

Abstract

In natural populations, individuals may be infected with multiple pathogens at a time. The direction and strength of co-infecting pathogen interactions are often unknown and dependent on the mechanism of interaction. They may be synergistic (together harming the host more) or antagonistic (together having less adverse effects on the host), compared to single infections. Here we have tested associations of infections and their co-infections with observed variation in growth rates, and survival in zebu cattle part of the IDEAL project cohort study. Complete clinical and infection life history data on 548 animals recruited at birth, examined and sampled every 5 weeks until one year old was used. After controlling for other significant covariates, the results reveal both synergistic interactions (lower growth rates) with *Theileria parva* and *Anaplasma marginale* coinfections, and antagonistic interactions (relatively higher growth rates) with *Theileria parva* and *Theileria mutans* co-infections. Additionally, helminth infections can have a strong negative effect on the growth rates but this is burden-dependent. The all-cause mortality rate was 16.1%, with no significant differences between calf sex or genotype. Helminth infections (strongyle eggs per gram (epg) of faeces) and *Theileria* spp high-intensity infections were associated with higher odds for mortality (OR = 1.27, $p < 0.001$ per 1000 epg increase, and OR = 5.5, $p < 0.001$, respectively). East Coast Fever (ECF) was the single most important disease associated with calf mortality accounting for 37.1% of all deaths, followed by Haemonchosis accounting for 11.2%. However, the risk of death due to ECF was itself influenced by helminth burden (OR = 1.41 per 1000 epg increase, $p < 0.001$). These findings present evidence of pathogen interactions affecting host growth and survival, and have important implications on disease control strategies, suggesting benefits of an integrated approach to worm and tick-borne diseases