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Age-structured models of epidemiological dynamics

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The mathematical modeling of populations assumes that individuals initially move between different stages, where all individuals have the same probability of becoming infected (homogeneous populations) independent of aspects such as spatial location, the behavior of the people, and their ages. The last aspect is precisely one of the important characteristics that describe the heterogeneity in populations and infectious diseases. Individuals of different ages may have distinct reproductive and survival capacities of the virus. Also, diseases may have different infection and mortality rates depending on the age groups to which an individual belongs [1].

In the study of population dynamics of epidemics, age distributions allow for the characterization of the heterogeneity of populations. This feature is a factor with significant influence on the epidemic temporal passing, outcomes of transmission, and spread of infectious diseases [2]. The behavior of populations and the frequencies of individual interactions can vary among age groups. The differences produce a high degree of diversity in transmission rates. Individuals of different ages may have several levels of immunity to infectious diseases affecting the specific mortality and recovery rates depending on the age group to which they belong [3].

Age-structured epidemiological models are presented and analyzed from two mathematical approaches. The first is considering age in a discrete form based on systems of ordinary differential equations (ODE). Here the age of the different groups is considered like nodes, and their connections are given by transmission and aging. The stability of age subgroups is studied, and the reproductive number is calculated with vaccination $\mathcal{R}_v$ within a subgroup. The second approach considers the age structure from a continuous approach using partial differential

equation (PDE) systems. In this model, the independence of time and age is assumed. Also, the existence, uniqueness, and stability of the endemic equilibrium when $\mathcal{R}_v > 1$ is established and the best scenario to mitigate epidemic outbreaks is determined.

Keywords: age-structured, reproductive number with vaccination, stability analysis

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