



BEATING THE BITE OF MOSQUITO-BORNE DISEASE

A Guide To Personal Protection Strategies Against Australian Mosquitoes

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Mosquito photography: Mr Stephen Doggett, Medical Entomology.

INTRODUCTION



Australian mosquitoes

- There are over 300 species of mosquito in Australia but less than 20 represent a significant risk to human health, either as nuisance-biting pests or vectors of disease.
- While all mosquitoes share the same basic biology, each species exploits a specific environmental niche that may range from highly saline estuarine wetlands, polluted urban environments, constructed wetlands, inland flood plains and small water holding containers found in residential backyards.

“While most mosquitoes bite at dusk and dawn, in Far North Queensland the dengue mosquito will bite throughout the day”

Mosquito biology

- During the warmer months, mosquitoes can take less than one week to complete their development from eggs to adults.
- Only female mosquitoes bite. Blood feeding on a human or animal provides the protein required for egg development.
- Mosquitoes are primarily attracted to carbon dioxide and the “smell” of our skin. Each mosquito species varies in its propensity to bite humans.
- People can vary in both their attractiveness to mosquitoes and their sensitivity to a mosquito bite. In addition,
- Mosquitoes rarely emerge infected with a virus, they must acquire it from feeding on an infective animal and the virus must infect the mosquito (a complex process that may take up to 10 days) before the virus can be transmitted to a human.
- Adult mosquitoes typically live for up to 3 weeks.



Aedes aegypti is the only mosquito species currently found in Australia known to transmit dengue and it is only found in Far North Queensland.



Coastal estuarine wetlands provide habitats for a range of pest mosquitoes including *Aedes vigilax* and *Aedes camptorhynchus*.



Backyard habitats including bird baths, buckets, pot plant saucers, discarded tyres, blocked guttering and unscreened rainwater tanks may provide habitats for pest mosquitoes.

Mosquito-borne disease in Australia

- Ross River virus and Barmah Forest virus are the two most widespread arboviruses in Australia. They cause non-fatal but potentially severely debilitating disease.
- Murray Valley encephalitis virus is potentially fatal and while annual activity is reported in the north-west of the country, epidemics of disease can occur in the south-east following flooding and extended periods of above average rainfall.
- Kunjin virus is closely related to Murray Valley encephalitis virus but infection results in a milder illness and no deaths have been reported.
- There are a number of other mosquito-borne viruses, including Sindbis virus, Stratford virus, Kokobera virus and Edge Hill virus, that are often found in local mosquitoes. However, while these viruses are generally not known to cause serious human disease, their presence may indicate potential activity of other, more serious, mosquito-borne viruses.
- Dengue only occurs in far north Queensland.
- Australia was declared free of malaria in 1981 (but introduced cases occasionally occur).

Personal protection measures

- Avoidance of mosquitoes when and where they are most active.
- Use of registered insect repellents.
- Responsible use of insecticides in and around the home.
- Minimising opportunities for mosquito breeding around the home.

AVOIDING MOSQUITOES

Avoidance of mosquitoes outdoors

- While mosquitoes can be active around the home, the greatest risk of mosquito-borne disease transmission typically occurs close to wetlands, bushland or other environments where both mosquitoes and wildlife are abundant.
- Avoid these natural habitats and times of the day when mosquitoes are most active. When mosquito populations are high, biting may be experienced at any time of the day but, generally, mosquitoes are most active at dawn and dusk.
- Mosquito populations will be highest close to breeding habitats such as wetlands or flooded areas. However, some mosquitoes can travel many kilometres from breeding habitats and will generally take refuge in woodland or forested areas.
- As well as the use of repellents (see below: Insect repellents), wearing loosely fitting long pants and long sleeved shirts will assist in reducing the number of mosquito bites received. Clothing can also be pre-treated with insecticides (e.g. permethrin) for added protection.

Avoidance of mosquitoes around the home

- Ensuring that windows, doorways and balconies are appropriately screened will provide protection from mosquitoes.
- Residual insecticide applications to the building and/or surrounding vegetation may provide protection (see below: Insecticides).
- Electronic vaporisers can provide effective protection indoors and in sheltered outdoor areas (see below: Insecticides).
- Bed nets, particularly those treated with insecticides (e.g. synthetic pyrethroids), can provide effective protection.
- The operation of ceiling or floor fans may assist in reducing mosquito activity.
- Ensuring that any opportunities for mosquito breeding immediately outside the home are eliminated can greatly reduce local mosquito populations.

Mosquito myths and misconceptions

- There is no scientific evidence that eating or drinking any particular food (e.g. bananas, garlic) can reduce the likelihood of being bitten by mosquitoes.
- There is no scientific evidence that taking vitamin B will reduce the likelihood of, or lessen the severity of an individual's reaction to, a mosquito bite.
- Mosquitoes cannot transmit HIV or other disease-causing viruses other than specific mosquito-borne viruses.
- Blood type and skin colour are generally not good predictors of the likelihood of being bitten by mosquitoes.
- Any activity (e.g. exercise) that increases body temperature or causes sweating may increase the risk of being bitten by mosquitoes.
- Studies have indicated that pregnant women may be more likely to be bitten by mosquitoes due to increased body temperature.
- Studies have shown that the consumption of alcohol may increase the risk of being bitten by a mosquito due to increased body temperature (and perhaps failure to reapply repellent).
- While there will always be community and media interest in why mosquitoes appear to bite some individuals more than others, the reality is that everyone is susceptible to mosquito bites and it only takes one bite for the potential transmission of disease-causing pathogens.

INSECT REPELLENTS



Insect repellents assist in preventing bites by repelling mosquitoes or inhibiting the mosquito's stimuli for blood feeding

“The stronger the concentration of an insect repellent, the less frequently it will need to be applied to stop mosquito bites”

“Repellents containing low concentrations of DEET or Picaridin, if applied correctly, should stop mosquito bites for around 2 hours”

What insect repellents are available?

- All insect repellents should be registered with the Australian Pesticides and Veterinary Medicines Authority (APVMA) before being made available for sale. Over 60 individual repellent formulations are currently registered in Australia.
- Brand names may vary but there are three main categories of repellents available; synthetic chemicals (DEET, picaridin and PMD), botanically derived products (e.g. Eucalyptus, Citronella, Melaleuca) and “wearable” devices (e.g. wrist bands and patches).
- DEET (diethyltoluamide) was developed by the US Army in the 1950s and is the most widely used and effective repellent. In Australia, it is available in formulations ranging from less than 10% up to 80%.
- Picaridin (also known as Icaridin) was developed in the 1990s and while proven to be as effective as DEET, is generally thought to have a more pleasant scent. In Australia, it is available in formulations ranging from less than 10% up to 20%.
- PMD (registered in Australia as “extract of lemon eucalyptus”) is not an essential oil product but rather a chemical derived from the distillation of the lemon eucalyptus plant. In Australia, it is currently available in a 30% formulation.
- Botanical products generally contain one or more of either *Eucalyptus*, *Citronella*, *Melaleuca*, peppermint or *Leptospermum* extracts in concentrations <10%. Botanical products have been shown to provide limited duration of protection.
- Patches and wrist bands, typically impregnated with botanical products, are available but do not offer effective protection from mosquitoes.
- A summary of products and their estimated protection times is provided in Table 1.

Registered topical mosquito repellents and their estimated reapplication times¹ in Australia.

Mosquito repellent	Concentration	Estimated reapplication times ²
Diethyltoluamide (DEET)	<10%	2 hr
	10-20%	3-4 hr
	20-40%	4-6 hr
	80%	As required
Picaridin	<10%	2 hr
	10-20%	3-4 hr
Extract of Lemon Eucalyptus (PMD)	30%	2 hr
Eucalyptus oil	<10%	1 hr
Melaleuca oil	<10%	1 hr
Citronella oil	<10%	1 hr
Blend of botanical extracts	<10%	1 hr

¹Estimate reapplication times are based on mean protection times recorded in laboratory tests conducted against *Aedes aegypti*.

²It is advised that repellents be reapplied as soon as any biting mosquitoes are noticed. The estimated reapplication times can be influenced by an individual's activity, climatic conditions and local mosquito populations. However, over application of a repellent will not increase protection times.

How do repellents work?

- Repellents do not kill mosquitoes, they prevent mosquito bites by inhibiting the mosquito's stimuli for blood feeding.
- Some mosquitoes may be attracted to individuals wearing repellent but mosquitoes will not bite if an effective repellent is used and it has been applied appropriately.
- The type and concentration of active ingredient in an insect repellent determines how long an individual will be protected from biting mosquitoes.
- Repellents are most effective if there is an even application to all areas of exposed skin, mosquitoes can detect, and bite, areas where no repellent has been applied.

How should repellents be applied?

- Repellent must be applied to all areas of exposed skin
- Applying large amounts of repellent does not result in longer periods of protection against bites.
- When using pump spray or roll-on formulations, it is important to evenly cover the skin and this may be best done by first applying the repellent from the container and then spreading over skin using your hands.
- Repellent sprays will not work effectively if they are applied sparingly or patchily. A quick spray "here and there" will generally not be sufficient to prevent mosquito bites.
- Repellents should not be applied to broken skin (i.e. cuts, abrasions).
- Repellents should not be applied beneath clothing.

Are insect repellents safe?

- There is often a perception that synthetic repellents such as DEET or picaridin can be toxic to humans. However, despite the widespread use of such products internationally, very few cases of adverse reactions have ever been documented.
- If there is a skin reaction to a repellent, wash the site with warm soapy water. For serious reactions, consult a medical professional and provide details of the repellent used. Poison Information Centre Australia can be contacted on 13 11 26.
- Serious adverse reactions generally result from gross misuse of repellents such as ingestion, ocular exposure or excessive application (both quantity and frequency of reapplication), particularly on young children.
- It should be remembered that botanical based products also have the potential to cause skin irritation.
- All repellents should be applied according to the instructions on the label. Only a small quantity of repellent, applied evenly to exposed skin, is required for effective protection. Do not apply repellents underneath clothing.
- There are no specific precautions that pregnant or lactating women should take above the standard directions for use of repellents.
- While some repellents may cause mild skin irritation, the failure to use repellents in some locations will almost certainly result in insect bites and the real possibility of acquiring an infectious disease.

Guidelines for insect repellent use on children

- Some insect repellents will contain warnings regarding age limitations for use on children. However, it is generally not recommended to use topical repellents on children under 3 months.
- Topical repellents should be avoided where possible for babies and physical barriers such as netting of prams, cots and play areas is preferred.
- Repellents containing <10% DEET or picaridin are considered safe if applied according to label instructions. Most importantly, children should not be allowed to apply their own repellents and carers should be cautious not to apply excessive amounts of repellent.
- When applying repellent to children, the repellent should be applied to the hands of the carer first and then to the exposed skin of the children. Only a thin, even coverage of repellent is required.
- Although they are often perceived to be safer, it is important to remember that repellents containing botanical extracts may still cause skin irritation and should be applied according to label instructions.

Combined repellent & sunscreen formulations

- Formulations are available that combine both insect repellents and sunscreen but the recommended rates of reapplication vary for the two products; sunscreen every two hours and insect repellent "as required".
- If combined products are to be used, those formulations contains <10% DEET or picaridin represent the lowest risk of over application.
- It is not recommended that sunscreen and insect repellent formulations be used solely as an everyday sunscreen.

OTHER METHODS OF PERSONAL PROTECTION



Mosquito coils can provide some assistance in repelling mosquitoes if they contain synthetic pyrethroids (e.g. allethrin)



Vapourisers provide effective protection against biting mosquitoes indoors or in sheltered outdoor areas.

Insecticides

- All insecticides should be registered with the Australian Pesticides and Veterinary Medicines Authority (APVMA) before being made available for sale or being applied by a pest controller.
- Electronic vaporiser units release insecticides (e.g. synthetic pyrethroids) from slow-release mats or liquids and can be very effective indoors or in sheltered outdoor areas
- Mosquito coils containing insecticides (e.g. synthetic pyrethroids) can be effective in sheltered outdoor areas but are generally not recommended for indoor areas. Coils containing only botanical products (e.g. citronella) offer less protection.
- Insecticides (e.g. synthetic pyrethroids) in the form of knockdown aerosols or residual surface sprays may assist in providing protection indoors.
- The application of insecticides (e.g. bifenthrin) onto the outside of buildings and/or terrestrial vegetation as “barrier treatment” has been shown to provide some protection for the homeowner. However, non-target impacts may be significant.

Electronic gadgets & traps

- Electronic devices that purport to repel mosquitoes with sound (e.g. ultrasonic devices) have repeatedly been shown to be ineffective and should not be used.
- Commercial mosquito traps vary greatly in their efficacy. While traps that primarily use carbon dioxide as an attractant will collect mosquitoes, there is no evidence that the operation of these traps around the home or garden will prevent mosquito bites. Traps that primarily use UV light will not generally collect many mosquitoes but rather large numbers of non-biting insects.

FIRST AID

Treatment of mosquito bites

- The classic “mozzie bite” is an itching, inflamed lump on the skin is an allergic reaction to the saliva injected by the mosquito during blood feeding.
- The severity of the reaction is highly variable between individuals and may be determined by a person’s sensitivity as well as prior exposure to mosquito bites.
- Clean and dry the bite with warm soapy water and a clean cloth.
- Application of a cool compress (i.e. icepack wrapped in cloth) can reduce inflammation.
- The application of a medication lotion (e.g. anti-inflammatory, anti-pruritic) or soothing substance (e.g. aloe vera) may reduce itchiness and the use of an antiseptic cream will prevent secondary infection. If secondary infection occurs, antibiotics may be required but consult a medical professional for specific advice.
- Severe reactions may need to be treated with topical or oral antihistamines but consult a medical professional for specific advice on the most suitable medication.
- Many home remedies exist for the treatment of mosquito bites. The application of a paste comprised of a mixture of baking/bi carb soda and water is thought to offer some relief from itching but there are no scientific studies to support this treatment.
- Care should be taken if applying essential oils (e.g. lavender or eucalyptus) directly to the skin as these products may result in secondary skin irritation.

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