

The infection risks from consumption of norovirus-contaminated tomatoes to individuals and populations – application of a novel risk assessment model to support the Codex Alimentarius

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Norovirus is a leading cause of foodborne illness worldwide. In 2012, the Codex Alimentarius recommended practices and processes to reduce the risk of noroviruses in foods. To inform updates to the Codex Alimentarius, the Food and Agriculture Organization of the United Nations (FAO) and the World Health Organization (WHO) are currently developing scientific guidance to reduce viral risks on foods. This scientific guidance includes recommendations of risk assessment models of viruses on foods for wide use among Member countries, including in Latin America. Thus, our goal was to develop an integrated risk assessment model for noroviruses on fruits and vegetables that could estimate both the individual- and population-level risks and support the efforts of FAO/WHO for the Codex Alimentarius. We demonstrated the use of this model to quantify the magnitude of disease risk to both individual consumers and to a population of consumers ingesting contaminated tomatoes with norovirus. We developed a quantitative microbial risk assessment (QMRA)-linked infectious disease transmission (IDT) model to 1) characterize individual risk from consumption of empirically-sampled, norovirus-contaminated tomatoes, and 2) simulate norovirus cases in a population from a norovirus-tomato seeding event. Sequence-confirmed norovirus GII.6 strains were isolated from tomatoes collected on Mexican farms and tomato norovirus concentration was quantified using digital RT-PCR. We used a QMRA model to estimate infection risks (10,000 iterations, mc2d package, 1:100 infectious ratio) based on empirically-sampled concentration data and age-stratified tomato consumption rates. Median infection risks varied by age, with the lowest risk ( $1.9 \times 10^{-4}$  per day) among children (<6 years): and the highest risk ( $1.4 \times 10^{-3}$  per day) among adults (21 to <60 years). These risks were integrated into the IDT model (N=100,000; 50% of population exposed to tomatoes) to simulate a one-time norovirus seeding event. Using the IDT model, a single outbreak from tomato consumption alone lasted four days with a cumulative incidence of 16 cases: 11 symptomatic, 5 asymptomatic. When simulating primary cases resulting from tomato consumption and secondary cases from contact with tomato-infected primary cases, the outbreak lasted 17 days with a cumulative incidence of 42 cases: 29 symptomatic; 13 asymptomatic. We compare these results with those of published reports in Latin American countries. This study underscores the utility of integrated risk assessment models to advance the precision of produce risk assessment and to inform effective mitigation strategies. Further, this study provides a novel risk assessment model useful for FAO/WHO's recommendations to strengthen the Codex Alimentarius and reduce the risk of viruses in foods among Member countries, including in Latin America.

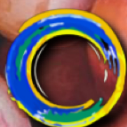


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