow water bodies with moderate tolerance to salinity, periodically influenced by tidal flows from estuarine waters;
- *drains*—a network of high volume drains for transporting large volumes of storm water;
- *freshwater*—non-saline water including rainwater or tap water;
- *vases*—used to display cut flowers, for striking plant cuttings and a potential breeding site for *Ae. aegypti*;
- *rainwater tanks*—increasingly used for the storage of fresh, rainwater and a potential breeding site for *Ae. aegypti*;
- *roof gutters*—located on domestic and industrial buildings and when blocked, a potential breeding site for *Ae. aegypti*.

Questions also described the participants (age, sex, occupation, length of residence in north Queensland) and households (dwelling type, number of residents and participants' role in household maintenance). Participants were also asked whether they perceived there to be problems with dengue mosquitoes in their city, suburb, back yard and around their home.

2.3. Sampling

Census data were used to establish targets in broad age and gender groups. Residents were sought for interview while the few visitors to the region answering the phone were excluded from each survey. Sample characteristics are described in Table 1. In this exploratory study, the sample size of 200 in each survey provides adequate study power ($\alpha = 0.80$) to estimate proportions of responses to questions about dengue mosquito breeding sites with a precision of $\pm 10\%$ (95% statistical confidence). The phone surveys were conducted using random selection of numbers on weekdays (5–8 pm) and weekends (9 am–8 pm), with three calls made to each selected number before replacement.

2.4. Analytical methods

For each sample in 2004, 2007 and 2008 in each city, factor analyses were used to examine the patterns in the 'yes' and 'no' responses. Factor analysis was chosen because the technique offers an objective way to search for the main patterns of correlations between participant responses to interview questions. The technique reduces the data to a smaller number of 'factors' that explain most of the variations in participant responses. Interpreting what the factors mean relies on collateral information about the most common views abroad in the population as revealed by the anthropological research. Each analysis used principal axis factoring with 'varimax' rotation, the default option in SPSS (14.0) and the most basic approach available, to extract the first two factors. The analysis provides for each of the eight above-listed environments a loading on each factor reflecting that environment's relative contribution to the factor. To compare patterns of responses over time and between cities, correlations (Kendall's rank correlation coefficient) across the six surveys between the rotated factor loadings for the eight above-listed environments were examined. Each participant is also scored on each factor based on their combination of responses to questions about the eight environments. In addition,

Table 2
Proportion who answered 'yes' to the question "Do you believe that dengue mosquitoes breed in the following environments?" by gender groups in three samples (400 people in each sample) in Cairns ($n = 200$) and Townsville ($n = 200$), far north Queensland.

Environment	2004				2007				2008			
	Cairns		Townsville		Cairns		Townsville		Cairns		Townsville	
	M*n* = 99	F*n* = 101	M*n* = 100	F*n* = 100	M*n* = 102	F*n* = 98	M*n* = 102	F*n* = 98	M*n* = 99	F*n* = 101	M*n* = 99	F *n* = 101
Brackish swamps	5%	12%	21%	5%	6%	9%	10%	4%	3%	5%	4%	5%
Rivers or creeks	14%	28%	41%	43%	20%	32%	23%	40%	30%	43%	46%	58%
Freshwater swamps	64%	78%	74%	74%	66%	80%	60%	77%	79%	77%	79%	78%
Freshwater	78%	77%	87%	77%	84%	64%	78%	70%	85%	74%	82%	76%
Drains	84%	92%	91%	90%	83%	86%	83%	86%	84%	82%	90%	98%
Rainwater tanks	94%	88%	90%	88%	83%	73%	73%	72%	84%	80%	90%	85%
Vases	100%	97%	97%	94%	94%	87%	95%	87%	93%	96%	95%	88%
Roof gutters	96%	95%	97%	94%	94%	94%	90%	88%	94%	94%	93%	96%

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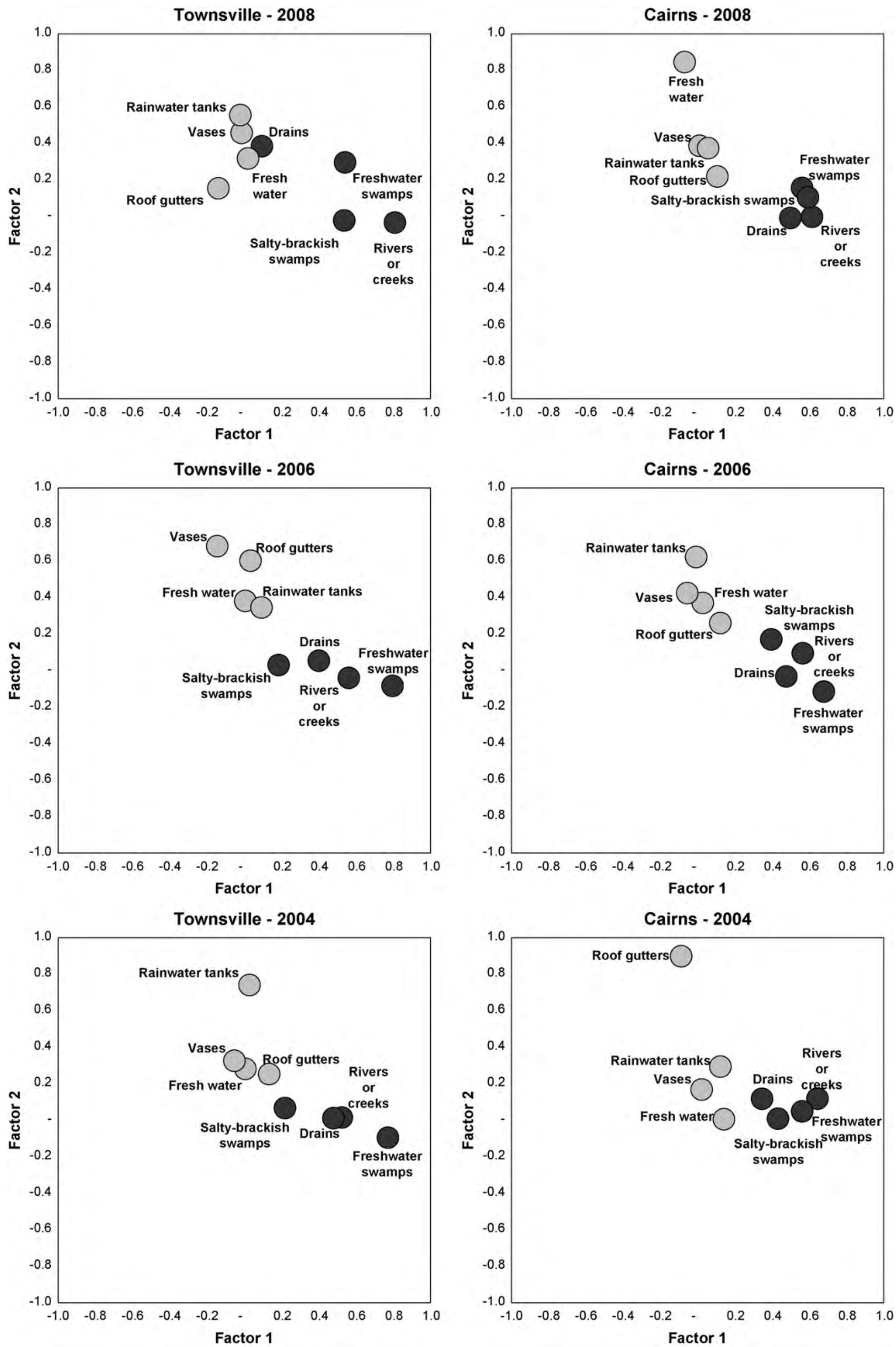

Fig. 1. 'Beyond the back yard' (factor 1) and 'domestic' (factor2) summarising patterns in knowledge of dengue mosquito breeding sites reported in three samples (400 people in each sample) in Cairns (n = 200) and Townsville (n = 200), far north Queensland, Australia. Factor plots in rotated factor space for factor analyses (principal axis factoring, Varimax rotation with Kaiser normalisation). Grey dots indicate sites around homes or buildings (roof gutters, rainwater tanks, vases, freshwater), black dots indicate areas beyond the suburban or domestic 'backyard' (storm water drains, rivers or creeks, freshwater or salty-brackish swamps).

the factor scores for each participant on factor 1 'beyond the back yard' and factor 2 'domestic' were used as variables in generalised linear modelling (GLM) to assess their associations with participant and household characteristics. All analyses used SPSS (version 14.0).

3. Results

3.1. Telephone surveys

A majority of participants in each year in both cities believed that environments close to the home such as rainwater tanks, vases and roof gutters were breeding sites for dengue mosquitoes (Table 2). However, participants also generally held the view that 'dengue mosquitoes' breed in environments that are not directly associated with their home, i.e. beyond their suburban back yards. A substantial majority of respondents also believed that drains, freshwater, rivers and creeks and freshwater swamps were dengue mosquito breeding sites (Table 2). In the environs of both Cairns and Townsville there are a variety of freshwater and estuarine environments, some are land locked some have water standing in them at high tide while others are seasonal and appear during the monsoon or "Wet" season as it is known locally. Consistently, small proportions of participants also believed that 'dengue mosquito's' breed in such saltwater or brackish swamps (Table 2). Responses to the unprompted question, "Where do dengue mosquitoes breed", were also consistent, commonly eliciting responses such as 'everywhere', 'anywhere', 'where there is water', 'in water' and 'in water that is lying around' (data not shown).

In factor analyses, the first factor extracted explained 22.9% of the variance in the 2004 data, 23.3% of the variance in 2007 and 25.5% in 2008 data. The rotated sums of squared loadings accounted for 13.5% of the variance in the 2004 data, 19.4% in the 2007 data and 16.4% in 2008. This indicates that the influence of factor 1 in summarising variations in patterns of participants' response was consistent across survey years. For each survey, factor 1 consistently differentiated environments between (i) rivers and creeks, freshwater swamps, saltwater or brackish swamps, drains and a second group (ii) rainwater tanks, vases and roof gutters which tended to cluster around a factor loading value of zero for factor 1. This pattern reflects the underlying belief that dengue mosquito's breed beyond the domestic setting (Fig. 1). For this reason, factor 1 was labelled 'beyond the back yard'. The freshwater category tended to be grouped with the more domestic categories of rainwater tanks, vases and roof gutters (Fig. 1). Factor 2 differentiated patterns in responses in each city and survey with rivers and creeks, freshwater swamps, saltwater or brackish swamps and drains tending to cluster around loading value of zero on factor 2 (Fig. 1). Factor 2 was labelled 'domestic' because it differentiated rainwater tanks, vases and roof gutters from the 'beyond the back yard' group of variables.

The rank orders of the rotated factor loadings for factor 1 for Townsville were compared with those for Cairns for each survey between the survey years (Kendall's tau). Similar rank orderings of the 2004 and 2007 surveys and the 2004 and 2008 surveys were statistically significant ($P \leq 0.05$) while the rank orderings for the 2007 and 2008 surveys were also similar and approached statistical significance ($P \leq 0.01$) (data not shown). These similar rankings reflect the strong consistency in beliefs about dengue mosquito breeding environments in the two cities over time.

Correlations between the rotated factor loadings for factor 1 ('beyond the back yard') and for factor 2 ('domestic') compared with social and demographic variables were assessed (data not shown). The general lack of differences across social and demographic variables in both cities at different times indicates that views about dengue breeding sites, summarised in the factor analyses, are commonly held across the population. For factor 2 there was no clear pattern of associations. For factor 1 there was found a tendency for differences between males and females in some surveys and associations between age group, dwelling type and number of residents in the dwelling in other surveys (data not shown). There appeared to be an association between the rotated factor loadings for factor 1 and whether the participant perceived a problem with dengue mosquitoes in their back yard in the 2008 Cairns data only. However, no such associations were found between whether the participant perceived there to be a problem with dengue mosquitoes in their town, suburb, back yard or home and the rotated factor loadings for factor 1 or factor 2 in any other survey. In separate analyses using data for males and females, all of the observed associations weakened (data not shown).

4. Discussion

North Queensland residents readily identify the "black and white striped mozzie" or "dengue mosquito" with dengue fever (Compass Research, 2004, 2007, 2008). However, the results of this study show that many people also appear to think that *Ae. aegypti* are ubiquitous in the landscape, that they live and breed around the home and in a range of places and environments in the broader landscape. Collateral information from earlier anthropological research confirms this (McNaughton, unpublished data). It further suggests that these places are commonly thought to produce significant numbers of 'dengue mosquitoes' and are areas over which residents feel they have no or limited immediate control or formal responsibility.

These findings are significant for a number of reasons. Firstly, entomological research strongly suggests that *Ae. aegypti* are peridomestic container breeders and are not likely to be found in swamps, creeks, puddles, stormwater drains or rivers (Focks et al., 1981; Fritchey, 1978). Secondly, the lay knowledge revealed in Cairns and Townsville may be exposing residents to greater risk from the disease. Thirdly, these findings have important implications for policy, the delivery of new control methods, dengue education and public action.

The similarity in the pattern of responses across the three samples and between cities suggests that lay knowledge about *Ae. aegypti* breeding habits and habitats has shifted little over time. This may indicate that it is posing challenges to current community-wide education campaigns. Significant numbers of those surveyed identified key breeding sites found around the home (Compass Research, 2004, 2007, 2008) indicating that key messages from local health campaigns have been taken up. However, this new information appears to have been layered on top of earlier or alternative understandings. These include the view that *Ae. aegypti* are ubiquitous in the landscape, evidenced by comments such as "they breed everywhere", "anywhere", "in the wild too" and "anywhere where there is water lying around".

The lack of differentiation across demographic factors such as age, sex, length of residence and employment, suggests that these perceptions are deeply entrenched in the population at large. A significant number of residents in the sample associate 'dengue mosquitoes' with areas beyond their home or business, beyond their control—areas that are the formal responsibility of local government authorities. Not only is this thinking likely to be placing the public at greater risk from the disease but it may also be providing a site for resisting public health messages which link 'dengue mosquitoes' to the domestic environment and encourage householders to take responsibility for their health and to manage risk. During the wet season when mosquitoes are abundant, local health authorities are inundated with formal requests from residents to "fog" (spray) swamps, creeks, and bodies of water lying around to control 'dengue mosquitoes' (G. Farrow, Cairns Regional Council Vector Control, personal communication 2008, 2009).

As Petersen and Lupton (1997) have shown, in the culture of the 'new public health', "individuals are expected to take responsibility for the care of their bodies [and homes] and to limit their potential to harm others through various preventative actions. Increasingly they are also expected, as part of their responsibilities of citizenship, to manage their own relationship to the risks of the environment, which are seen to be everywhere and in everything" (see also Crawford, 1998; Nettleton, 1995; Petersen and Bunton, 1997; Petersen and Lupton, 1997). Documented examples of community resistance to or rejection of health messages focused on the individual are evident in the extant literature (Balshem, 1991; Roisin Pill and Stott, 1982). Our evidence suggests that the public may be resisting the idea that breeding sites are entirely within their individual control or responsibility. Such resistance is likely to have a substantial impact on the public's reception and acceptance of public health messages, which insist that disease management is the responsibility of the individual. Indeed, these beliefs may be persisting in spite of public health messages and provide an implicit source of critique of these campaigns. As one survey respondent expressed it "contrary to the TV ads [dengue fever campaign] they [*Ae. aegypti*] are in the wild too". In the recent dengue outbreak (2009–2010) local authorities removed more than 50,000 breeding sites, and in some cases returned to the same properties multiple times only to find more larvae (B. Montgomery, Queensland Health, personal communication).

Whether lay knowledge is considered bio-medically or entomologically 'accurate', it is crucial to examine and understand these ideas if we are to attempt to address them. As Suarez et al. (2005) has argued, understanding lay knowledge of dengue and its vectors is crucial, especially if there is evidence to suggest that health education messages are being ignored or resisted. The findings of this study do provide some insights into possible future directions for public health campaigns. This might include, greater emphasis upon messages that stress the distinction that *Ae. aegypti* live with or near people because female *Ae. aegypti* require a blood meal to produce their eggs and humans are their preferred source; *Ae. aegypti* are container breeders – they lay their eggs at the edges of containers; *Ae. aegypti* are not able to fly very far – at most around 100–200 m (if they are present in the home then it is likely they are breeding nearby).

However, to develop more effective communication, education and disease-management strategies in the region we would first need to examine *why* the public think the way they do. For although these results suggest a clear pattern is emerging - one that is also confirmed by ongoing anthropological research (McNaughton, unpublished data) – it does not and cannot tell us *why* so many people are thinking this way given the nature of the survey instrument. We can, however, offer some speculative insights into why so many people across factors such as age, gender, and length of time in the region, appear to be thinking this way. As noted earlier, it has been well established that lay knowledge of disease (and disease vectors) is highly experiential and observation and interaction with one's local environment is often a key factor in the development of these understandings. In both cities surveyed, a significant number of residents live in close proximity to creeks, swamps, lagoons, and beaches—most notably in Cairns. Residents frequently experience mosquitoes in their back yards and in the watery spaces located beyond it. They are bitten by mosquitoes, see their larvae and pupae in water, and encounter them in significant numbers during the 'Wet season' (monsoon).

In recent years health authorities and local media have encouraged the public to identify the dengue mosquito by its physical appearance—notably its black and white striped legs. However, several mosquitoes common to the area bear a notable resemblance to *Ae. aegypti*. This includes the most common species in urban Australia, *Aedes notoscriptus*, which is "often confused with" *Ae. aegypti* (Van den Hurk et al., 2001), *Culex annulirostris* which is found in freshwater swamps, *Aedes vigilax* which is found in salt marshes and *Verralina funerea* which lives and breeds around brackish swamps. Thus, local residents are being bitten in a variety of locales by a variety of mosquitoes that bear a striking resemblance to *Ae. aegypti*. Thus, while the view that *Ae. aegypti* live and breed in the 'wild' or the 'bush' contradicts and may in some cases directly challenge public health messages; given the similarity in appearance of many local mosquito's and the challenges in identifying them with the naked eye, it is not surprising that many people associate *Ae. aegypti* with water and water bodies located beyond the suburban back yard and beyond their control.

Of course the data examined here cannot show us how lay knowledge about the mosquito is manifested in action or inaction, for that would require a different survey instrument. What it can tell us is that these assumptions are widespread, have not shifted greatly in recent years and further, may be placing people at greater risk and impacting on their management of the mosquito and correspondingly, the disease. This data also allows us to make an argument for the importance of examining lay knowledge in the development of public health initiatives.

5. Conclusions

Dengue fever is a serious health issue in north Queensland and is on the increase internationally. In 2009, the city of Cairns experienced its worst outbreak since WW2. Currently, very little is known about lay knowledge of the disease or its vector in Australia or internationally and this study provides several important insights in this regard. A significant number of people in north Queensland appear to believe that *Ae. aegypti* live and breed in a range of habitats located outside of the suburban back yard, when, in fact, these mosquitoes are not found in these locales but in and around peoples' homes and places of work. We have proposed that lay knowledge of *Ae. aegypti* may be placing the public at risk from dengue, effecting the uptake of health education messages and influencing mosquito management practices in domestic settings.

This paper has also shown that if we are to communicate more effectively with those at risk from dengue fever, we need to seriously consider what people know about the vector and the disease and how they have come to know it (Nichter, 1989). Medical anthropology has established that if we do not fully understand the contexts in which these ideas are operating then interventions are likely to fail, or at best, miss their target. Given the scarcity of research into lay understandings of dengue or its vector/s, the rapid and devastating global expansion of the disease and the amount of resources being expended on health education and community engagement, it is crucial that we begin to rigorously explore lay knowledge of this disease and its vectors.

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