Overview: Defining Thirdhand Smoke

Georg E. Matt
Dep of Psychology
College of Sciences
San Diego State University
gmatt@sciences.sdsu.edu

SAN DIEGO STATE UNIVERSITY

Acknowledgments

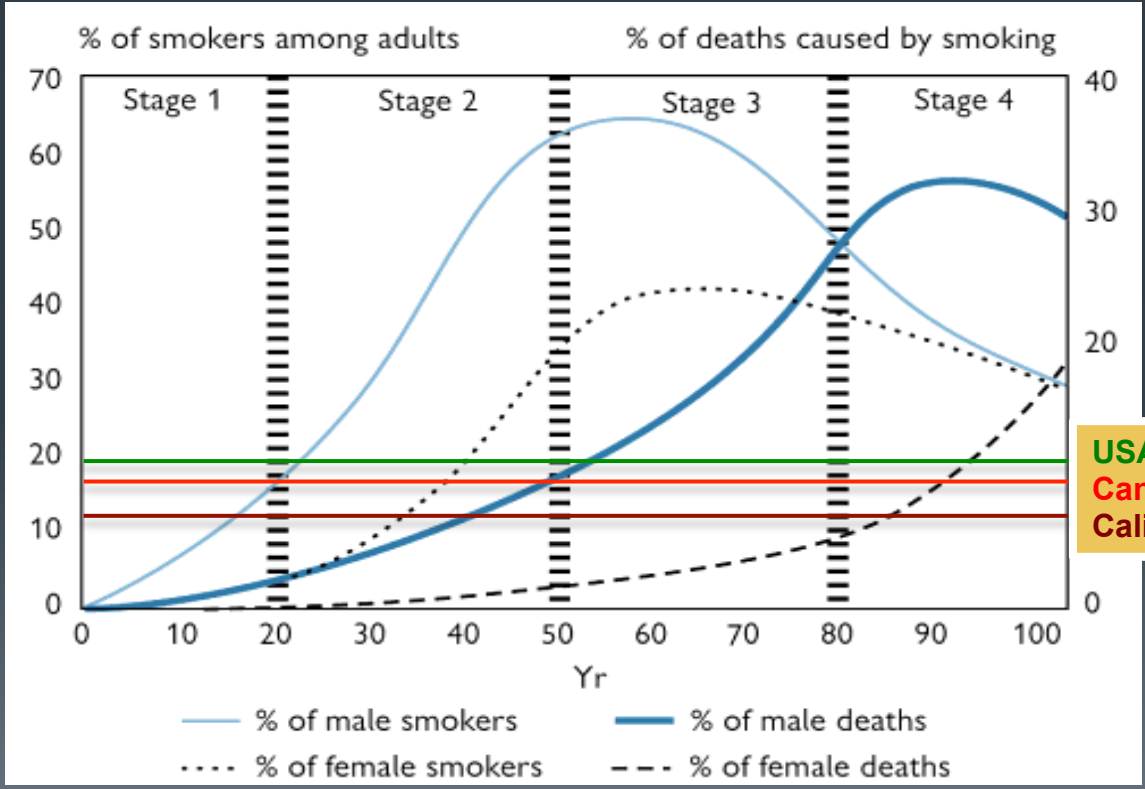
- **Ontario Tobacco Research Unit**
- **California Tobacco Related Disease Research Program**
- **Collaborators and Colleagues**
  - Quintana, Hovell, Hoh, Chatfield, Winston, Zakarian, Brewer, Ma, Romero, Galaviz
  - Bernert, Song, Singer, Winickoff, Schick, Gundel, Destaillats, Sleiman, Nazaroff, Benowitz, Jacob, Rehan, Talbot, Samet, Pankow, Martins-Green
- **Students**
  - Aguilar, Boland, Crane, Cullimore, Floro, Galaviz, Gamble, Gamboa, Gehrman, Juarez, Junker, Kirkpatrick, Novianti, Oei, Pham, Salem, Tassinario, Timmermann, Tran, Uribe, Wong
- **Research Participants**
  - Hundreds of nonsmoking and smoking research participants who answered survey questions, allowed us to examine dust, air, and surfaces in their private homes and cars, and provided us with biological samples to examine exposure to tobacco smoke pollutants

Overview

1. The Context of Thirdhand Tobacco Smoke (THS)
   - Global: Tobacco Epidemic
   - Local: Microenvironments
2. Defining Thirdhand Tobacco Smoke
   - Firsthand Smoke (FHS)
   - Secondhand Smoke (SHS)
   - Thirdhand Smoke (THS)
3. THS Pollution & Exposure in Everyday Life
   - Homes, private cars, hotels, rental cars, taxis
4. Challenges & Opportunities
   - Research and Tobacco Control

1. Context: The Global Tobacco Epidemic

Lopez et al.'s (1994) Descriptive Model



Transitions through 4 stages can be characterized by changes in 3 variables:

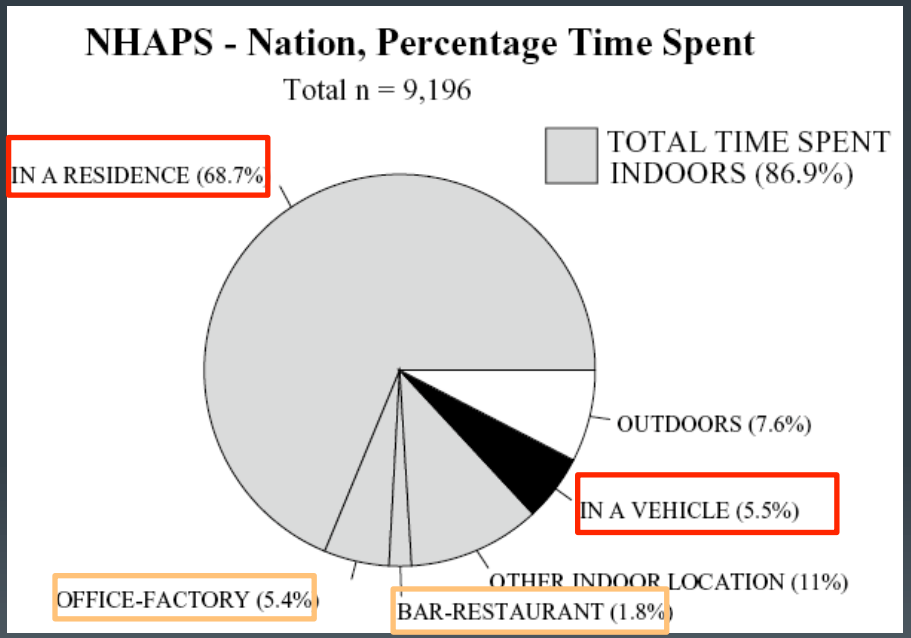
- Prevalence in adult population
- Consumption (e.g., cigs/day)
- Mortality due to smoking

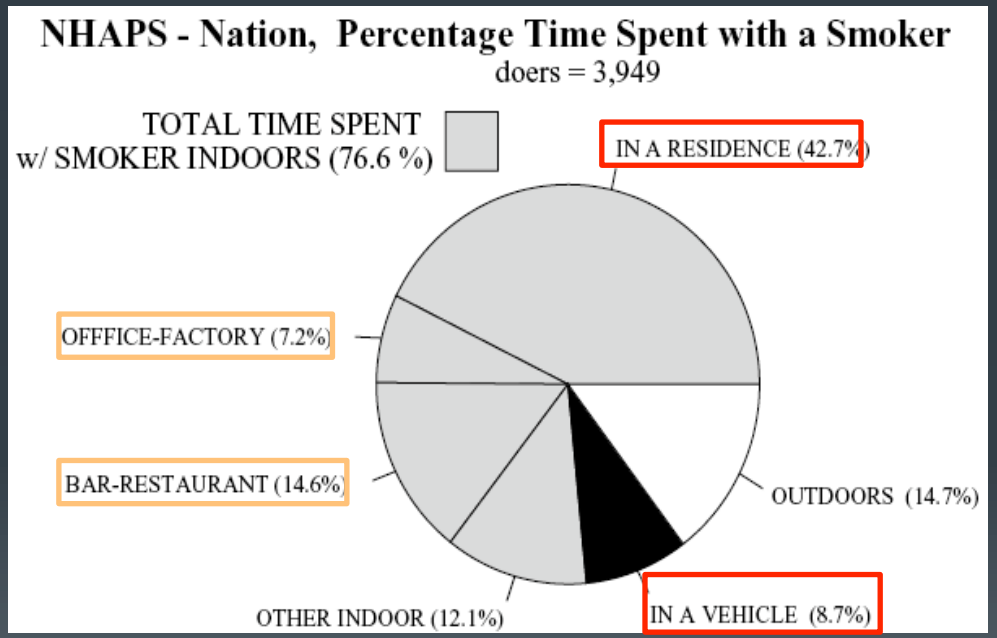
USA 2011: 19.6% (MMWR 9/30/11)
Canada 2010: 16.7% (CTUMS 2010)
California 2010: 11.9% (CDPH, 2011)

Where do we go from here? Stage 5?

Lopez, A.D, Collishaw, N.E., Piha, T. (1994). A descriptive model of the cigarette epidemic in developed countries. Tob Control, 3:242-247.

1. Context: Local Microenvironments





Klepeis, N.E. et al. (2001). The National Human Activity Pattern Survey (NHAPS): a resource for assessing exposure to environmental pollutants. Journal of Exposure Analysis and Environmental Epidemiology 11: 231-252.

2. Tobacco Smoke

Two major types of tobacco smoke

- side-stream smoke
- main-stream smoke

2. Active Smoking: Firsthand Smoke (FHS)

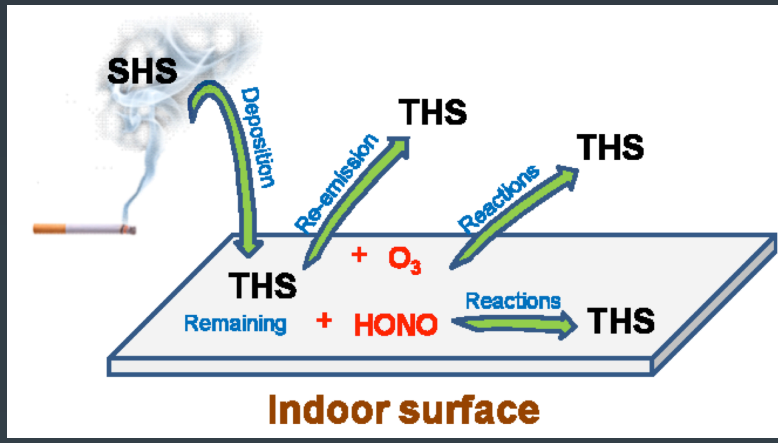
- Inhaling mainstream smoke
- Composition and exposure depends on
  - cigarette composition,
  - the frequency, duration, and volume of puffs
  - how a smoker inhales and exhales
- 4,000+ compounds in gas-phase and particulate-phase
- Primary exposure pathway: inhalation
- Duration: 5-10 minutes
- 15-25 puffs
- Affects one person

2. Passive Smoking: Secondhand Smoke (SHS)

- Composition
  - 15%= exhaled main-stream smoke
  - 85%= of side-stream smoke
- Side- and main-stream smoke contain many of the same chemical compounds
- Side-stream smoke differs from main-stream smoke
  - Tobacco burns at lower temperature, leading to incomplete combustion
  - Higher concentrations of toxic gases and particles
  - Produces smaller particles that reach and stay in deep lung
- SHS travels throughout a room, home, neighboring apartments, outdoor spaces
- Affects multiple persons in physical proximity to the active smoker
- Duration: while smoking takes place and thereafter: moments, minutes, hours?

2. Residual Tobacco Smoke: Thirdhand Smoke (THS)

- THS consists of residual tobacco smoke pollutants that
  - remain on surfaces and in dust
  - are re-emitted back into the gas phase from reservoirs storing pollutants
  - are re-suspended from accumulated dust deposits
  - react with oxidants and other compounds in the environment to yield secondary pollutants.



- The constituents of THS that have been identified so far
  - Nicotine, 3-ethenylpyridine, phenols, cresols, sterols, naphthalene, formaldehyde, fatty acids, polymeric combustion byproduct metals
  - tobacco-specific nitrosamines, some not found in freshly emitted tobacco smoke (i.e., secondary pollutants)
  - PAH in settled house dust
  - Formation of ultrafine particle (<100nm)

2. Residual Tobacco Smoke: Thirdhand Smoke

- THS exposure results from
  - The involuntary inhalation, ingestion, or dermal uptake of THS pollutants
  - In the air, in dust, and on surfaces
- THS exposure include
  - Inhalation of gas phase compounds re-emitted into the air from indoor surfaces and
  - Inhalation of particles re-suspended from deposits
  - Dermal update and ingestion of tobacco smoke particles that have settled, deposited, and accumulated on surfaces.

3. THS Pollution and Exposure in Everyday Life: Persistent and Pervasive

Private Homes of Smokers with and without Smoking Bans

- Surfaces, dust, and air are contaminated in homes of smokers with infants.
- Smoking outside the home does not protect a home from residual tobacco smoke pollution.
- Infants of smokers are at risk of tobacco smoke exposure in their homes through dust, surfaces, and air.
- Smoking outside the home and away from the infant reduces but does not protect a smoker's home from tobacco smoke contamination and a smoker's infant from exposure.

Matt GE, Quintana PJ, Hovell MF, *et al.* Households contaminated by environmental tobacco smoke: sources of infant exposures. *Tobacco Control* 2004;**13**(1):29-3

3. THS Pollution and Exposure in Everyday Life: Persistent and Pervasive

When Smoker Move Out and Nonsmokers Move in

- Smokers leave behind THS in dust and on surfaces: nicotine levels are significantly higher in former smoker apartments than in nonsmoker apartments.
- THS persists for months.
- New nonsmoking residents pick up THS on their hands.
- New nonsmoker residents are exposed to THS.
- Biological exposure in new nonsmoking residents (i.e., urine cotinine levels) is correlated with THS levels on apartment surfaces and their hands.

Matt GE, Quintana PJ, Zakarian JM, *et al.* When smokers move out and non-smokers move in: residential thirdhand smoke pollution and exposure. *Tob Control* 2011;**20**(1):e1.

3. THS Pollution and Exposure in Everyday Life: Persistent and Pervasive

Private Cars for Sale

- Cars sold by smokers are polluted with THS regardless of smoking ban
- Cars sold by smokers w/out smoking bans show higher levels of pollution than those sold by smokers w/ ban
- Smoker cars show elevated levels of nicotine in the air, in dust, and on surfaces
- Compared to nonsmoker cars of equivalent make, model, year, KBB value, smoker cars are offered at 7-8% less, or approx. $700 for an average car.
- According to KBB, this loss in value is equivalent to all of the following being broken: air conditioning, power steering, power windows, power door locks, cruise control, and the dual front airbags

Matt GE, Romero R, Ma D, *et al.* Tobacco use and asking prices of used cars: prevalence, costs, and new opportunities for changing smoking behavior. Tobacco Induced Diseases. . *Tobacco Induced Diseases* 2008;**4**:1-8.

3. THS Pollution and Exposure in Everyday Life: Persistent and Pervasive

Rental Cars

- 3 out of 4 designated nonsmoker cars have been smoked in
- Compared to private cars of nonsmokers w/ smoking bans, show significantly elevated levels of THS on surfaces and dust.
- Tobacco smoke pollutants build up over time on surfaces and in dust even when smoking occurs only occasionally.
- Non-smoking signage (e.g., sticker in car, sign on key chain) was associated with lower levels of tobacco smoke pollutants.
- Existing Policies largely fail in protecting nonsmokers from renting cars in which previous renters have smoked
- Failures in implementing, communicating, training, monitoring, enforcing policies

Matt GE, Fortmann AL, Quintana PJ, *et al*. Towards smoke-free rental cars: an evaluation of voluntary smoking restrictions in California. *Tob Control* 2012. doi:10.1136/tobaccocontrol-2011-050231 .

3. THS Pollution and Exposure in Everyday Life: Persistent and Pervasive

Taxi Vehicles

- Hamilton, ON: Exploring new approaches to compliance enforcement of Smoke Free Ontario Act
- 93% had a “No Smoking” decal, but
- … ashes were present in 40% of taxi vehicles
- … tobacco odour was noticeable in 25% of taxi vehicles
- Surface wipes showed the following median levels of nicotine
  - 35 $\mu g/m^2$ in taxis classified as “No Smoker “
  - 664 $\mu g/m^2$ in taxis classified as “Smoker“
  - For comparison:
    In San Diego, California, private cars of nonsmokers with smoking ban: 0.14 $\mu g/m^2$

Cora McCloy, Maritt Kirst, Erika Yates, Roberta Ferrence, Robert Schwartz, Kevin McDonald, Debra Massie (Nov 2, 2011). Smoking and taxi vehicles: A problem-solving/community engagement approach to risk-based enforcement. 7thNational Conference on Tobacco or Health, Toronto, November 2nd, 2011

3. THS Pollution and Exposure in Everyday Life: Persistent and Pervasive

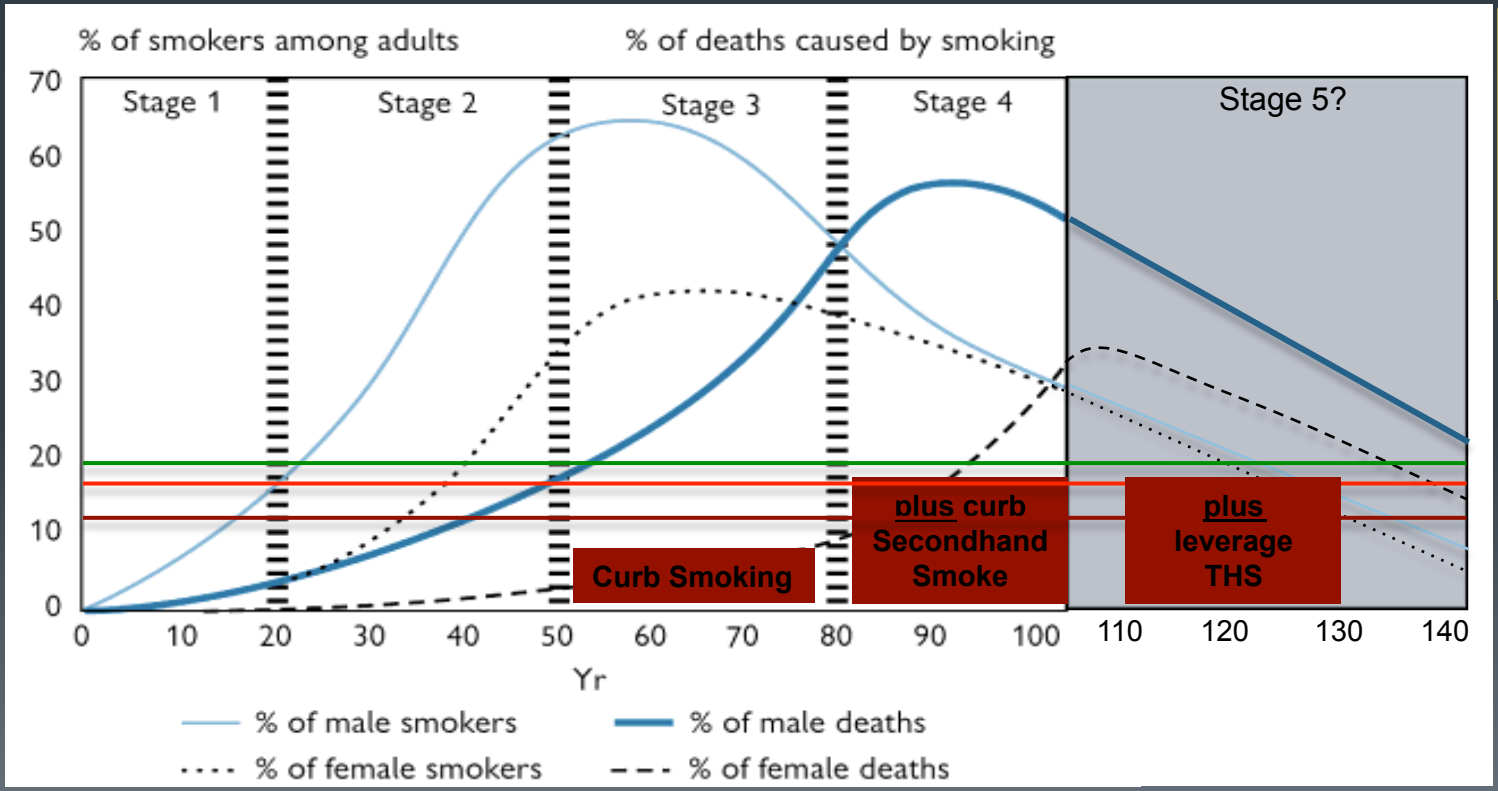
Hotel Rooms

- Smoker rooms and hallways in smoker hotels are polluted with THS in the air and on surfaces.
- Guests staying in smoker hotel rooms pick up THS on their hands and are exposed to THS.
- Nonsmoker rooms in smoker hotels and hallways outside of nonsmoker rooms are polluted with THS.
- Higher levels of nicotine on guest room surfaces are correlated with higher levels of nicotine on guests' hands and higher levels of cotinine in their urine.
- Housekeepers working more hours and cleaning more smoker guestrooms show higher levels of tobaccos smoke exposure.

G.E. Matt, Quintana, et al. (2012). Smoking Policies and Secondhand Smoke in Hotels. 17RT-0162H TRDRP.

A Global Perspective: The Tobacco Epidemic

A model of the cigarette epidemic (Lopez et al. 1994)



Stage 5: How can we bring about changes in attitudes, behaviors, policies to reduce smoking prevalence to <5%?

2010/11
USA
Canada
California

Lopez, A.D, Collishaw, N.E., Piha, T. (1994). A descriptive model of the cigarette epidemic in developed countries. Tob Control, 3:242-247.

Challenges and Opportunities

Things we have learned

- THS is a long-term consequence of smoking behavior
- THS is very pervasive if an indoor environment has been regularly smoked in:
  - Living rooms, bedrooms, private cars, hotel rooms, rental cars
  - Dust, surfaces, air
- THS is very persistent: days, weeks, months, years
- Nonsmokers living and working in THS polluted indoor spaces are being exposed
- THS Exposure profiles differ from 1HS and 2HS
  - Relatively high, moments/minutes vs relatively low, 24/7
  - Acute vs cumulative
- Voluntary smoking bans are often poorly implemented
- Significant loopholes in CA's public policies to protect nonsmokers: policies are not keeping up with evidence on 2HS and 3HS
- Risk groups
  - Workers in settings where smoking is allowed : e.g., housekeepers, drivers
  - Buyers, users, renters of facilities, cars, objects, etc. used by smokers
  - residents of residential facilities wheresmoking is allowed
  - Children

Challenges and Opportunities

Things to be learned

- Pathways of THS exposure
- THS constituents
- Aging of constituents
- Interactions with other pollutants and oxidants
- Exposure to constituents
- Clean-up
- Markers of THS: tobacco specific, representative of THS pollutants
- Markers of THS exposure: specific to THS, representative of exposure to THS pollutants
- Unique incremental health risks
- Cumulative health risks
- Individual differences in risks associated with exposure to pollutants
- Disentangle main and interaction effects in
  - Smokers: FHS x SHS x THS
  - Passive smokers: SHS x THS

Challenges and Opportunities

Leverage THS to

- **Strengthen Voluntary Smoking Bans**
  - Implementation of policies is critical: establish nonsmoker policies –> train & communicate –> monitor compliance -> verify/validate -> provide feedback (rewards, penalties)
- **Close existing loopholes**
  - Hotels, cars, residential facilities, small employers, card rooms, casinos, family child care homes
- **Expand tobacco control: denormalize tobacco use**
  - Private and semi-private spaces; vulnerable populations
- **Facilitate market responses to consumer preferences for smoke-free environments**
  - If you can smell it, you can sell it.
  - Disclosure of previous smoking by previous owners, users, renters
  - Include THS in valuation of real estate, personal property, rental property
  - In the minds of consumers (nonsmokers and smokers), make the connection between the sensory experience of odor and physiological exposure
  - Certification of Smoke-Free and Smoke-Polluted Microenvironments

Leveraging THS: Latest Success

Gates, Heaven