

The mystery of the less deadly mosquito nets

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Research published in *Nature Communications* shows that insecticide-treated mosquito nets, the mainstay in the global battle against malaria, are not providing the protection they once did—and scientists say that's a

cause for serious concern in tropical and subtropical countries around the globe.

Long-Lasting Insecticidal Nets, or LLINs, are credited with having saved 6.8 million lives from 2000 to 2015.

"While an untreated net stops mosquitoes from biting you while you sleep—providing valuable protection—these nets are treated with a long-life insecticide that actually kills mosquitoes that come in contact with them," said Dr. Stephan Karl, a malaria researcher from James Cook University's Australian Institute of Tropical Health and Medicine, and the Papua New Guinea Institute of Medical Research.

"LLINs add a community-level protective effect by massively decreasing the overall number of mosquitoes. In other words, even people not directly using these nets benefit by their being present in the communities," Dr. Karl said.

The introduction of LLINs in Papua New Guinea in 2006 led to a significant drop in malaria cases, but the rate of infections has since bounced back—from less than 1% in 2013-2014 to 7.1% in 2016-2017.

"The nets are really a frontline defense—in Papua New Guinea they are the only tools used at present in the national campaign against the mosquitoes that can carry malaria," said co-author Dr. Moses Laman, Deputy Director at the PNG Institute of Medical Research.

"Malaria kills around half a million people worldwide each year, so any suggestion that the nets are not working is cause for grave concern."

When researchers in Papua New Guinea, Australia and the UK investigated, their search took an unexpected twist.

"Early on it was believed the rise in cases was due to shortages in anti-malarial drugs," said co-author Tim Freeman, country manager of Rotarians Against Malaria. "But after the drug supply was restored, cases continued to climb." Rotarians Against Malaria assists Papua New Guinea's National Department of Health with net distribution across the country.

Other possible explanations were investigated. Were mosquitoes building resistance to the insecticide, or avoiding the insecticide by feeding more on animals and humans outdoors? Were people getting bitten more often because greater access to electricity enabled them to stay up later?

"We can certainly rule out insecticide resistance as our studies have shown over and over again that there is currently no insecticide resistance in the [malaria](#) mosquitoes in PNG," Dr. Karl said.

"Each of the remaining factors could contribute to an increasing rate of infections to some extent, but the rapid rise in cases — to almost pre-control levels—indicated that we were still missing a major cause."

The [mosquito nets](#) themselves were not an obvious culprit, since their insecticide content is tested regularly in pre-delivery inspections.

The LLINs used in Papua New Guinea are all made by a single company (Vestergaard) to specifications set by the World Health Organisation. The model (PermaNet 2.0) is widely used—in 2014 it accounted for the largest market share of LLNIs globally.

It was when the researchers tested the nets' performance at knocking down and killing mosquitoes that the problem was revealed.

"With new nets manufactured up to 2012, the percentage of mosquitoes killed was always close to 100%," Dr. Karl said.

"Using the same standard tests with new nets produced from 2013 to 2019, the kill rate dropped to an average of 40%, with some of the nets not killing any mosquitoes at all.

"That's an alarming loss of efficacy in critical protective equipment.

"This also calls into question the regulations and standards governing the quality of LLINs worldwide, if such nets are still considered acceptable."

All nets tested appeared to have the same amount of insecticide, which poses the question of how nets with the same insecticide levels could be less lethal to mosquitoes.

The authors agree that the answer most likely lies in changes to the manufacture of the nets. "We hope to work with the manufacturer to investigate further," Dr. Karl said.

In the meantime, the researchers urge that LLINs be tested for their ability to kill [mosquitoes](#)—not just their insecticide content.

They have notified the World Health Organisation and the manufacturer of their findings.

More information: Rebecca Vinit et al, Decreased bioefficacy of long-lasting insecticidal nets and the resurgence of malaria in Papua New Guinea, *Nature Communications* (2020). [DOI: 10.1038/s41467-020-17456-2](#)

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