24. How human interactions drive SARS-CoV-2 transmission in indoor spaces-Insights from incorporating pedestrian behavior in epidemiological simulation models

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SARS-Cov-2 transmission in indoor spaces, where most infection events occur, fundamentally depends on the types and the duration of human contact and how these accumulate to epidemiologically meaningful interactions. Understanding how complex human behavior interfaces with the biology of the virus to propagate transmission and dictate the outcomes of non-pharmaceutical intervention is important for the informed and safe reopening of spaces. We developed a combined Pedestrian Dynamics - Virus Spread model (PeDViS model): an individual-based simulation model that combines microscopic pedestrian behavior models (Nomad) and virus spread models that simulate direct and indirect transmission routes (QVEmod). We calibrated Nomad to nationwide human mobility monitoring data that were collected at different stages before and during the pandemic. Next, data on outbreak clusters in restaurants in the Netherlands were used to validate the epidemiological outputs of PeDVis. The calibrated model was then used to investigate the risks of exposure to the virus relative to the duration, distance, density, and context of human interactions. Specifically, we compared individual virus exposures relative to the benchmark contact of 1.5 meters for 15 minutes, often used by public health agencies to determine 'at risk' contacts, and evaluated the circumstances under which individuals are at risk of contracting infection despite the adherence to distancing measures. Lastly, we enumerated how combining intervention tools that target different routes of transmission can aid in reducing transmission risks. The multi-dimensionality of SARS-CoV-2 transmission emerges from the interplay of human behavior and the dispersal dynamics of respiratory viruses in indoor environments. Incorporating this interplay in risk assessments may improve decision-making on how to mitigate indoor-transmission and safely reopen indoor spaces.

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