

Modeling from the margins to the masses: Perspectives on commercial tobacco and health equity

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Disclosures

No conflicts of interest to disclose.

Acknowledgments

Land

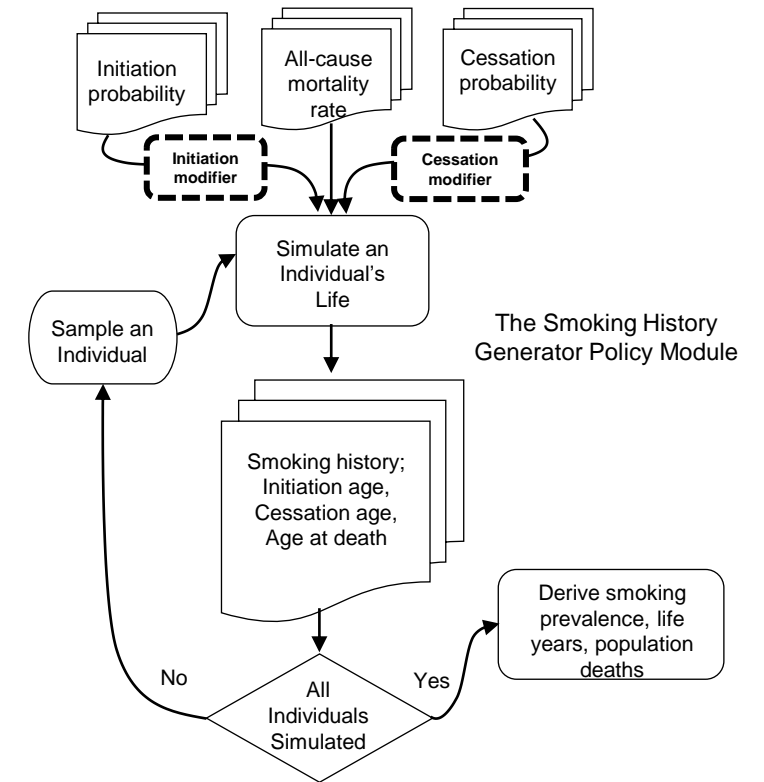
- New Haven exists on Wappinger, Quinnipiac, Paugussett land
- San Antonio exists on Tonkawa, Coahuiltecan, Jumanos, Ndé Kónitsaqáí Gokíyaa (Lipan Apache) land

Funding

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Tobacco simulation models and health equity

- Monitor and forecast trends in commercial tobacco use disparities over time
- Evaluate and compare *'what-if'* intervention scenarios and their short and long-term impacts
- Investigate underlying dynamics that influence disparities
- Identify intervention strategies that have the greatest potential to achieve health equity goals



Health equity objectives

1. WHO: “the absence of unfair and avoidable or remediable differences in health among population groups defined socially, economically, demographically or geographically”
2. Healthy People 2030: “the attainment of the highest level of health for all people”
3. “efforts to impact the determinants of health, reduce health disparities, and work toward health equity cannot fully be understood without the use of metrics. Measurement can also offer indication of what interventions best address disparities, their determinants, and ultimately impact progress toward equity.”

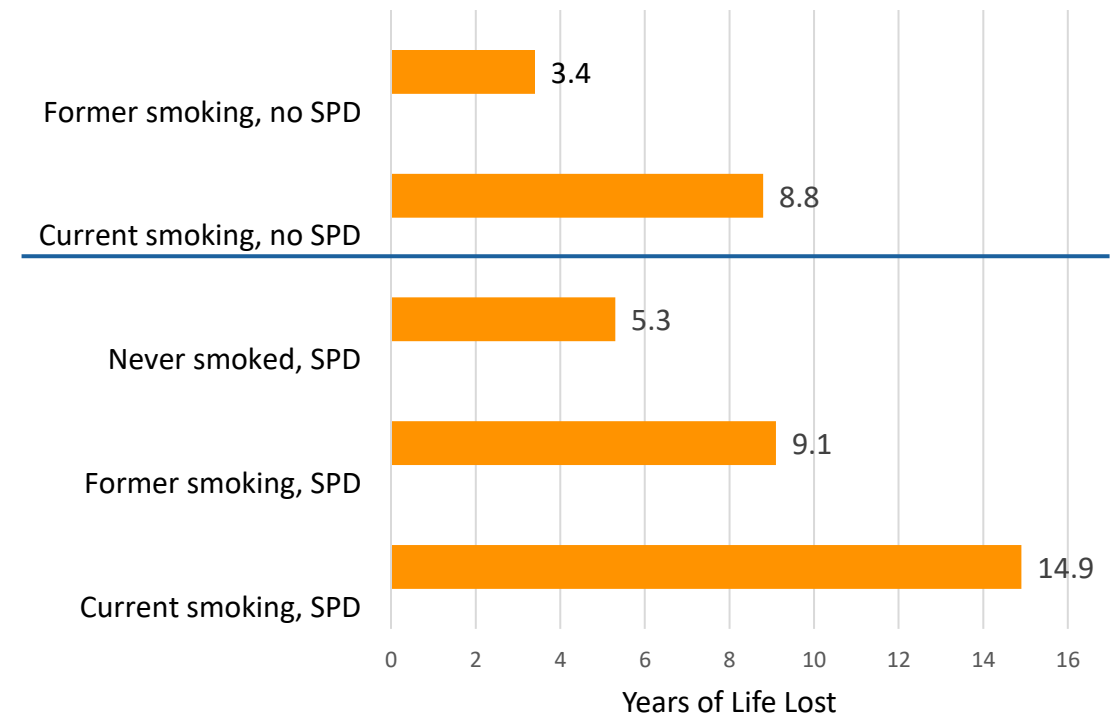
- 1. Reduce health inequities between the most and least harmed**
- 2. Maximize the health of groups disproportionately harmed**
- 3. Build data infrastructure to monitor health equity progress**

1. Reduce inequities between the most and least harmed

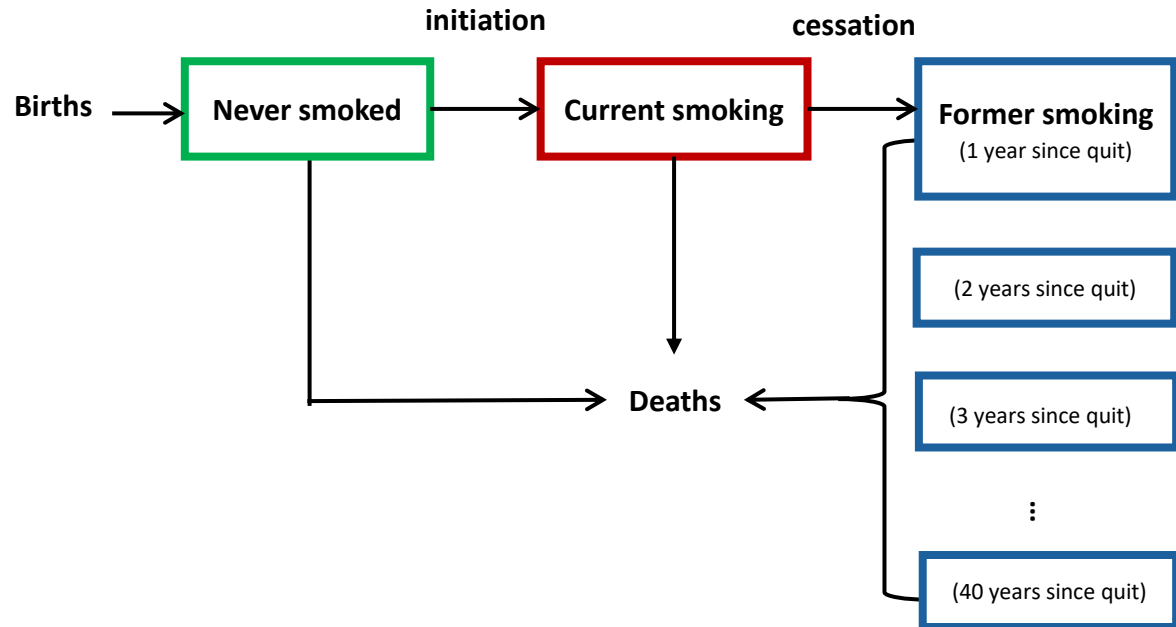
- People with Serious Psychological Distress (SPD) comprise 3.7% of the US adult population
 - Kessler-6 item scale screens for serious mental illness in general population
 - Scores ≥ 13 = SPD
 - Scores < 13 = No SPD.
- Current smoking by SPD status

2021	Total	SPD	No SPD
Men	13.1%	32.5%	12.6%
Women	10.1%	15.7%	9.3%

Life expectancy reduction by smoking and SPD status at age 40



Modeling smoking among people with and without SPD



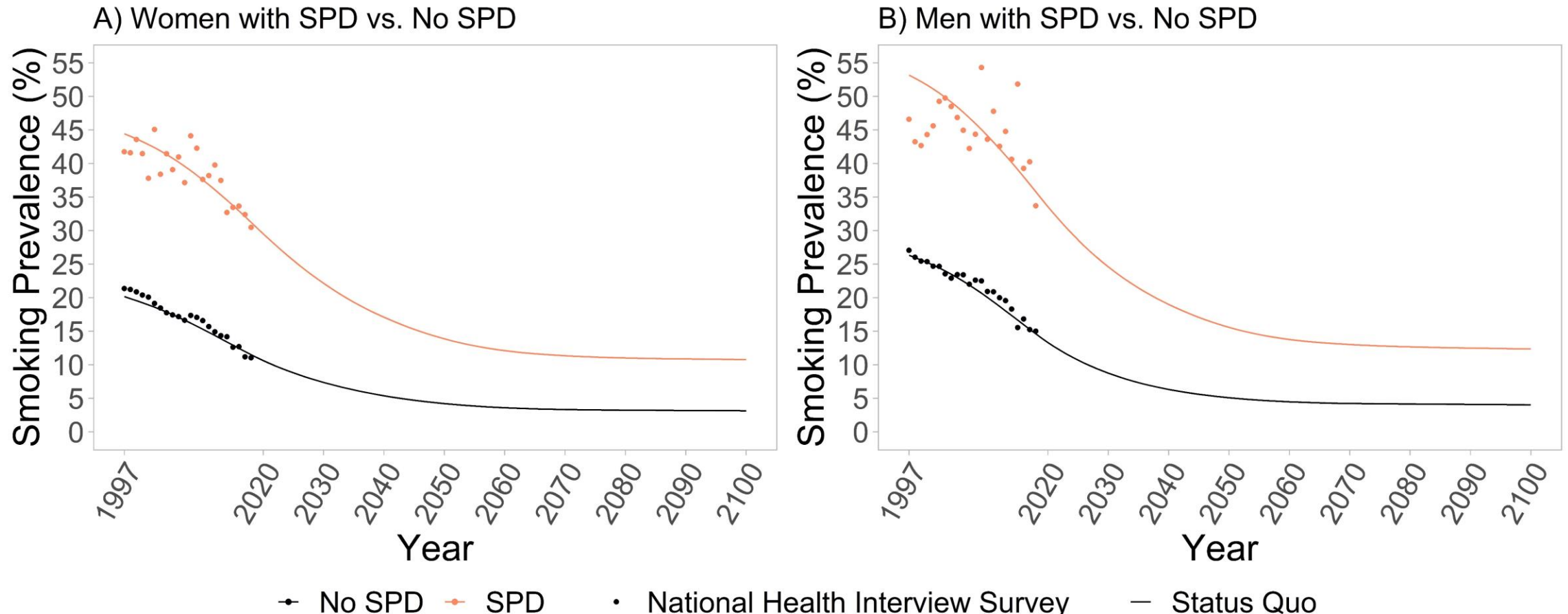
- Smoking-attributable deaths

$$= \sum_{a,g} P \left(prev_{cs} \times (\mu_{cs} - \mu_{ns}) + prev_{fs} \times (\mu_{fs} - \mu_{ns}) \right)$$

- Years of life lost = $(e_{ns,a,g} \times SAD_{a,g})$.

- Populations modeled separately based on proportion with and without SPD by gender and age group in NHIS
- Dynamics of psychological distress not modeled
- CISNET annual initiation and cessation probabilities by age, gender, birth cohort
 - Calibrated for the SPD population

Smoking among people with and without serious psychological distress (SPD)



How will smoking disparities by SPD status change over time?

Smoking disparity measures for adults with and without serious psychological distress, Status Quo scenario, 2023-2100

	Year	2023	2040	2060	2080	2100	Change from 2023-2100
Women	SPD smoking prevalence	27.0%	17.0%	12.0%	10.9%	10.7%	-60%
	Non-SPD smoking prevalence	9.4%	5.4%	3.6%	3.2%	3.1%	-67%
	Absolute difference	17.6%	11.6%	8.4%	7.7%	7.6%	
	Relative difference	1.9	2.1	2.3	2.4	2.5	
	Prevalence ratio	2.9	3.1	3.3	3.4	3.5	
Men	SPD smoking prevalence	30.1%	18.7%	13.6%	12.5%	12.2%	-59%
	Non-SPD smoking prevalence	11.5%	6.3%	4.5%	4.1%	4.0%	-65%
	Absolute difference	18.2%	12.0%	9.6%	8.4%	7.6%	
	Relative difference	1.6	2.0	2.0	2.0	2.1	
	Prevalence ratio	2.6	3.0	3.0	3.0	3.1	

1. Reduce inequities between the most and least harmed

- Whether smoking-related disparities will improve or worsen over time depends on what type of metric is used
 - Absolute metrics: overall population trends
 - Relative metrics: fairness as principle
- Health equity, in relative terms, is a moving target if advantaged groups continue to benefit from tobacco control progress
- Both absolute and relative metrics should be used

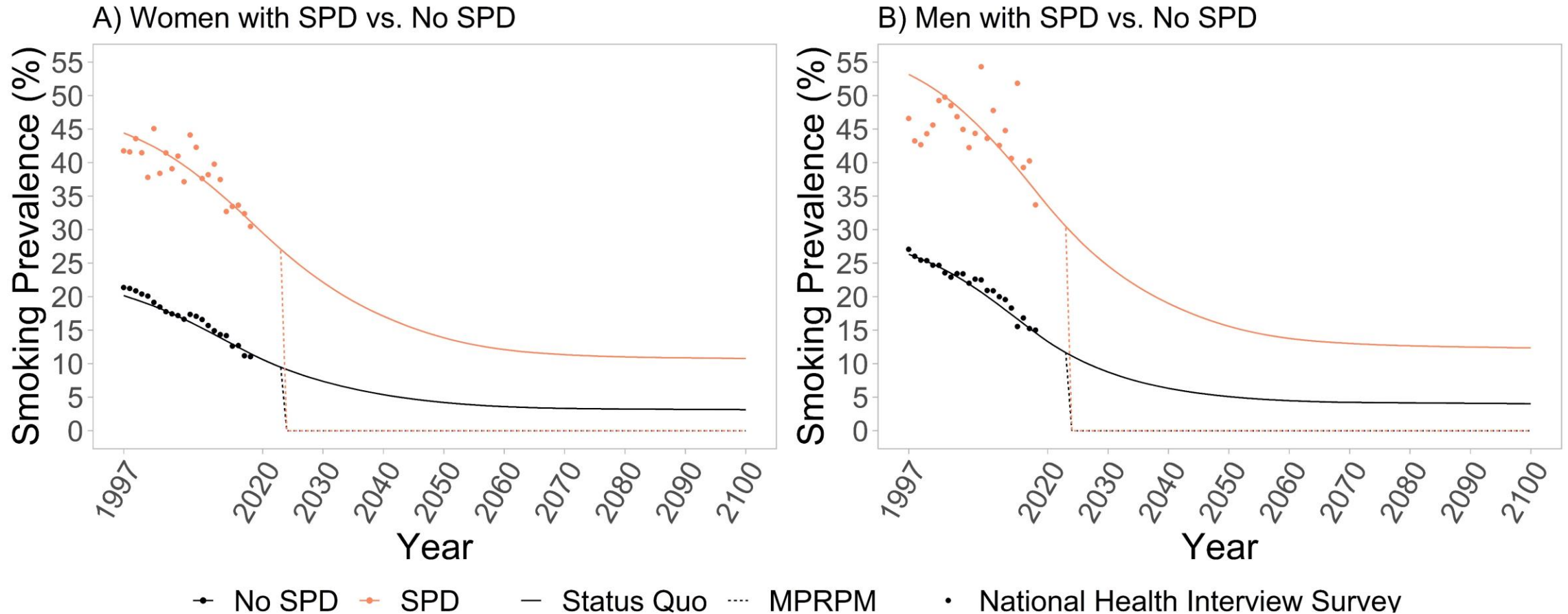
2. Maximize the health of groups disproportionately harmed

- Maximum Potential Reduction in Premature Mortality (MPRPM)
 - All individuals who smoke immediately quit in 2024
 - No new smoking initiation occurs from 2023 to 2100.

What is the relative contribution of prevention vs cessation to the MPRPM?

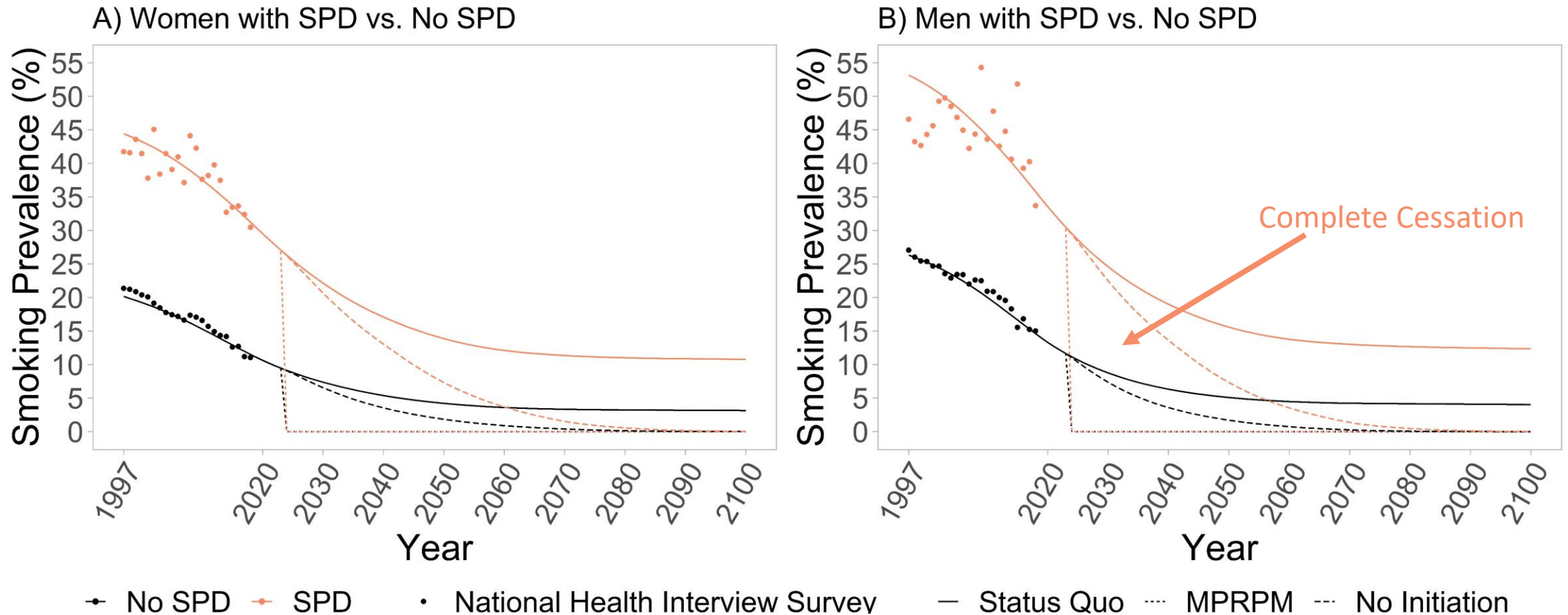
- No Initiation
 - No new smoking initiation occurs from 2023 to 2100
 - Cessation rates remain unchanged
- Complete Cessation = MPRPM – No Initiation

Smoking among people with and without serious psychological distress (SPD)



Calibrated to NHIS 1997-2018;
NHIS did not collect SPD data in 2019-2020.

Smoking among people with and without serious psychological distress (SPD)



Calibrated to NHIS 1997-2018;
NHIS did not collect SPD data in 2019-2020.

The impact of cessation on mortality reductions

SPD	Cumulative premature deaths averted					Cumulative life-years gained				
Year	No-Initiation scenario	MPRPM scenario	Difference (Complete cessation)	No-Initiation as % of MPRPM	Complete Cessation as % of MPRPM	No-Initiation scenario	MPRPM scenario	Difference (Complete cessation)	No-Initiation as % of MPRPM	Complete Cessation as % of MPRPM
2030	0	22,209	22,209	0.0%	100.0%	0	300,086	300,086	0.0%	100.0%
2040	1	79,510	79,509	0.0%	100.0%	11	1,151,416	1,151,405	0.0%	100.0%
2050	20	152,795	152,775	0.0%	100.0%	371	2,121,556	2,121,185	0.0%	100.0%
2060	843	221,366	220,523	0.4%	99.6%	19,713	2,949,742	2,930,029	0.7%	99.3%
2070	6,531	275,751	269,220	2.4%	97.6%	140,960	3,584,136	3,443,176	3.9%	96.1%
2080	21,484	318,331	296,847	6.8%	93.3%	432,082	4,088,688	3,656,606	10.6%	89.4%
2090	43,066	353,509	310,443	12.2%	87.8%	797,883	4,527,661	3,729,778	17.6%	82.4%
2100	69,868	385,513	315,645	18.1%	81.9%	1,178,656	4,927,790	3,749,134	23.9%	76.1%

Smoking among people with major depressive episodes

- 8.4% of US adults with Current Major Depressive Episode (MDE)
 - 21.0 million adults
 - Men: 6.1%
 - Women: 10.5%
- MDE = 2 week+ period during which the respondent reports experiencing at least 5 of 9 symptoms (DSM-IV/5) in the past year
 - No exclusions due to illness, mourning, substance use disorders, or other psychiatric disorder

- Past 30-day cigarette smoking prevalence by MDE status

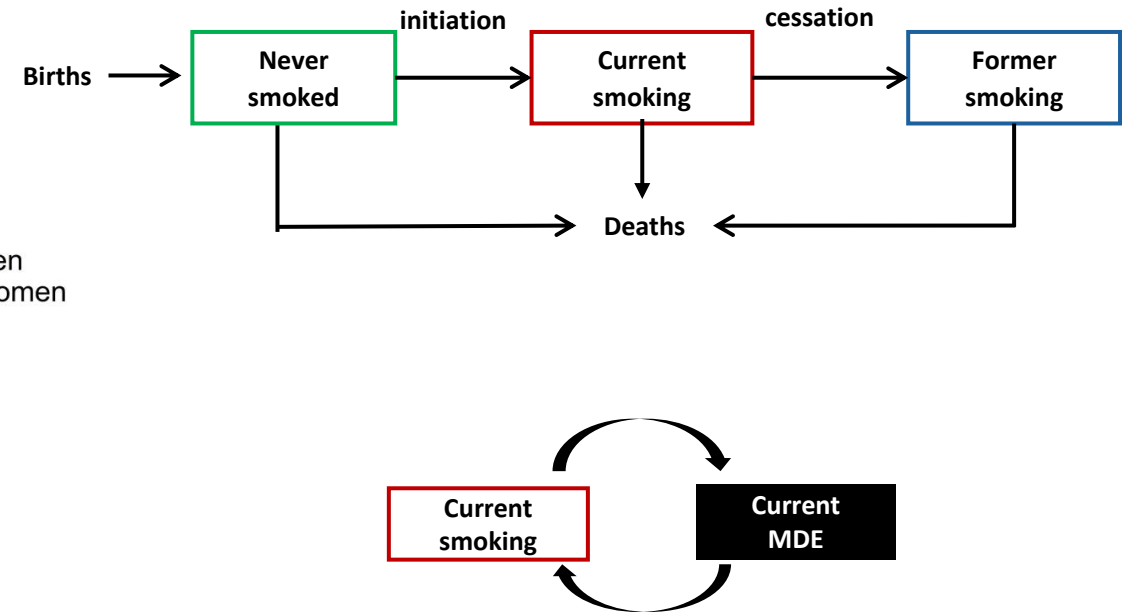
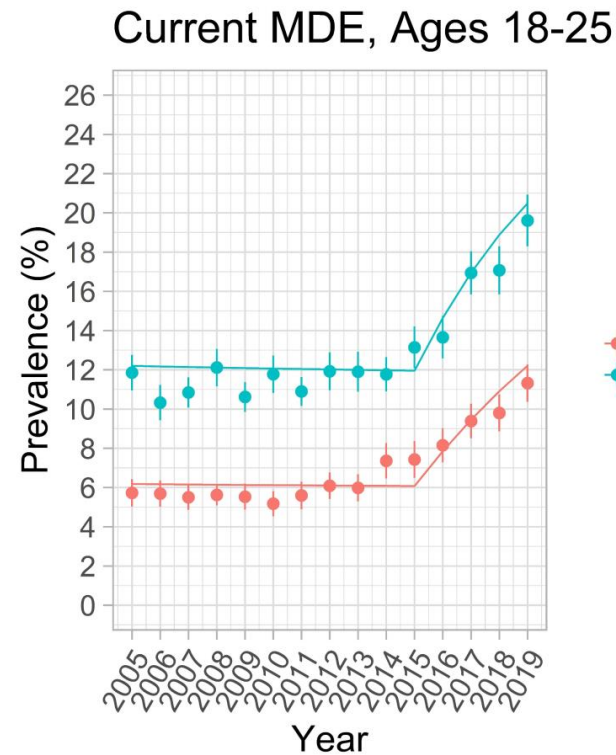
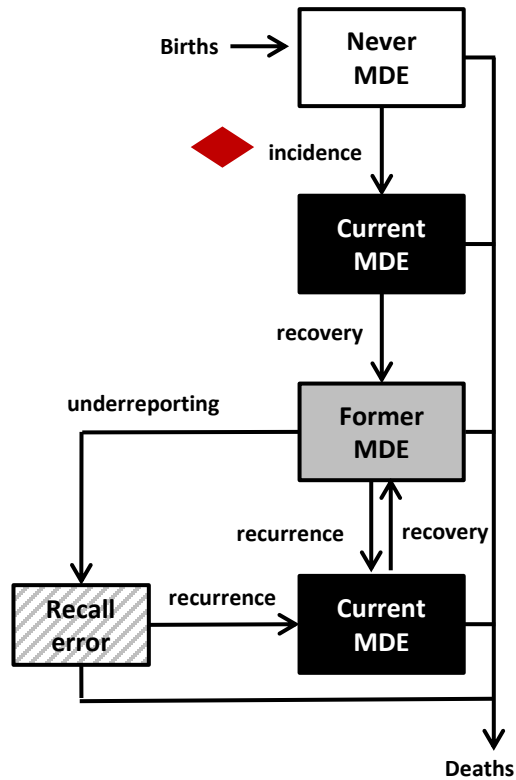
2020	Total, Ages 18+	Current MDE	Never MDE
Men	17.5%	24.4%	16.7%
Women	14.6%	22.4%	12.6%

- Most public and private mental health settings do not offer smoking cessation treatment
 - 37.6% report offering cessation counseling
 - 25.2% report offering NRT

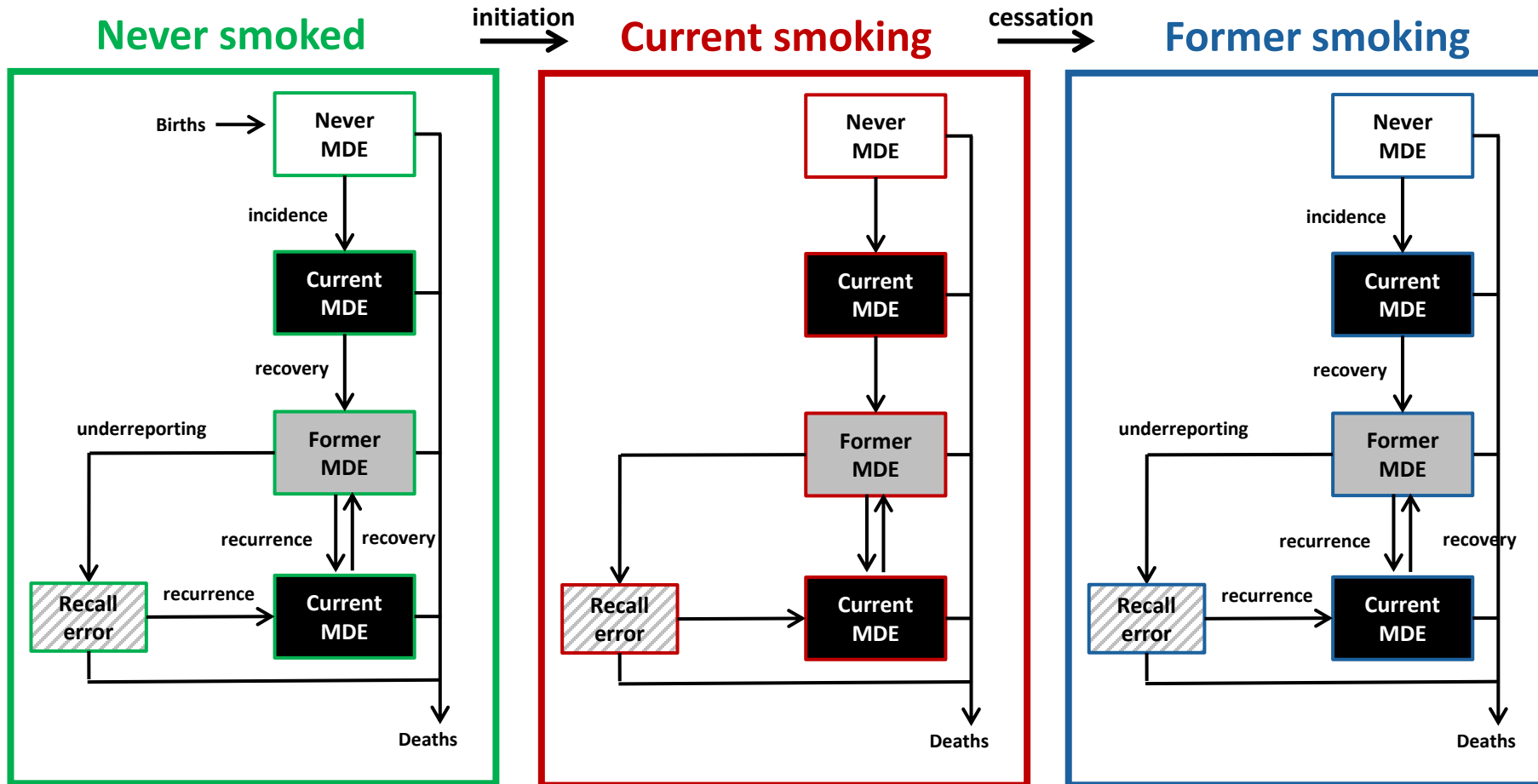
Cessation treatment in mental health settings

- Systematic review of cessation treatment RCTs among patients with MD evaluated long-term cessation:
 - Pharmacological Treatment Risk Ratio = 1.588 (95% CI: 1.230-2.049)
 - Varenicline, nicotine gum, fluoxetine, bupropion, nicotine patch
- Evaluate and quantify the potential missed opportunity for tobacco control by modeling 'what if' scenarios:
 - Cessation treatment used by all patients in mental health settings?
 - Increased mental health service and cessation treatment utilization?
 - Cessation treatments became more effective?
- Compare best case 'treatment' scenarios with best case 'cessation' scenario
 - Maximum Potential Cessation (MPC) scenario

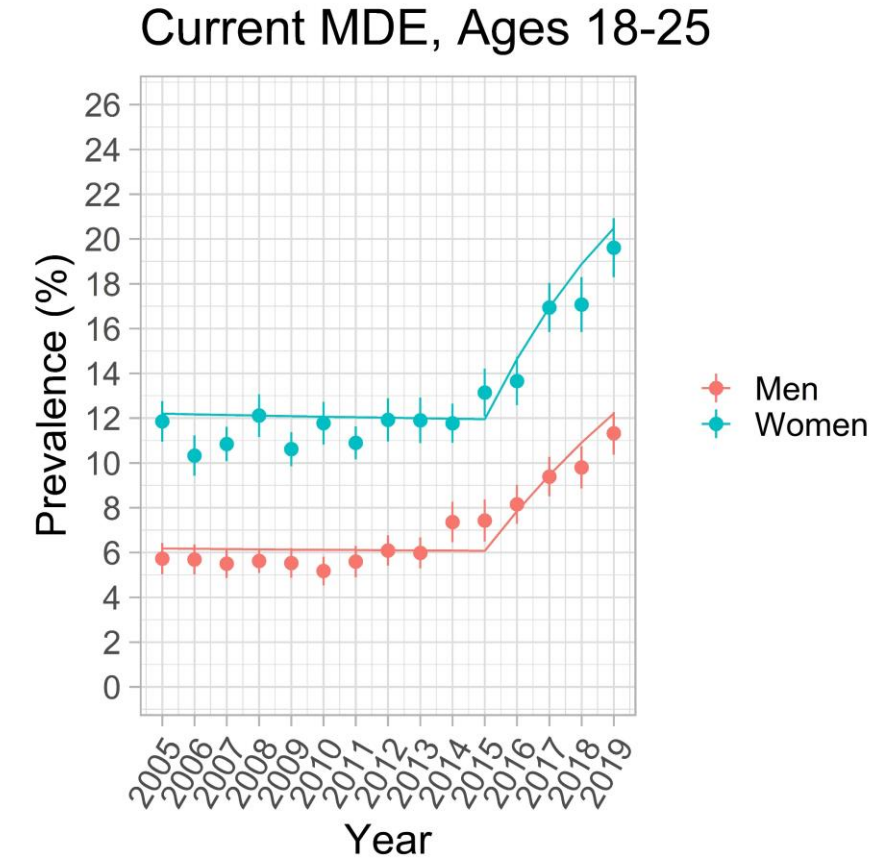
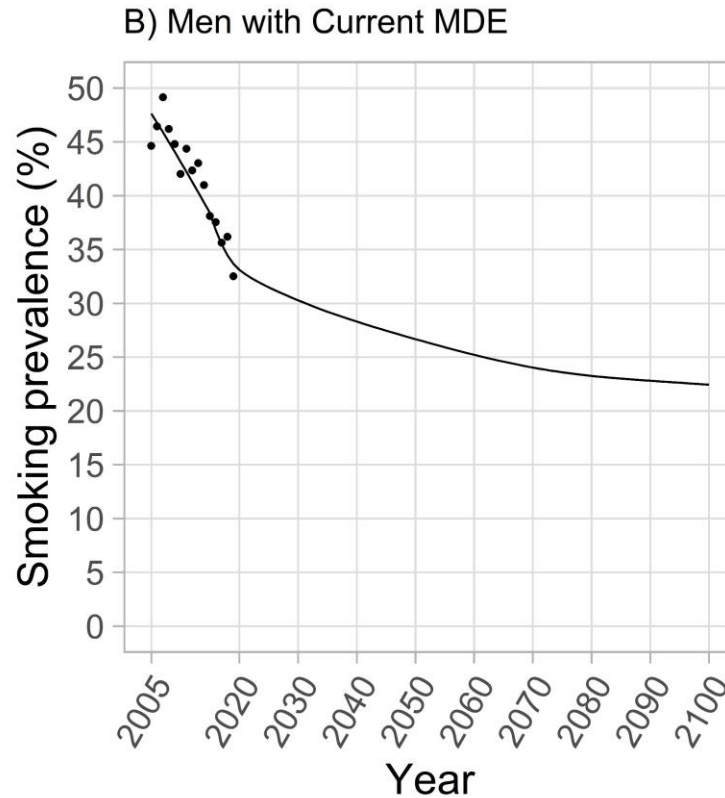
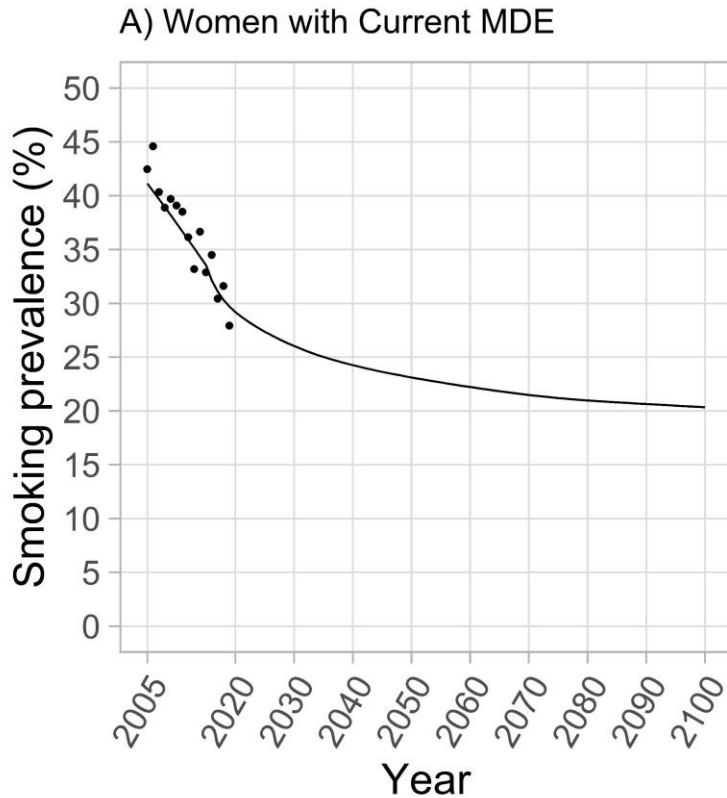
Model development and calibration



Major Depression and Smoking (MDS) model



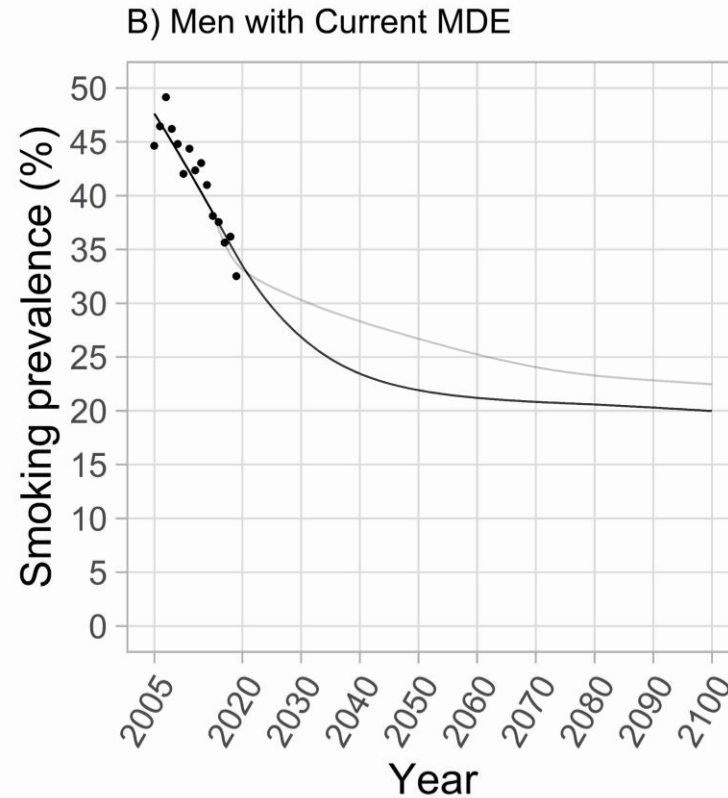
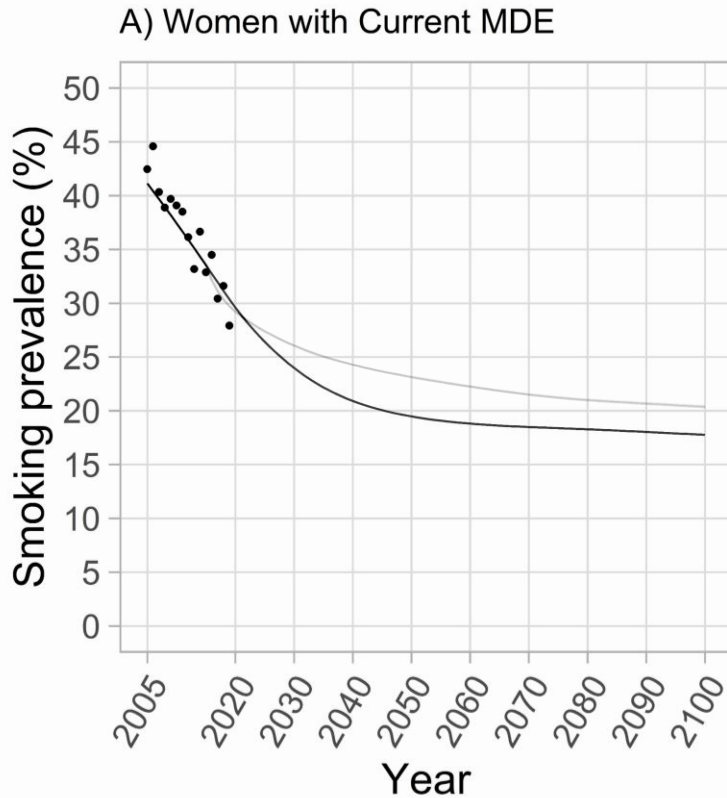
Model projections under baseline scenario



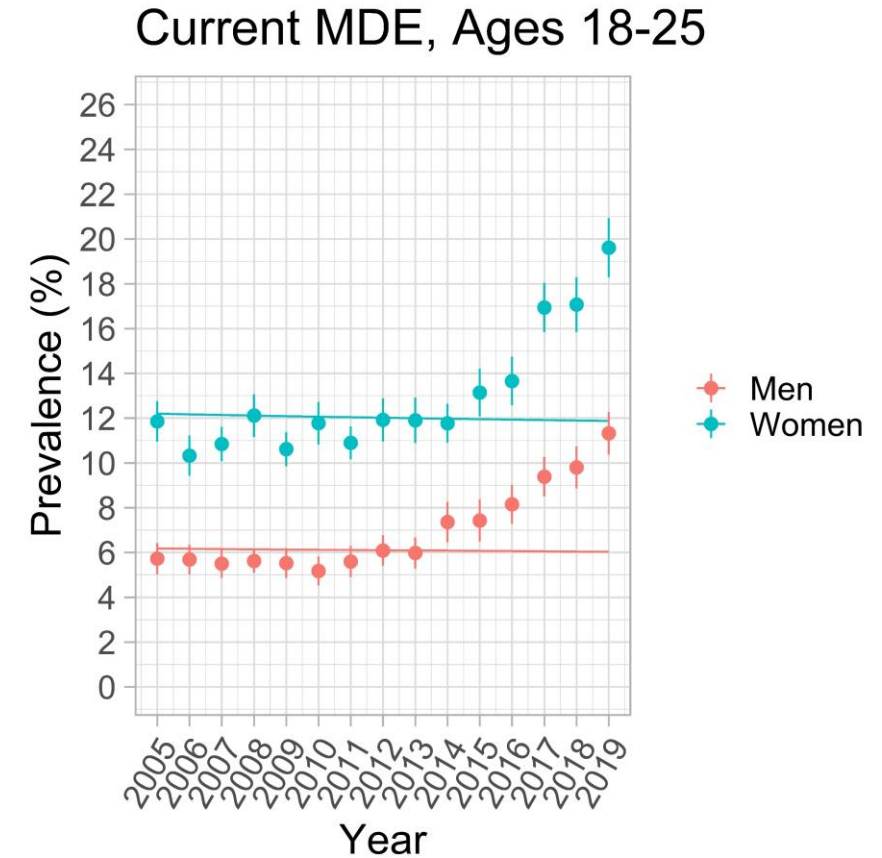
• NSDUH — Baseline

Current smoking is defined as smoking at all within the past year and smoking at least 100 lifetime cigarettes. This models permanent smoking cessation and accounts for high rates of relapse within the first year of quitting. Model calibrated to NSDUH 2005-2019 data.

Model projections under baseline scenario, No MDE increase

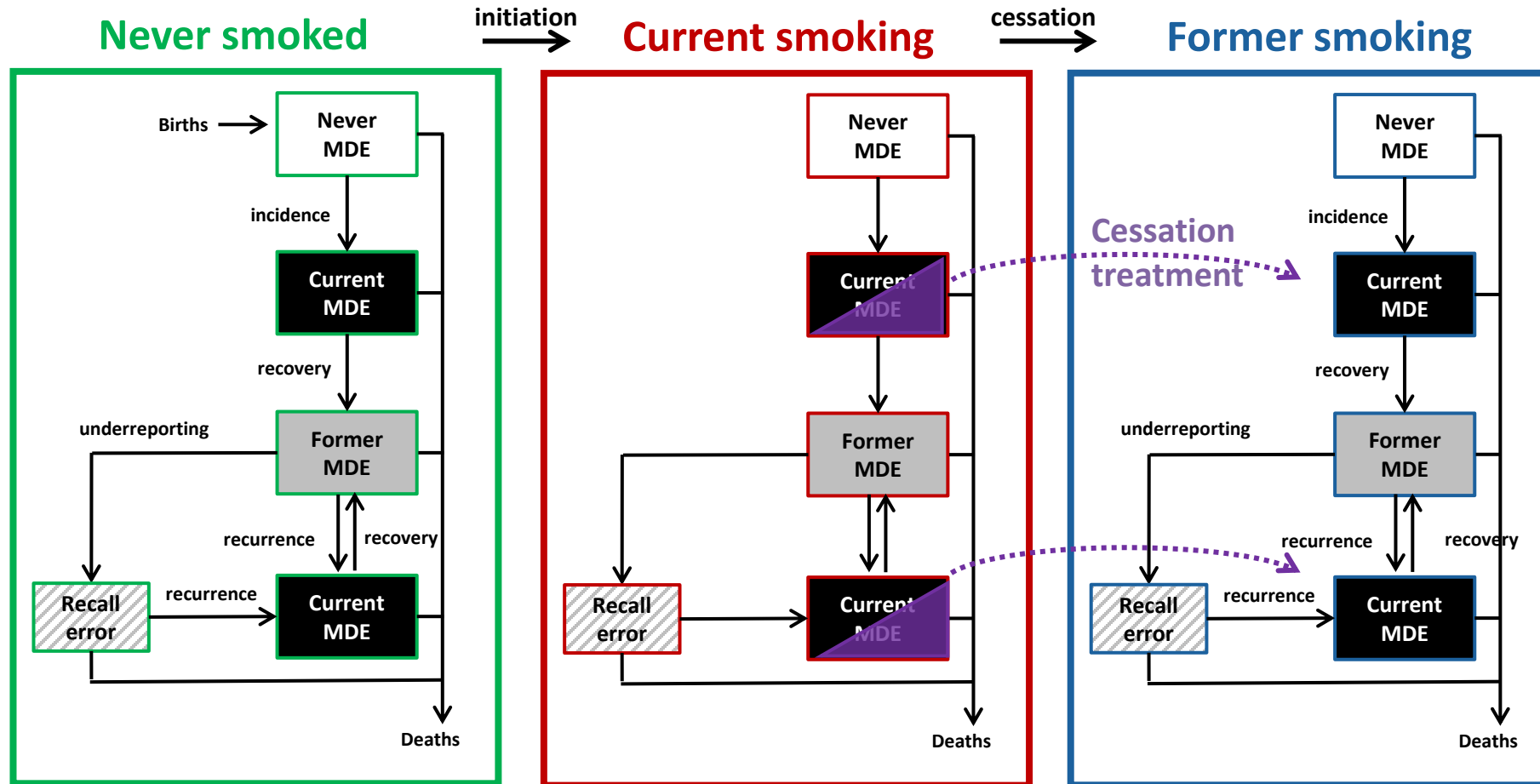


• NSDUH — Baseline



Current smoking is defined as smoking at all within the past year and smoking at least 100 lifetime cigarettes. This models permanent smoking cessation and accounts for high rates of relapse within the first year of quitting. Model calibrated to NSDUH 2005-2019 data.

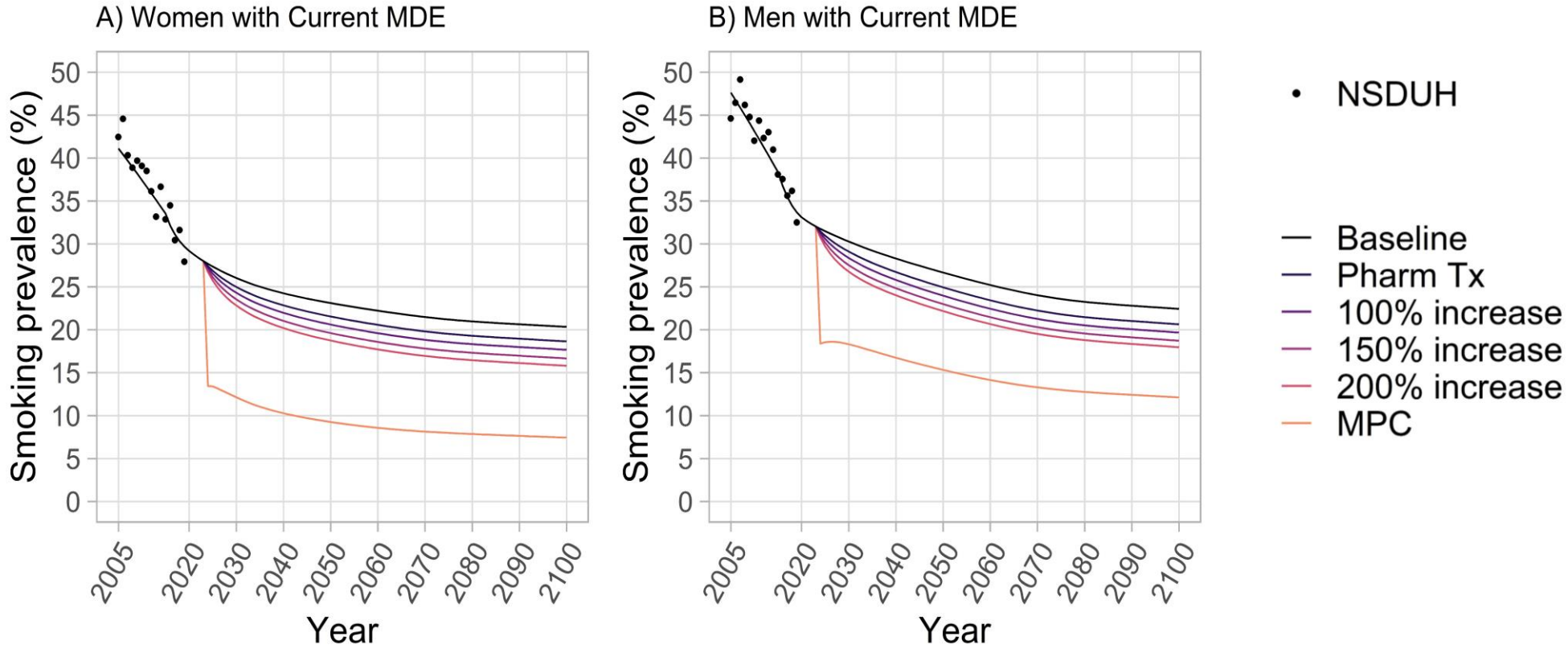
MDS model with intervention



Mental health service utilization =
Proportion of current smoking adults with MDEs who self-report seeing a health professional for their depression

Age group	Women	Men
18-25	49.6%	37.5%
26-34	62.3%	44.8%
35-49	70.7%	54.1%
50-64	73.3%	66.1%
65+	67.6%	59.0%
Total	65.8%	51.3%

Intervention scenarios, 2024-2100



Current smoking is defined as smoking at all within the past year and smoking at least 100 lifetime cigarettes. This models permanent smoking cessation and accounts for high rates of relapse within the first year of quitting. Model calibrated to NSDUH 2005-2019 data.

Intervention outcomes for adults with MDEs, 2024-2100

effectiveness



2024-2100	Mental health service utilization	Cessation treatment intervention (% of MPC)				
		Pharm Tx (58.8% increase)	100% increase	150% increase	200% increase	MPC
Premature deaths avoided (thousands)	No change from baseline	98 (19.2%)	150 (29.4%)	200 (39.2%)	239 (47%)	509
	Increase by 10%	106 (19.7%)	161 (30.1%)	215 (40.1%)	257 (48%)	534
	Increase by 20%	115 (20.4%)	175 (31.1%)	232 (41.3%)	277 (49.3%)	562
	100%	158 (23.9%)	237 (35.9%)	310 (46.9%)	365 (55.2%)	662
Life years gained (millions)	No change from baseline	0.4 (18.7%)	0.7 (28.8%)	0.9 (38.5%)	1.1 (46.2%)	2.3
	Increase by 10%	0.5 (19.2%)	0.7 (29.4%)	1 (39.3%)	1.2 (47.1%)	2.5
	Increase by 20%	0.5 (19.8%)	0.8 (30.2%)	1 (40.3%)	1.2 (48.2%)	2.6
	100%	0.7 (23.2%)	1.1 (34.9%)	1.4 (45.7%)	1.7 (54%)	3.1

E-cig vs NRT for cessation:
RR=1.63
(1.30-2.04)

uptake



2. Maximize the health of groups disproportionately harmed

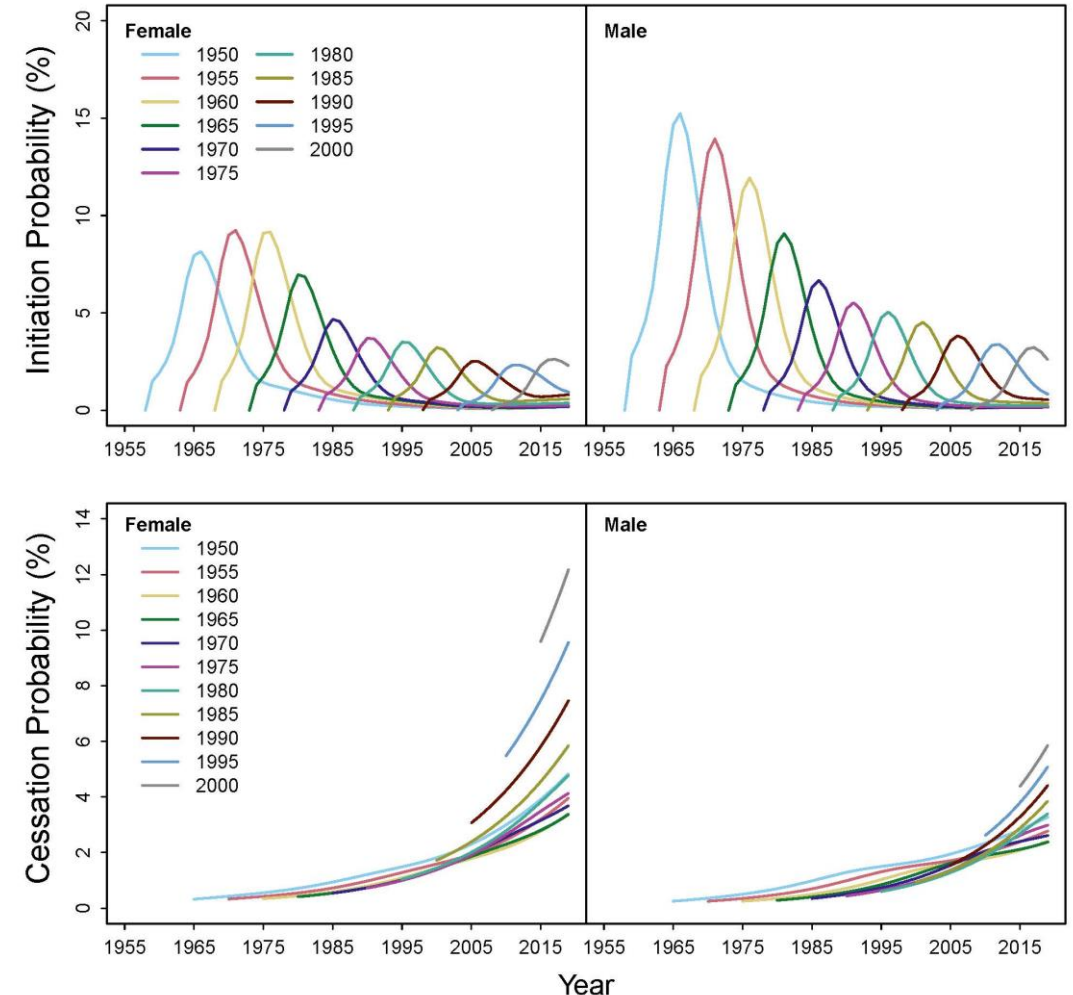
- Cessation improvements achieve largest health gains compared to initiation
- Smoking projections influenced by underlying dynamics in populations of interest
 - Unclear whether rising MDEs among young adults are period vs cohort effects
- Health gains from cessation treatments are modest even under highly optimistic conditions
 - Providing cessation treatment to patients with MDEs would reduce smoking-related mortality
 - But cessation treatments need to be much more effective
- Bolder strategies are needed to complement treatment interventions
 - Pharmacological interventions are necessary but not sufficient to achieve health equity goals

3. Build data infrastructure to monitor health equity progress

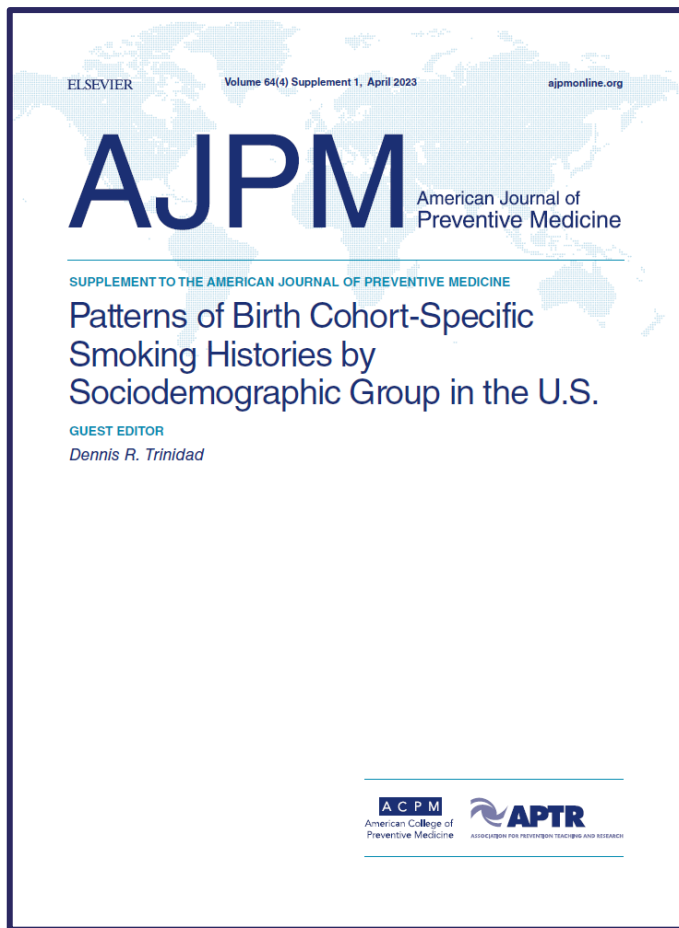
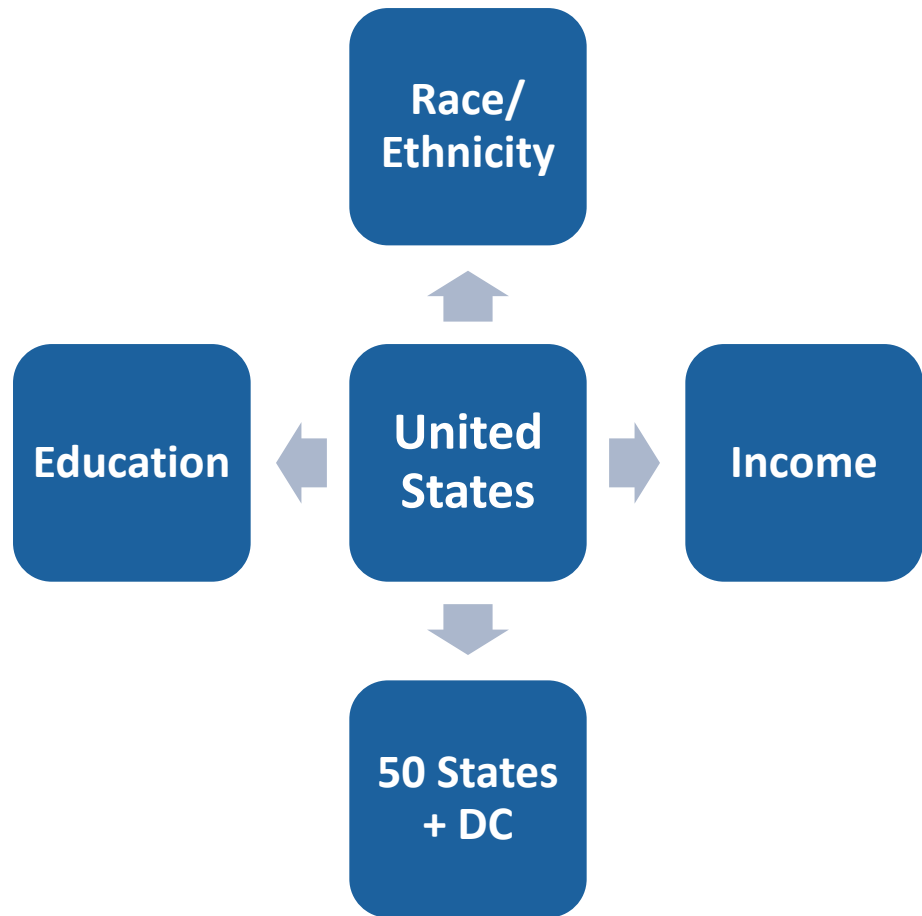
- Smoking prevalence alone is not the most informative
 - Comprised of distinct behaviors addressed through different intervention strategies:
 - Initiation, cessation, smoking intensity, transition behaviors
- Changing patterns by birth cohort are essential to understand both past and future
- Detailed data necessary for population models of disparate groups are often lacking
- Cancer Intervention and Surveillance Modeling Network (CISNET) age, period, and cohort analyses generates detailed smoking histories used in many tobacco simulation models

Age-Period-Cohort Analyses

- NHIS 1965-2018
- APC logistic regression models
- Temporal APC effects modeled using constrained natural splines
- Smoking initiation, cessation, intensity, prevalence, duration by age, year, gender, and birth cohort
- Parameters ready-for-use as inputs to simulation models



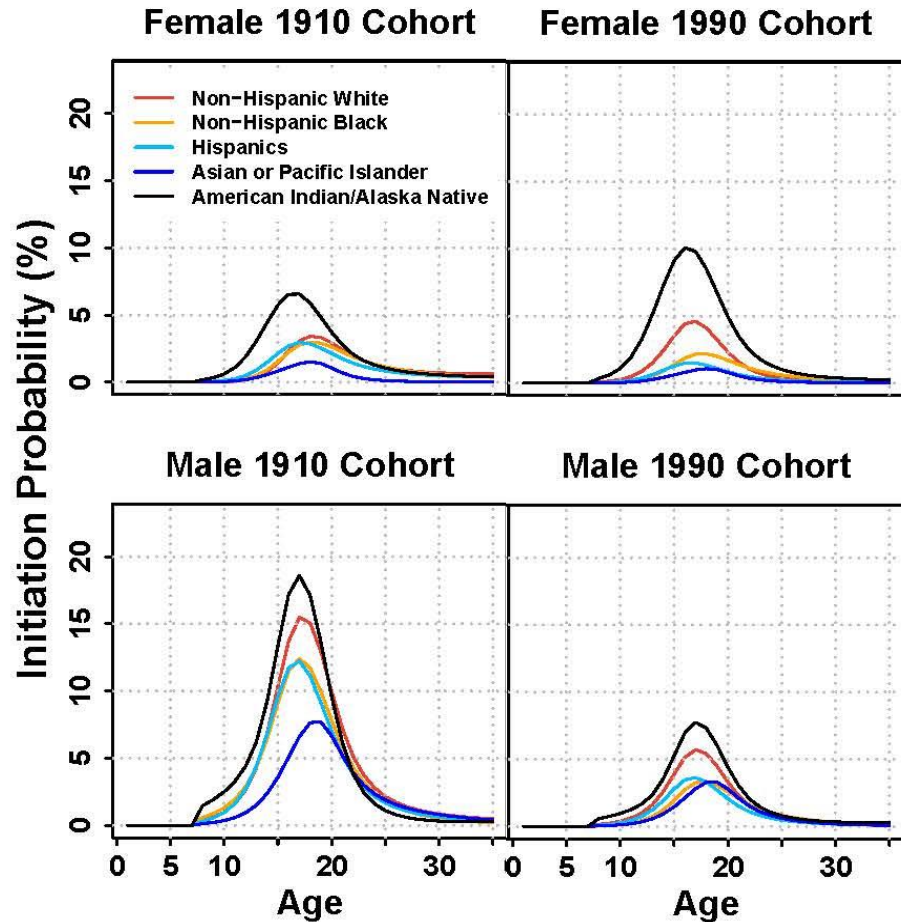
Extensions of the Age-Period-Cohort Framework for US Population Smoking Histories



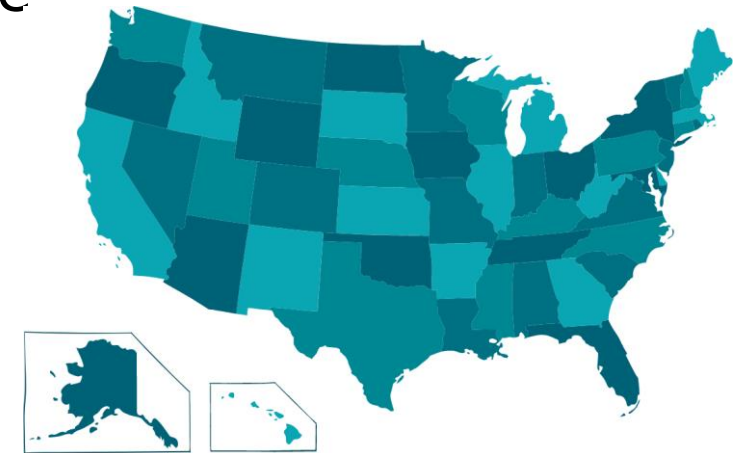


Race/Ethnicity

50 States + DC

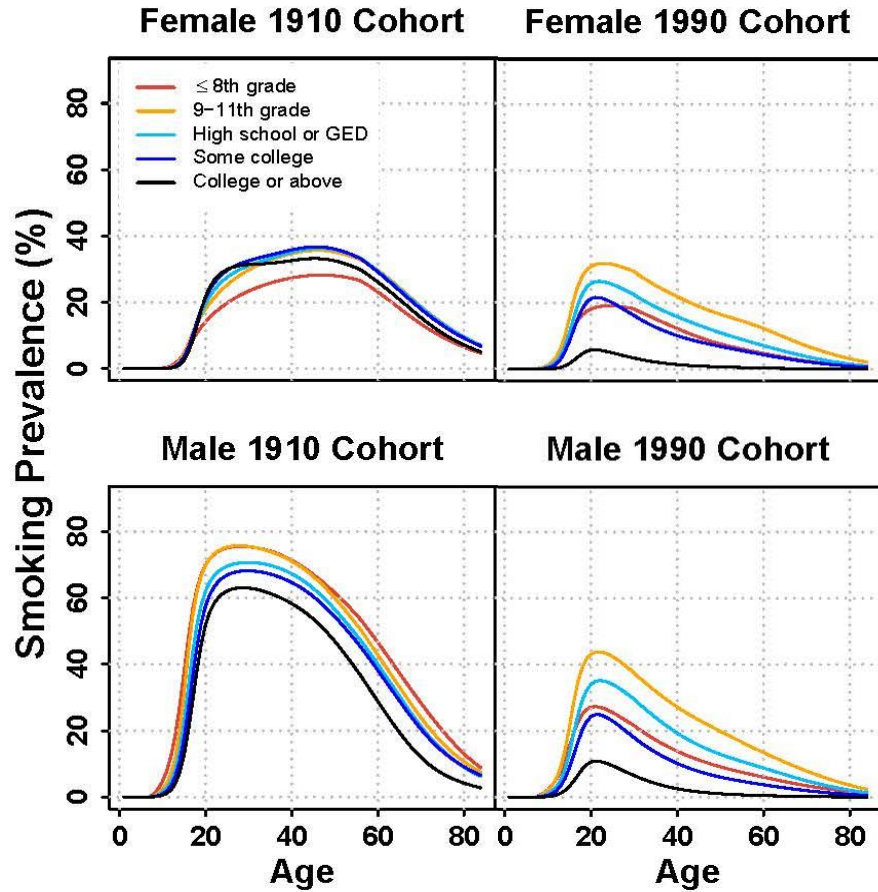


- NHIS 1965-2018
 - Age effects for ever smoking
- TUS-CPS 1992-2019
 - Variation in smoking histories by state

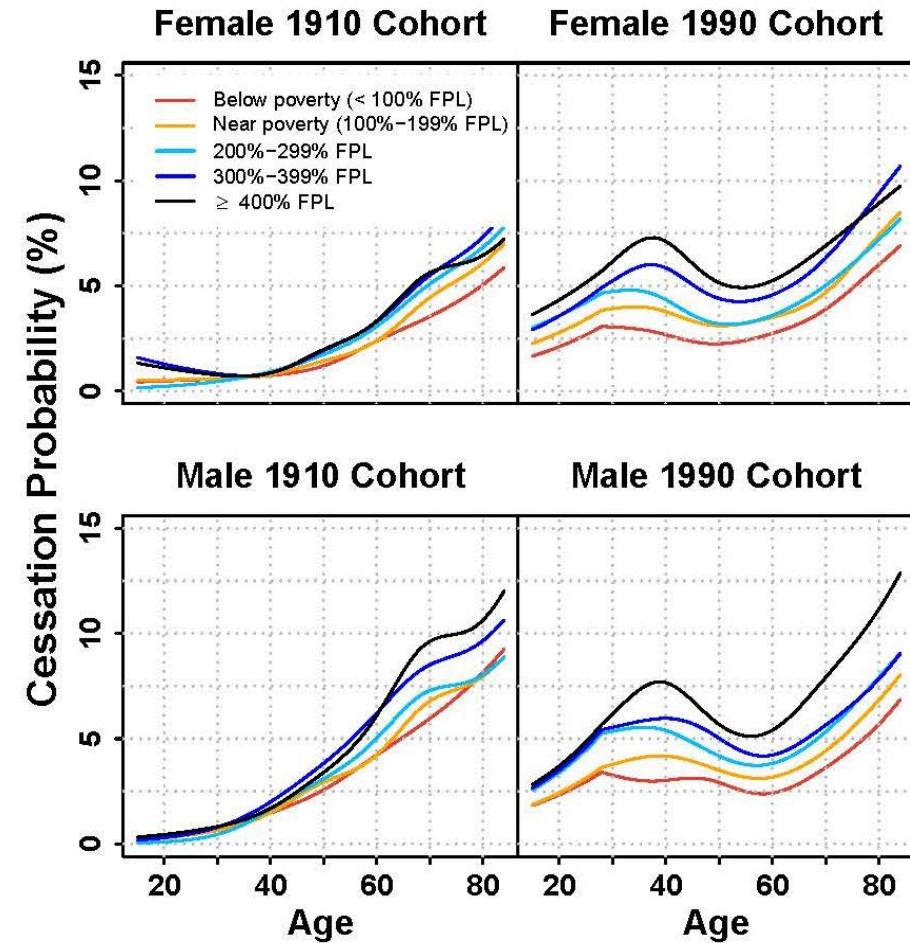




Educational attainment



Family income



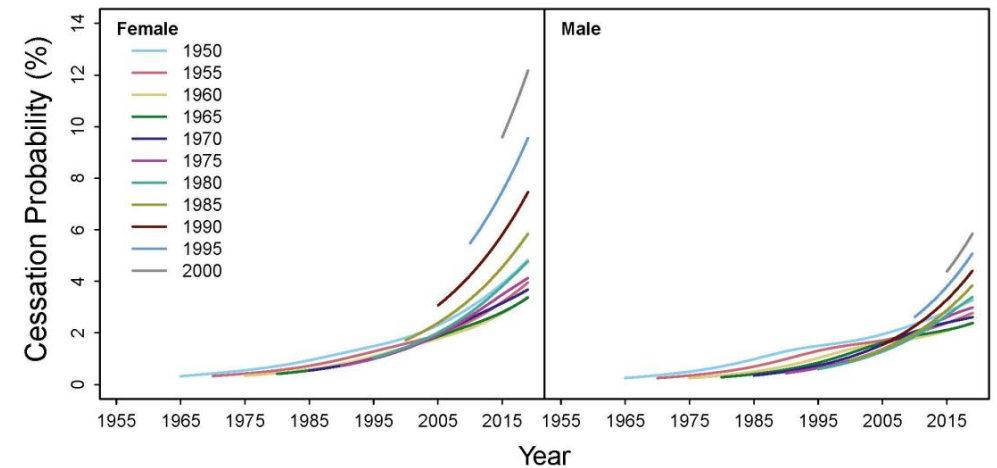
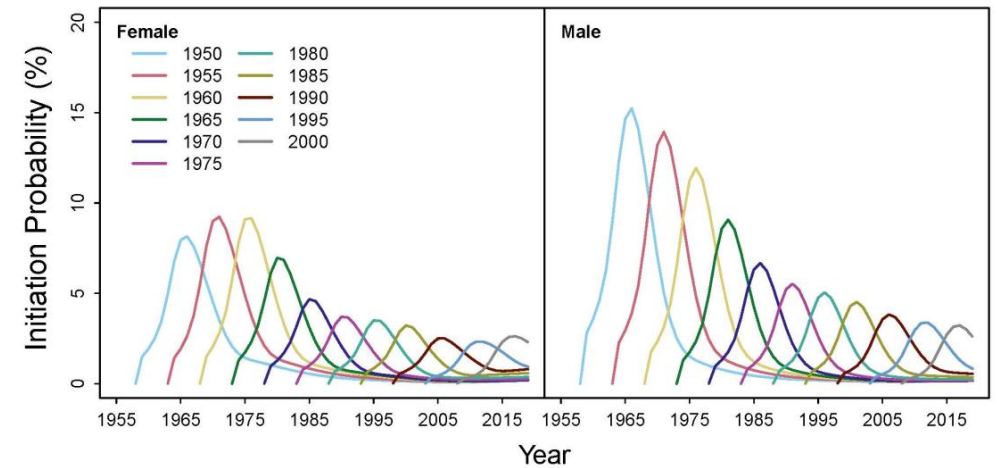


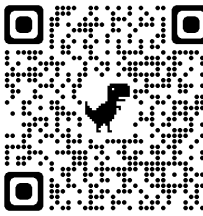
Global Disparities

Extending APC framework to generate detailed historical smoking patterns by birth cohort in

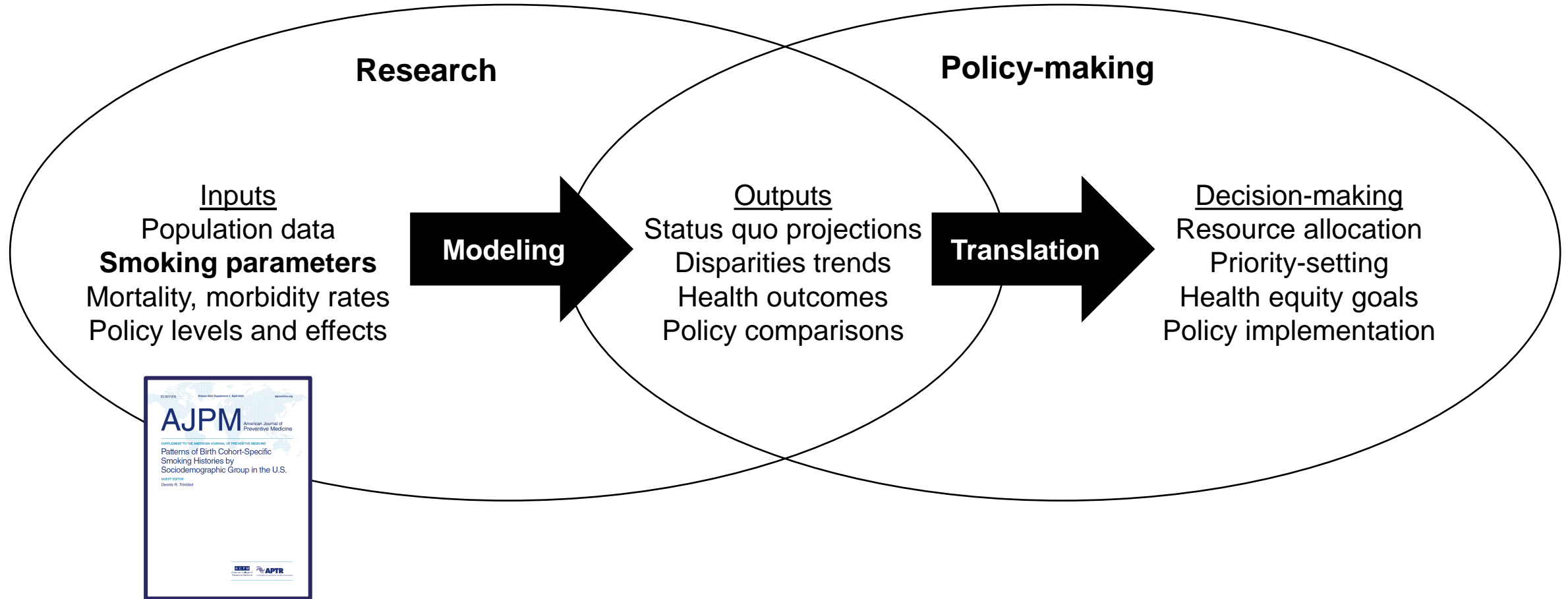
- Brazil
- Mexico (underway)
- Argentina (underway)

Poster Session 4
Poster # 048
Today 4:45-
6:15pm





Research and policy planning strategy



3. Build data infrastructure to monitor health equity progress

- Surveillance and data infrastructure deficits hinder health equity research and policy progress
- Smoking parameters will soon be publicly available for download at apps.cisnetismokingparameters.org
- Detailed cohort-specific inputs can support modeling research for priority populations
- Opportunities for APC framework to be extended to other countries with limited data

Looking Ahead

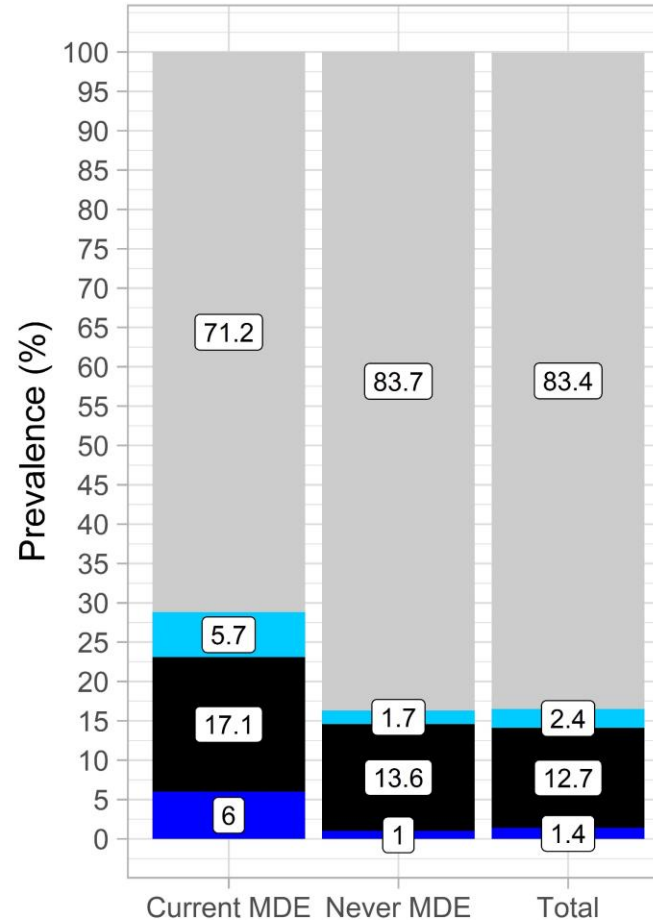
- E-cigarette use in models by mental health status

Looking Ahead

- Higher e-cig and dual use among people with MDEs and SPD

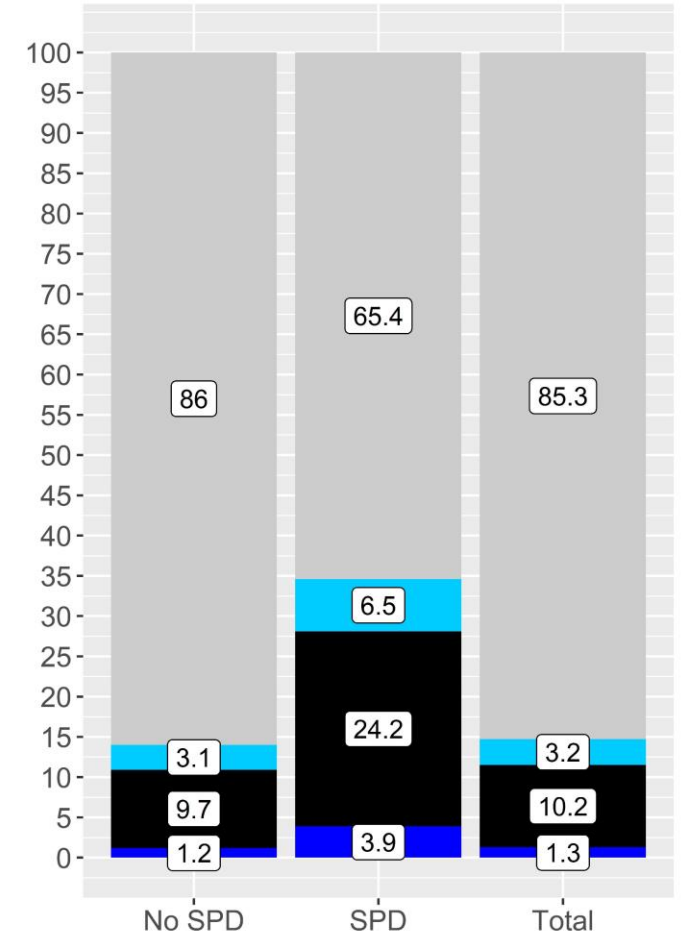


Past 30 day tobacco use



NSDUH 2020

Current tobacco use



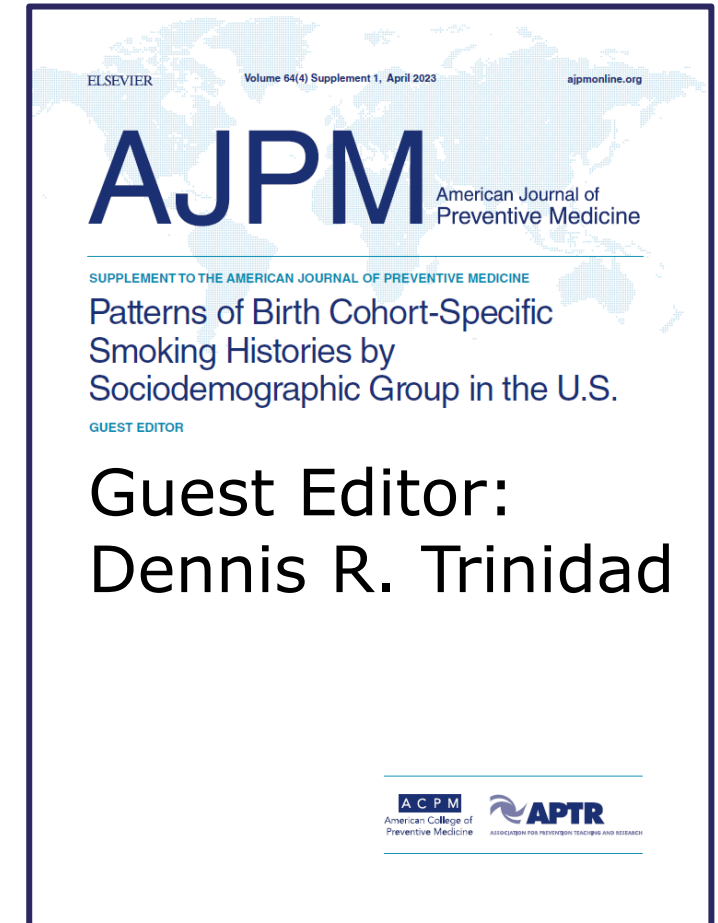
NHIS 2021

Looking Ahead

- E-cigarette use in models by mental health status
- E-cigarette and cigar use by race/ethnicity, education
- COVID-19 impacts on tobacco use behaviors
- Reduced nicotine cigarette policy and implications for health equity
- Extend models to include morbidity and economic outcomes
- Model diverse populations as the rule, not the exception
- Health equity as the tobacco endgame

CISNET Supplement Authors

- Pianpian Cao
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- Chosen Family
- Family