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Coinfections by noninteracting pathogens are not independent and require new tests of interaction

Abstract: If pathogen species, strains, or clones do not interact, intuition suggests the proportion of coinfecting hosts should be the product of the individual prevalences. Independence consequently underpins the wide range of methods for detecting pathogen interactions from cross-sectional survey data. However, the very simplest of epidemiological models challenge the underlying assumption of statistical independence. Even if pathogens do not interact, death of coinfecting hosts causes net prevalences of individual pathogens to decrease simultaneously. The induced positive correlation between prevalences means the proportion of coinfecting hosts is expected to be higher than multiplication would suggest. By modelling the dynamics of multiple noninteracting pathogens causing chronic infections, we develop a pair of novel tests of interaction that properly account for nonindependence between pathogens causing lifelong infection. Our tests allow us to reinterpret data from previous studies including pathogens of humans, plants, and animals. Our work demonstrates how methods to identify interactions between pathogens can be updated using simple epidemic models.

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