How we do the research...

CAsToR Briefing

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The Center for the Assessment of Tobacco Regulations (CAsToR) aims to provide evidence-based and expert-informed modeling of the behavioral and public health impacts of FDA tobacco rules or other regulatory actions, focusing on Impact Analysis, Behavior and Health Effects as Scientific Domains.

A primer on computational models in tobacco control

This brief summarizes presentations by CAsToR researchers at the pre-conference workshop "An Introduction to Computational Modeling in Tobacco Policy and Regulatory Science Research " held at the Society for Research on Nicotine and Tobacco's annual conference in Baltimore, MD in March 2026.

Key takeaways.

- Simulation models apply assumptions based on theory, data, and computational rules to project future outcomes and evaluate alternative scenarios.
- Models are used by researchers and the FDA Center for Tobacco Products (CTP) to assess the potential public health impacts of new products and policies.

What is simulation modeling?

Simulation modeling is a research approach that integrates theory, empirical data, and computational rules to represent complex systems and project how they evolve over time.

Simulation modeling is an applied, team-based science requiring diverse sources of data and different forms of expertise.

In tobacco control research, simulation models are often used to predict how a policy or intervention might impact future population health.

How do we know if a model is accurate?

Simulation modeling is a structured, systematic treatment of uncertainty. Models make assumptions explicit to predict how systems might change and react under a given intervention.

Simulation models are based on informed assumptions and predict what might happen in the future or could have happened in the past under different scenarios, but they can't do so with absolute certainty. There's always some uncertainty involved.

There are several ways to check the validity of a simulation model. Researchers examine the **assumptions** made, the **mechanisms** that connect cause and effect, the **sensitivity** of the findings to changes in parameters, the **consistency** of past predictions with actual levels or trends,and the level of **uncertainty** in the model's estimates.

What kinds of models are used in tobacco control research?

To decide which model works best for a project, researchers first identify the outcomes they are trying to estimate. There are several different types of models typically used in tobacco control research (see **Table 1** for a summary):

1. System dynamics

System dynamics models are used to identify root causes of an observed trend over time. In system dynamics modeling, researchers are interested in feedback loops and delays, and incorporate "stocks and flows" (e.g. populations aging in/out of the system). The model represents how an intervention affects how variables, such as individual consumer behavior and industry behavior, interact with each other.

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Table 1. Types of simulation models, what they do, and examples from tobacco control.

Model type	Purpose	Examples from tobacco control
System dynamics	Identify root causes of an observed trend over time; simulate feedback loops in a system	Causal loop diagrams to evaluate tobacco policy effects on smoking among low-income and racial/ethnic minorities [1]
Agent-based	Simulate peer influence and how behavior spreads	Peer-influenced smoking initiation among youth [2]
Macro- and microsimulation	Simulate individual state transitions, health trajectories, disease pathways, and long-term outcomes	CISNET smoking history models in cohorts, such as simulations of public health effects of vaping [3] and a U.S. ban on menthol in cigarettes and cigars [4]
Discrete event simulation	Simulate how a sequence of discrete events in a system evolve over time	A discrete-event simulation of smoking-cessation strategies based on varenicline pivotal trial data [5]

2. Agent-based
Agent-based models are used to understand how behaviors spread across a heterogeneous population. In agent-based modeling, individual agents interact with each other in a defined social network.

3. Macro- and microsimulation
Macrosimulation models are used to simulate how and when populations transition to different states in their life histories and health trajectories, while microsimulations focus on individuals.

4. Discrete event simulation
Discrete event simulation models are used to simulate individual events that occur over time. In discrete event simulation models, researchers employ a sequence of discrete events that occur over specific points in time to understand how the system evolves from one state to another state.

What data sources are used in modeling?

Simulation modeling requires diverse sources of data. This can include data from:

- **Econometric studies** and **randomized controlled trials (RCTs)** that provide estimates of policy effects. Ideally, models use causal estimates (or, if causal estimates are not available, informed range estimates).
- **Evidence synthesis** from literature reviews, meta-analyses, and systematic reviews. Systematic reviews are preferable, given they are transparent, assess study quality, and identify patterns in the scientific literature.
- **Surveillance instruments** such as public health data from the National Center for Health Statistics, SEER, CDC WONDER and other longitudinal data collection efforts.
- **Qualitative studies** such as case studies, expert panels, and interviews can identify and inform model parameters, mechanisms, and implementation.

How are models used to inform policy?

The FDA CTP uses simulation models to assess new product applications and estimate how products might impact population health and behaviors.

Simulation models are also used in tobacco control to assess the projected impact of rules and regulations on public health.

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Citations

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