What does war have to do with malaria?

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Abstract
Malaria has been a big problem in Pakistan for a long time now, especially near the border with Afghanistan, where many refugees come from. Because of nearby war it’s really hard to collect any data regarding this problem. We managed to examine blood samples from febrile patients from this area (these are people who showed up at the hospital with fever). Through genetic analysis we found out that 86% of the blood samples were infected with *Plasmodium vivax* and 12% with *P. falciparum* - the parasites which cause malaria. Public health in this region is worse than in any other area in the country. Many of the cases of malaria are severe. Mostly children get sick. This study is hopefully the first step in taking control of the situation in the area.

Introduction
We change the natural world every day in many different ways, often without even realizing it. Wars around the world have many consequences – air, soil and water get polluted, people and animals get killed, cities and their infrastructure get destroyed. Wars also go hand in hand with diseases. Military conflict often takes more casualties by infections rather than on the battlefield. Civilians flee away from wars and go to refugee camps. These camps become crowded and dirty really fast, and that way transmission of all sorts of diseases becomes extremely easy. In warmer regions that includes the so called vector-borne diseases – you become sick after an infected insect or another arthropod (e.g. tick) bites you. Once you are infected, you can infect another insect and a vicious circle goes on.

In the late 1970s, a war started in Afghanistan which continued for more than a decade. That made healthcare really hard to provide to the people in the region. As a result the country faced an old enemy – malaria, a severe disease transmitted through mosquitoes, which had previously been eradicated. **Malaria is endemic (present) in warm tropical countries, and rarely seen in temperate climate.** When an infected mosquito bites you it gives you a certain microbe – not a bacteria or a virus, but a parasite, called *Plasmodium*. There are different species of *Plasmodium* but all of them can make you sick with fever, headache and vomiting. The sad thing is that malaria had just been completely destroyed in Afghanistan but then, because of war, it reappeared.

Many of the local people flee to neighboring Pakistan which is also an endemic area for malaria. As a result, there is now a malaria epidemic in the border regions of Pakistan. We set out to find out which exact parasite causes malaria and who is most likely to get sick?
We collected 216 blood samples from people who have malaria symptoms, living in a Pakistan region still in war conflict and with lots of refugees. In order to see who gets mostly sick, the samples were from both men and women of different ages, including small children. Firstly the blood samples were observed under a microscope, to see if the parasite was there. Plasmodium is big enough to be seen like this but sometimes it’s really hard to distinguish the different species (P. vivax vs. P. falciparum) – it’s like seeing a difference between two dots on a piece of paper.

If a Plasmodium was seen, the blood was also examined by a genetic method - a genes analysis called PCR. In this type of analysis, we looked for certain genes which are unique for each of the species. (Just as humans and apes share many of the same genes but some genes are uniquely human, Plasmodium species share much of their genetic code but there are some unique genes for each species.) PCR genes analysis is a lot more accurate in determining exactly who caused the malaria.

**Methods**

We observed *Plasmodium* parasites under microscope in all 216 blood samples. We found *Plasmodium* genes, however, in only 178 of them. Since PCR gene analysis is a more accurate method in diagnosing malaria, we relied on that.

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**Results**

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**Who got sick the most?** Mostly males – 125 out of 178 (that’s ~70% of the cases) and only 53 female. Perhaps even more importantly, 58% of the cases were children and teenagers (Fig. 1).

What about who caused malaria? We already mentioned a few different species of *Plasmodium* P. vivax and P. falciparum are the most common. Using the microscope, 175 of the blood samples turned out to have *P. vivax*, 31 - *P. falciparum*, and 10 contained both parasites. Using the genetic method, we detected *P. vivax* genes in 154 of the blood samples, *P. falciparum* genes in 21 and both genes in 3 blood samples.

Regardless of the species that infected them, though, most of the patients had developed severe symptoms of malaria: inability to sit, seizures, loss of consciousness, and difficulty breathing.
Discussion

War conflicts not only make healthcare harder to achieve but they also make it really tough to collect the necessary data in order to take steps to control the diseases. The current paper reports the first epidemiological data from this conflict-ridden region of Pakistan. As sanitation there gets worse, the number of malaria cases increases and many of them are severe.

We found that *P. vivax* is a lot more common than *P. falciparum*, and we did not detect any *P. ovale* or *P. malariae* - two other *Plasmodium* species. This is consistent with what we know about *P. vivax* - it is transmitted by mosquitoes which prefer hilly areas - just like the region on the border between Pakistan and Afghanistan.

We also determined that the people who mostly get sick are males between 10 and 20 years of age. One possible explanation is because men are more likely to stay outdoors than women. In this region, it is forbidden for most women to go out by themselves. When they do, they are all covered in clothes so they are bitten by mosquitoes a lot less frequently.

Another question is why children? Most probably that is because they have not yet developed immunity against malaria. As they grow up, people living in endemic regions gradually develop immunity against the parasite. Another reason might be that children don’t care very much about mosquito bites and don’t try to avoid them.

Conclusion

Mosquitoes as well as diseases don’t know borders. Armed conflicts and war refugees also help spread lots of infectious diseases. In addition, scientists expect that with climate change, most diseases, especially vector-borne ones may spread further and further away as mosquitoes and other arthropods find new breeding grounds.

For vector-borne diseases the best prevention is to avoid bites. One can do that by using repellents, insect bednets, long trousers, long socks when living in or visiting an endemic area. If you protect yourself, you protect others as well.

Glossary of Key Terms

**Vector-borne diseases** – diseases that are transmitted through the bite of blood sucking arthropods such as mosquitoes, ticks, fleas, sandflies and others. Examples for vector-borne diseases other than malaria are Yellow fever, Dengue, Zika, West Nile Fever, Lyme disease, Tick-borne encephalitis.
**Plasmodium** – eukaryotic parasite; causes malaria. Five different species of Plasmodium cause malaria, mostly *P. falciparum* and *P. vivax*.

**Endemic vs. epidemic** – a disease is endemic if it is regularly seen in some region. Different from epidemic which means there has been an outbreak of a particular disease. E.g. Ebola is endemic in West Africa but only sometimes are there epidemics and outbreaks.

**Disease control** – different measures authorities and people take to prevent the spread of some diseases. E.g. To control malaria we can avoid being bitten by mosquitoes, avoid leaving stagnant water where mosquitoes can breed; ensure fast diagnosis etc.

**Repellent** – a chemical that is used to stop insects (and sometimes ticks) from biting you. Most commonly the chemical is DEET.

**Arthropod** – an invertebrate animal of the large phylum *Arthropoda*, such as an insect, spider, or crustacean, characterized by an exoskeleton (external skeleton), a segmented body, and jointed appendages (legs).

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**Check your understanding**

1. How does malaria spread?
2. Is *Plasmodium* A) bacteria B) virus C) eukaryotic D) parasite
3. Why are refugee camps likely location for infectious diseases?
4. Why is malaria found in warm climates?
5. Keeping in mind that vectors are the primary and often only source of infection with vector-borne diseases, what do you think – do they get sick as well?
6. What can we do to protect ourselves and others from vector-borne diseases?

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Climate change and vector-borne disease


**KEY TERMS**

Tropics, war, malaria, vector-borne diseases, epidemiology, genes

**SCIENTIFIC METHODS**

Microscopy, genetic analysis (PCR), methods comparison