Title: Asymptotic behavior of an epidemic model with infinitely many variants.

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Abstract: We investigate the long-time dynamics of a SIR epidemic model with infinitely many pathogen variants infecting a homogeneous host population. We show that the basic reproduction number R_0 of the pathogen can be defined in that case and corresponds to a threshold between the persistence ($R_0>1$) and the extinction ($R_0\leq 1$) of the pathogen. When ($R_0>1$) and the maximal fitness is attained by at least one variant, we show that the systems reaches an equilibrium state that can be explicitly determined from the initial data. When ($R_0>1$) but none of the variants attain the maximal fitness, the situation is more intricate. We show that, in general, the pathogen is uniformly persistent and all families of variants that have a uniformly dominated fitness eventually get extinct. We derive a condition under which the total mass of pathogens converges to a limit which can be computed explicitly. We also find counterexamples that show that, when our condition is not met, the total mass of pathogen may converge to an unexpected value, or the system can even reach an eternally transient behaviour where the mass oscillates between several values. We illustrate our results with numerical simulation.