

# Effectiveness, Safety, and Use of Permethrin-Treated Clothing to Prevent Mosquito Bites<sup>1</sup>

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## Introduction

Mosquito-borne diseases pose a significant public health concern in Florida and many other regions worldwide (Beard et al. 2019). Beyond transmitting diseases such as West Nile virus disease, Zika, dengue, and malaria, mosquitoes also create a nuisance that disrupts outdoor activities. Although repellents remain a standard, safe, and effective method of protection against mosquito bites, growing evidence indicates that permethrin-treated clothing offers an additional option for people looking to reduce their risk of mosquito bites (Banks et al. 2014).

This publication summarizes current scientific evidence on the effectiveness and safety of permethrin-treated clothing. The goal is to provide information and practical guidance on permethrin-treated clothing to the public to create safer and more comfortable outdoor experiences. It also aims to offer evidence-based information for public health professionals, medical providers, and mosquito-control personnel interested in using or recommending permethrin-treated clothing.

## What is permethrin-treated clothing, and how does it work?

Permethrin-treated clothing is clothing that has been treated with permethrin, a type of commonly used pesticide that also acts as a repellent (Gajendiran and Abraham 2018). When an insect or tick lands on permethrin-treated clothing, it either repels them immediately or kills them after contact (Banks et al. 2014). People can treat their own clothing and gear at home or buy pre-treated (factory-treated) products. Permethrin binds tightly to the fabric fibers, allowing the protection to last through multiple washes (Frances et al. 2014; Connally et al. 2019). While permethrin-treated clothing is also very effective against ticks, this publication focuses on its use for mosquito bite prevention.

## Effectiveness of Permethrin-Treated Clothing

Many scientific studies have found that wearing permethrin-treated clothing can reduce the number of mosquito bites a person receives. For example, studies shows that factory-treated (ready-to-wear) clothes can reduce mosquito bites by 37% to 94% (Banks et al. 2014). The level of protection depends on many factors such as the type of mosquito (Rowland et al. 1999), treatment method (Vang et al. 2022), and how much of the person's body is covered (Orsborne et al. 2016).

### Examples of Scientific Evidence on Permethrin-Treated Clothing Effectiveness

A study in 2016 used a semi-natural experimental condition to determine the effectiveness of permethrin-treated clothing produced by Insect Shield® against *Aedes aegypti* (Linnaeus), a mosquito type that can spread dengue and Zika viruses (Figure 1). When test subjects wore permethrin-treated long-sleeved shirts and long pants, they received 91% fewer mosquito bites compared to when they wore similar clothing not treated with permethrin (Orsborne et al. 2016). This study also found that the protection was lower when less skin was covered. Wearing treated short sleeves and shorts reduced bites by 49%.



Figure 1. Adult female *Aedes aegypti* mosquito taking blood from a human arm.

Credit: Sergio Mendez-Cardona, UF/IFAS

Another earlier study in Florida looked at protection against salt-marsh mosquitoes, *Aedes taeniorhynchus* (Wiedemann), which are common in coastal areas. This study found that volunteers who wore permethrin-treated uniforms and used DEET spray received the fewest mosquito bites, around two bites over a nine-hour period. In comparison, those who used only treated clothing got 54 bites on average, and those who used only DEET got 99 bites on average (Schreck et al. 1984). This suggests that permethrin-treated clothing can be very effective when paired with spray-on repellents.

## Safety of Permethrin-Treated Clothing

Permethrin-treated clothing is generally considered safe for both adults and children when used as directed (United States Environmental Protection Agency 2025). The United States Environmental Protection Agency (EPA) has reviewed studies on long-term use and found **no health risks** from wearing permethrin-treated clothing. The amount of permethrin absorbed through the skin is well below the level of safety concern (Roszbach et al. 2010; Sullivan et al. 2019). Mild skin irritation is rare (National Research Council (US) Subcommittee to Review Permethrin Toxicity from Military Uniforms 1994). If you have sensitive skin, try the clothing for short periods at first. It is also safe to wear around pets and during pregnancy. However, permethrin is **toxic to cats when wet** (Linnett 2008), so let clothing dry completely before allowing contact with cats.

## Use of Permethrin-Treated Clothing

### Factory-Treated (Ready-to-Wear) Clothing vs at-Home Spray-Treated Clothing

There are two main options to choose between when selecting permethrin-treated clothing: you may decide to buy factory-treated clothes from retailers or you may decide to treat your own garments with permethrin spray (commonly available at 0.5% concentration). Factory-treated clothes appear to offer more consistent and longer-lasting protection (Vang et al. 2022). However, at-home clothing treatment can be more affordable. If you choose to treat your own clothing, follow the product instructions carefully. Spray permethrin only on clothing, never directly on your skin. Allow clothing to dry fully before you wear it. Apply permethrin in an outdoor, well-ventilated area (Figure 2). Re-treat after the recommended number of washes. Note that factory-treated items should never be re-treated.



Figure 2 . At-home treatment of clothing with 0.5% permethrin spray. Shirts are hung outdoors and sprayed evenly, then allowed to dry completely before they are worn. Always read and follow the product label instructions.

Credit: Tyler Maire, UF/IFAS

### Longevity and Wash Durability

Many factory-treated garments claim to remain effective for up to 70 washes. In contrast, do-it-yourself spray treatments typically last about six washes. Studies have shown that washing gradually reduces the effectiveness of permethrin because a small amount of the chemical is washed off the garment each time it is washed (Banks et al. 2015; Sullivan et al. 2019). To prolong the effectiveness of treated clothing, follow care instructions. Wash treated garments separately using a gentle cycle with mild detergent; avoid using bleach or fabric softeners; line-dry permethrin-treated garments whenever possible instead of using a clothes dryer; and minimize prolonged sun exposure.

### Maximize your mosquito protection with treated clothing.

Permethrin-treated clothing can be used in combination with EPA-registered topical repellents (e.g., DEET, picaridin). Specifically, a topical repellent should be used on any exposed skin not covered by permethrin-treated clothing. This two-pronged approach can significantly lower the likelihood of bites (Schreck et al. 1984). Additional activities to prevent mosquito bites include eliminating standing water around the home, applying larvicides, installing window screens and maintaining them in good repair, and using other bite protection methods such as bed nets, head nets, and spatial repellents (e.g., mosquito coils and devices that emit pyrethroid-based insecticides into the air).

## What about untreated clothing?

Untreated clothing can offer limited protection against mosquito bites. Mosquitoes have a long needle-like mouthpart called a proboscis. The proboscis allows a mosquito to easily bite through thin or tight-fitting fabrics like T-shirts or leggings. Dark-colored clothing renders you more visible to mosquitoes, so wearing light-colored, loose-fitting clothing does help reduce bites to some extent. However, in areas with high mosquito activity, treated clothing can provide much greater protection.

## Conclusions and Recommendations

Permethrin-treated clothing is a safe and effective way to reduce mosquito bites. When combined with topical repellents, it offers effective protection against both itchy, nuisance bites and, more importantly, diseases like dengue, Zika, and West Nile virus disease. Permethrin-treated clothing is especially useful for people who spend time outdoors such as hikers, campers, gardeners, outdoor workers, and residents of high-mosquito areas. It is also safe for use by pregnant women and children, making it a good option for families. Permethrin-treated clothing should be considered a part of an overall mosquito protection toolkit. Consider adding treated clothing to your mosquito-fighting arsenal along with topical and spatial repellents; eliminating mosquito larval habitats; and using nets and screens. Together, these tools and activities can help reduce bite nuisance and protect you from mosquito-borne illnesses.

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