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Ticks and tick-borne pathogens in Finland: a crowdsourcing based study

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Background: Ticks are the primary vectors for several zoonotic infections worldwide. The most important tick-borne diseases in Finland are Lyme borreliosis (LB) and tick-borne encephalitis (TBE). The tick situation in Finland is exceptional, since the northernmost border of the tick distribution area in Europe, and the distribution borderline of *Ixodes ricinus* and *I. persulcatus* are both located within the country. However, the distribution of the tick species and the diversity of tick-borne pathogens have not been thoroughly investigated in Finland.

Material/methods: Tick collection with the traditional researcher-driven methods (e.g. flagging) is laborious, and temporally and geographically restricted. In contrast, crowdsourcing is an effective method in various research settings for gathering material. To construct a nationwide collection of ticks, we launched a campaign using the crowdsourcing approach where citizens were asked to participate in the tick collection, and to send the collected ticks to us along with information on the collection site and date, and species of the possible host. A subset of 2,038 ticks of the received material was screened for of *Borrelia burgdorferi* s.l., *B. miyamotoi*, and TBE-virus.

Results: Approximately 7,000 shipments were received, containing nearly 20,000 individual ticks from all over Finland. The collected material revealed for the first time the nationwide distribution of *I. persulcatus* and a northwards shift in distribution of *I. ricinus* in Finland. Prevalence of *B. burgdorferi* s.l. was 14.2% in *I. ricinus* and 19.8% in *I. persulcatus*, and prevalence of *B. miyamotoi* was 0.2% in *I. ricinus* and 0.4% in *I. persulcatus*. TBE-virus prevalence was 0.2% in *I. ricinus* and 3.0% in *I. persulcatus*. Further, we identified new risk areas for TBE in Finland, and the presence of *B. miyamotoi* in ticks from mainland Finland

Conclusions: Our tick collection offers an exceptionally comprehensive overview of ticks and tick-borne pathogens in Finland. Importantly, the study demonstrates the overwhelming power of citizen-science in accomplishing a collection effort, which would have been impossible by the scientific community alone.