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Modeling the spread and mitigation of absenteeism among university students: a stage-structured compartmental approach with optimal control: a supplementary report

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Student absenteeism in higher education is well documented as a correlate of poor performance, yet it is rarely modeled as a dynamic, socially transmitted process. Existing compartmental treatments either omit the latent phase preceding a first absence or collapse occasional and habitual absence into a single class, and none permits intervention to be targeted by stage. We formulate a five-compartment namely Susceptible Exposed Occasional Absentees Habitual Absentees Re-engaged (SEACR) model with a graded force of infection, in which exposed, occasional, and habitual students transmit at different weights, and a direct relapse pathway returning re-engaged students to occasional absence without re-exposure. We derive the absenteeism threshold number in closed form and prove that it increases strictly with the relapse rate, that the absenteeism-persistent equilibrium is unique whenever it exists, so that the bifurcation at threshold unity is forward, and that the absenteeism-free equilibrium is globally asymptotically stable. An optimal control problem with three stage-specific controls, namely prevention, early intervention, and remediation, was examined using Pontryagin s maximum principle. For an illustrative cohort, the threshold is 2.4487, and global sensitivity analysis identifies early re-engagement as the most influential recovery parameter, with a partial rank correlation coefficient of 0.894 against 0.825 for remediation. Cost-effectiveness analysis ranks early intervention first under the baseline cost weights, but this ranking changes across alternative assumed cost weights; therefore, single-point cost-effectiveness conclusions should be interpreted cautiously.

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