The Effects of Smoking Cessation on Mental Health: Evidence from a Randomized Trial

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Overview

Disclosures

- We have not received any funding for this project
- We have not received any tobacco-related funding in the past
- There are no additional conflicts of interest to disclose

Overview

Smoking and Mental Health

- Smoking is harmful to the smoker and those around them
  - Anti-tobacco policies deter take-up (e.g., taxes) or encourage cessation (e.g., nicotine replacement therapy)
  - Should take into account unintended effects on mental health
- Mental illness is costly
  - 1 in 5 adults in the U.S. in 2019 (SAMHSA 2020)
  - Treatment increases earnings, improves physical health, and increases parental investments in children (Ridley et al. 2020)

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Relationship between Smoking and Mental Health

- Those with mental illness are 2-3x more likely to be smokers
  - Causal mechanisms not well-understood
    - ★ Hypothesis 1: smoking $\rightarrow$ worse mental health
    - ★ Hypothesis 2: poor mental health $\rightarrow$ smoking
    - ★ Hypothesis 3: not causally related, coincide due to SES, genetics, etc.
- Effects of nicotine
  - Psychoactive drug, acts as stimulant and depressant
    - ★ may worsen OR relieve anxiety & depression (Picciotto et al, 2002)
  - Use of nicotine as "self-medication" (hypothesis 2)
    - ★ teenagers initiate begin after stressful events (Friedman, 2020);
    - ★ smokers report smoking improves mood (withdrawal?)

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Relationship between Smoking and Mental Health

- Effects unrelated to nicotine
  - Behavioral changes
    - ★ alcohol as complement (Dee, 1999); social activities
  - Depression due to decline in physical health
- Thus, smoking and mental health may be related in many ways
  - comparisons of mental health b/w smokers and non-smokers are likely biased
  - need exogenous variation to estimate causal effects

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Lung Health Study

- Re-use data from the Lung Health Study (LHS).
  - Randomized controlled trial w/ smokers at risk for COPD
  - Goal: Study effect of prescription inhaler on COPD onset
  - Treatment: intensive cessation intervention + inhaler
  - Followed for the next five years
  - Randomization $\rightarrow$ clean estimation of causal effects
- Study participants included 5,887 at-risk smokers, age 35-65
  - recruited in 1987-1988 at 10 clinical centers in U.S. and Canada
  - no serious illnesses or plans to move away from the clinic area
  - Note, participants more White, college-educated, motivated to quit than average smoker

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Lung Health Study: Treatment

- Three equal groups: two treatment arms, one control arm
  - Treated individuals undergo cessation program in early 1989
    - ★ One group got prescription inhaler, other gets placebo
- Smoking cessation program:
  1. physician's message about lung impairment and disease risk
  2. "10 week, 12-session group program emphasizing cognitive and behavioral strategies for cessation"
  3. support from family members
  4. 6 months of nicotine gum

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Lung Health Study

- 5 years of follow-up (1990-1994)
  - Treated individuals return to clinic every 4 months
    - ⋆ Promote inhaler usage, prevent relapse
  - All individuals re-interviewd annually (5x)
    - ⋆ Health and healthcare info, pulmonary testing to validate cessation
- Success or failure?
  - Cessation program highly effective (sustained quit: 22% vs. 5%)
  - Attrition low (96% in year 5)
  - BUT inhaler had little added benefit, study deemed "failure" (Anthonisen et al, 1994)
    - ⋆ → Many measures left un-examined

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Prior Research using LHS to Estimate Causal Effects

- Increased cessation and lung function after 5 and 11 years (Kanner et al., 1996; Anthonisen et al., 1994; Anthonisen et al., 2002)
- Lower rates of respiratory illness at 5 years (Kanner et al., 2001)
- Reduction in mortality at 14.5 years (Anthonisen et al., 2005)
- No difference in alcohol usage at 1 year (Murray et al., 1996)
- Increase in BMI of .8 to 1.9 points, or 11-12 lbs for avg male (Courtemanche et al., 2018)
- Spouses also more likely to quit smoking (Fletcher and Marksteiner, 2017)

Overview

Data: Mental Health Outcomes

"Indicate the extent to which you have been troubled in the last four months by any of the following [conditions]: Severe (3), Moderate (2), Mild (1), or Not at all (0)."

- Irritability, insomnia, mood changes, nervousness, psych. illness
- **Distress Scale**$_{it}$ = sum scores across conditions, for i in year t
- **Severe Distress**$_{it}$ = share of conditions for which i indicates "severe" in year t

- List presc. drugs over last 12 months, bring bottles
  - **Anti-Depressant**$_{it}$ = any anti-depressant taken by i in year t
  - **Anti-Anxiety**$_{it}$ = any anti-anxiety drug taken by i in year t

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Data: Outcomes

- Short vs. Long-Run Effects of Quitting
  - differentiate b/w effects of nicotine withdrawal and long-term effects
    - withdrawal may affect 1st interview (+2 months after nic gum runs out)
  - For each outcome Y, define
    - $Y^{\text{short-run}} = Y_{i1}$
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Empirical Method

- We estimate the causal effect of cessation program as follows:

$$Y_i = \alpha + \beta \text{Treatment}_i + \epsilon_i \tag{1}$$

  - Y_i is a measure of smoking or mental health
  - $Treatment_i$ indicates i is assigned to either treatment arm
  - Adjust ϵ_i for heteroskedasticity across individuals
  - Alternative approach: IV using cigarettes per day

- Random assignment $\rightarrow$ $Treatment_i$ is independent of ϵ_i
  - Confirm balanced sample Here
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Gender Heterogeneity

- Existing evidence suggests heterogeneous effects by gender
  - Men historically more likely to smoke (Holford et al.2014)
  - Smoking activates male smokers' reward pathways more (Cosgrove et al. 2014), specifically tied to nicotine (Perkins and Karelitz, 2015)
- Estimate effects separately for men and women

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Smoking Behavior

- Treatment effects on long-run smoking behavior: Here
  - Sustained quitting ↑ 16.9 pp (307%)
    - ⋆ men are more responsive than women (337% vs. 262%)
  - Treatment works primarily to increase sustained quitting
    - ⋆ women somewhat more likely to relapse
  - Cigs/day ↓ 8.1 (38%)
    - ⋆ treatment also works on intensive margin
    - ⋆ similar % declines for men and women

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Mental Health Outcomes

- Treatment effects on long-run mental health: Here
  - Overall, small and insig. effects on distress scale
    - ⋆ for men, small and insig. increase
    - ⋆ for women, ↓ 0.25 (10%)
  - Effects by components of distress scale: Here and Here
    - ⋆ for women, insomnia and nervousness scores ↓ 18% and 13%
  - Severe distress
    - ⋆ for men, ↑ 0.48, 37% of mean
    - ⋆ small, negative for women

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  - Likelihood of taking anti-depressants or anti-anxiety drugs
    - for men, marginally significant increase in anxiolytics of 0.7pp (33%)
    - for women, negative effects, but imprecise
    - no differences in 2SLS estimates
- To summarize:
  - Women's mental health improved, through reductions in insomnia and nervousness (not Rx)
  - For men, comparatively worse effects on mental health
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Smoking and Mental Health

- Treatment effects on short-run outcomes Here (2SLS estimates: Here)
  - Current quit ↑ 26.0 pp (279%)
  - Cigs/day ↓ 12.4 (47.9%)
    - ⋆ Larger than long-term measures
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  - Distress scale ↑ 0.21 (12%)
  - Severe distress ↑ 0.01 (28%)
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Conclusion

- Relationship b/w smoking and mental health is not well-understood
  - (1) Smoking $\rightarrow$ poor mental health
  - (2) Poor mental health $\rightarrow$ smoking
  - (3) No causal relationship

- Use Lung Health Study to estimate effects of cessation on mental health
  - women experience long-run mental health gains (1)
  - no evidence of improvements for men (3)
    - in fact, small increase in severe disturbances (2)

- Policies that aim to reduce cigarette consumption may have mental health benefits, in particular for women
  - Cessation policies and mental health supports may be complementary policies, in particular for men

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Contribution

- New evidence on causal effects of smoking on mental health
  - Inform anti-smoking policy, esp. cessation efforts
    - ★ Under ACA, increased use of cessation aids by low-SES individuals (Cotti et al, 2019)
    - ★ Generate welfare benefits in long-run for women
    - ★ for men, anti-smoking policy and mental health supports may be complementary
    - ★ Implications for e-cigarettes, which deliver nicotine
- Use caution in extrapolating our results
  - LHS is more white, urban, & college-educated; only 35-65; at-risk for COPD
  - Participants want to quit
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Pre-Treatment Characteristics, Analysis Sample

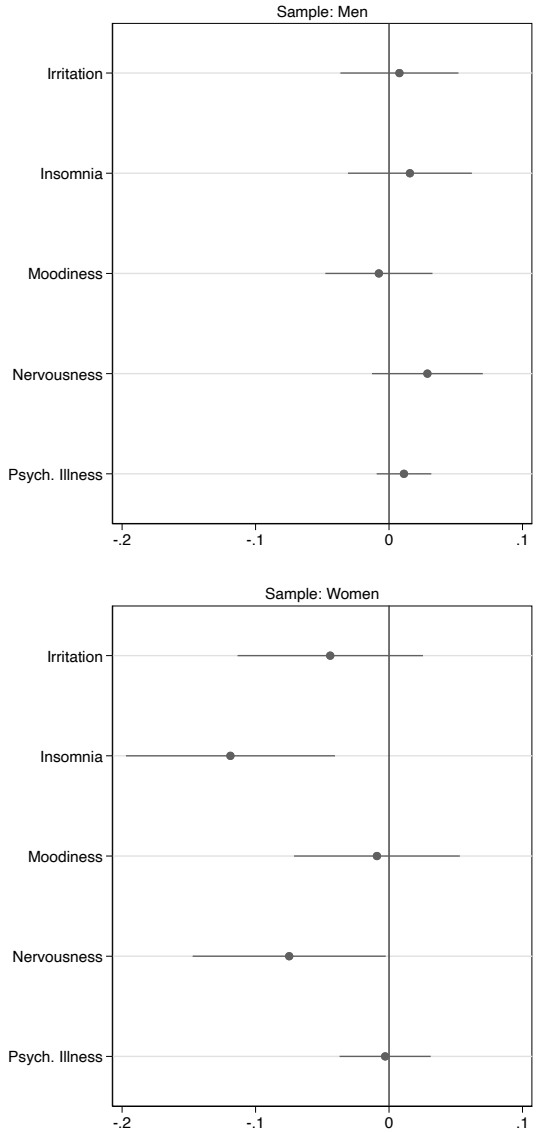
Back

	Treatment	Control	Diff	P-Val
Age	48.45	48.48	0.03	0.86
Male	0.62	0.64	0.02	0.21
no HS Diploma	0.12	0.12	-0.00	0.78
HS Diploma	0.30	0.29	-0.01	0.40
Cigs. per Day	31.29	30.99	-0.31	0.39
Age, First Cigarette	17.43	17.57	0.14	0.20
Total Distress Score	1.89	1.81	-0.08	0.25
Distress: Severe	0.02	0.02	-0.00	0.76
Irritability, Past 4 Mos.	0.55	0.52	-0.02	0.28
Insomnia, Past 4 Mos.	0.40	0.39	-0.01	0.74
Mood Changes, Past 4 Mos.	0.40	0.40	-0.01	0.74
Nervous, Past 4 Mos.	0.49	0.46	-0.03	0.14
Psych. Problems, Past 4 Mos.	0.05	0.05	-0.01	0.50
Anti-Depress., Past Year	0.01	0.02	0.00	0.43
Anxiolytic, Past Year	0.03	0.02	-0.00	0.84
Observations	3,812	1,893	5,705	5,705

Sample has non-missing values of long-run distress scale and Rx outcomes.

Long-Run Effects of Cessation Program on Distress Score Components

Back



Notes: Displayed above are point estimates and 95% confidence intervals corresponding to β from Eq. (1).

Table: Long-Run Effects of the Cessation Program on Smoking, Part 1 Back

	(1) Sustained Quit	(2) Current Quit	(3) Cigs per Day
Panel A: All			
Treatment	0.1689	0.1894	-8.0687
	(0.0086)	(0.0101)	(0.3674)
	[0.0000]	[0.0000]	[0.0000]
Obs.	5,627	5,705	5,705
Control Mean	0.0546	0.1724	21.4838

Notes: The dataset is the Lung Health Study, limited to individuals with non-missing values of the dependent variable and the long-run distress score. Each point estimate, heteroskedasticity-robust standard error (in parentheses) and p-value (in brackets) is from a separate regression estimating Eq. 1. At the bottom of the table, we report p-values from a Chi-squared test of whether the difference in coefficients for men and women is equal to 0.

Table: Long-Run Effects of the Cessation Program on Smoking, Part 2 Back

	(1) Sustained Quit	(2) Current Quit	(3) Cigs per Day
Panel B: Men			
Treatment	0.1843	0.1922	-8.6535
	(0.0110)	(0.0129)	(0.4880)
	[0.0000]	[0.0000]	[0.0000]
Obs.	3,519	3,575	3,575
Control Mean	0.0546	0.1779	22.4267
Panel C: Women			
Treatment	0.1438	0.1854	-6.9925
	(0.0137)	(0.0163)	(0.5374)
	[0.0000]	[0.0000]	[0.0000]
Obs.	2,108	2,130	2,130
Control Mean	0.0547	0.1627	19.8210
P-Value, Men-Women	0.0214	0.7420	0.0221

Table: Long-Run Effects of Cessation Program on Mental Health, Part 1 Back

	(1) Distress Scale	(2) Distress: Severe	(3) Anxiolytic	(4) Anti-Depressant
Panel A: All				
Treatment	-0.0436	0.0016	0.0082	-0.0024
	(0.0671)	(0.0020)	(0.0072)	(0.0074)
	[0.5165]	[0.4187]	[0.2563]	[0.7514]
Obs.	5,705	5,705	5,705	5,705
Control Mean	1.7719	0.0204	0.0681	0.0766

Notes: Each point estimate, heteroskedasticity-robust standard error (in parentheses) and p-value (in brackets) is from a separate regression estimating Eq. 1. We estimate IV regressions of the effects of smoking cigarettes on these outcomes (Eq. 3) separately for men and women. At the bottom of the table, we report the difference between these estimates and the p-value from a Chi-squared test of whether the difference in coefficients is equal to 0.

Table: Long-Run Effects of Cessation Program on Mental Health, Part 2 Back

	(1) Distress Scale	(2) Dist: Severe	(3) Anxiolytic	(4) Anti-Dep.
Panel B: Men				
Treatment	0.0558	0.0048	0.0068	-0.0026
	(0.0762)	(0.0022)	(0.0039)	(0.0044)
	[0.4644]	[0.0259]	[0.0824]	[0.5557]
Obs.	3,575	3,575	3,575	3,575
Control Mean	1.4151	0.0131	0.0206	0.0266
Panel C: Women				
Treatment	-0.2510	-0.0046	-0.0020	-0.0055
	(0.1231)	(0.0038)	(0.0071)	(0.0076)
	[0.0416]	[0.2307]	[0.7747]	[0.4714]
Obs.	2,130	2,130	2,130	2,130
Control Mean	2.4010	0.0334	0.0448	0.0523
Diff, M-W: b/cigs	-0.0423	-0.0012	-0.0011	-0.0005
P-Value	0.0309	0.0438	0.3326	0.6897

Table: Short-Run Effects of Cessation Program, Part 1

Back

	(1) Quit	(2) Cigs/Day	(3) Distress Scale	(4) Dist.: Severe	(5) Anxiolytic	(6) Anti-Dep.
Panel A: All						
Treatment	0.2604	-12.3920	0.2113	0.0051	0.0010	0.0035
	(0.0102)	(0.3649)	(0.0704)	(0.0025)	(0.0044)	(0.0038)
	[0.0000]	[0.0000]	[0.0027]	[0.0388]	[0.8272]	[0.3585]
Obs.	5,705	5,484	5,474	5,497	5,497	5,497
Control Mean	0.0930	25.9182	1.6778	0.0181	0.0241	0.0164

Notes: Each point estimate, heteroskedasticity-robust standard error (in parentheses) and p-value (in brackets) is from a separate regression estimating Eq. 1. At the bottom of Columns (2) and (3), we report the p-value from a Chi-squared test of whether the coefficient estimates for men and women are equal. At the bottom of Columns (3)-(5), we report the difference between these estimates and the p-value from a test of whether they are equal.

Table: Short-Run Effects of Cessation Program, Part 2

Back

	(1) Quit	(2) Cigs/Day	(3) Distress Scale	(4) Dist.: Severe	(5) Anxiolytic	(6) Anti-Dep.
Panel B: Men						
Treatment	0.2735	-13.7460	0.2286	0.0056	0.0013	0.0025
	(0.0129)	(0.4766)	(0.0813)	(0.0026)	(0.0050)	(0.0039)
	[0.0000]	[0.0000]	[0.0050]	[0.0334]	[0.7942]	[0.5338]
Obs.	3,575	3,418	3,410	3,427	3,427	3,427
Control Mean	0.0911	27.4547	1.3804	0.0117	0.0190	0.0112
Panel C: Women						
Treatment	0.2386	-10.0173	0.1470	0.0036	-0.0002	0.0044
	(0.0168)	(0.5450)	(0.1272)	(0.0049)	(0.0084)	(0.0076)
	[0.0000]	[0.0000]	[0.2482]	[0.4700]	[0.9813]	[0.5592]
Obs.	2,130	2,066	2,064	2,070	2,070	2,070
Control Mean	0.0964	23.2489	2.1940	0.0291	0.0330	0.0255
Diff, M-W: b/cigs			-0.0033	0.0000	-0.0001	0.0003
P-Value	0.0987	0.0000	0.7927	0.9376	0.9026	0.7383

Table: Long-Run Effects on Mental Health, 2SLS Estimates

Back

	(1) Distress Scale	(2) Distress: Severe	(3) Anxiolytic	(4) Anti-Dep.
Panel A: Men				
Avg. Cigarettes per Day, Years 2-5	-0.0064	-0.0006	-0.0008	0.0003
	(0.0089)	(0.0003)	(0.0005)	(0.0005)
	[0.4666]	[0.0285]	[0.0836]	[0.5560]
Obs.	3,575	3,575	3,575	3,575
Control Mean, Men	1.4151	0.0131	0.0206	0.0266
F-Statistic	315	315	315	315
Panel B: Women				
Avg. Cigarettes per Day, Years 2-5	0.0359	0.0007	0.0003	0.0008
	(0.0175)	(0.0005)	(0.0010)	(0.0011)
	[0.0403]	[0.2284]	[0.7749]	[0.4726]
Obs.	2,130	2,130	2,130	2,130
Control Mean, Women	2.4010	0.0334	0.0448	0.0523
F-Statistic	169	169	169	169

Table: Long-Run Effects on Distress Score Components, Part 1 Back

	(1) Irritation	(2) Insomnia	(3) Moodiness	(4) Nervous	(5) Psych. Illness
Panel A: All					
Treatment	-0.0084	-0.0300	-0.0058	-0.0057	0.0068
	(0.0195)	(0.0212)	(0.0175)	(0.0193)	(0.0092)
	[0.6674]	[0.1578]	[0.7398]	[0.7699]	[0.4598]
Obs.	5,705	5,705	5,705	5,705	5,705
Control Mean	0.4697	0.4526	0.3589	0.4057	0.0850

Each point estimate, heteroskedasticity-robust standard error (in parentheses) and p-value (in brackets) is from a separate 2SLS regression estimating Eq. 3. At the bottom of the table, we report the F-Statistic from the first stage regression (Eq. 2).

Table: Long-Run Effects on Distress Score Components, Part 2

Back

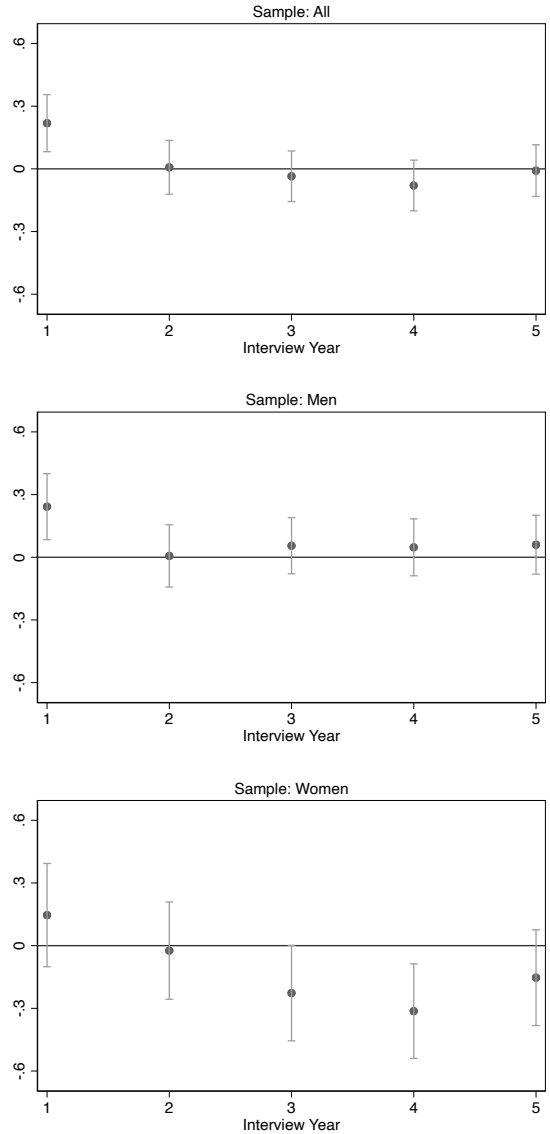
	(1) Irritation	(2) Insomnia	(3) Moodiness	(4) Nervous	(5) Psych. Illness
Panel B: Men					
Treatment	0.0078	0.0157	-0.0076	0.0287	0.0112
	(0.0226)	(0.0237)	(0.0205)	(0.0212)	(0.0104)
	[0.7303]	[0.5086]	[0.7104]	[0.1744]	[0.2835]
Obs.	3,575	3,575	3,575	3,575	3,575
Control Mean	0.3960	0.3411	0.3096	0.3037	0.0648
Panel C: Women					
Treatment	-0.0440	-0.1188	-0.0091	-0.0748	-0.0029
	(0.0354)	(0.0399)	(0.0317)	(0.0369)	(0.0174)
	[0.2137]	[0.0030]	[0.7747]	[0.0427]	[0.8674]
Obs.	2,130	2,130	2,130	2,130	2,130
Control Mean	0.5998	0.6494	0.4457	0.5856	0.1204
Diff, M-W: b/cigs	-0.0072	-0.0188	-0.0004	-0.0140	-0.0017
P-Value	0.2057	0.0030	0.9348	0.0153	0.5363

Table: Short-Run Effects on Mental Health, 2SLS Estimates

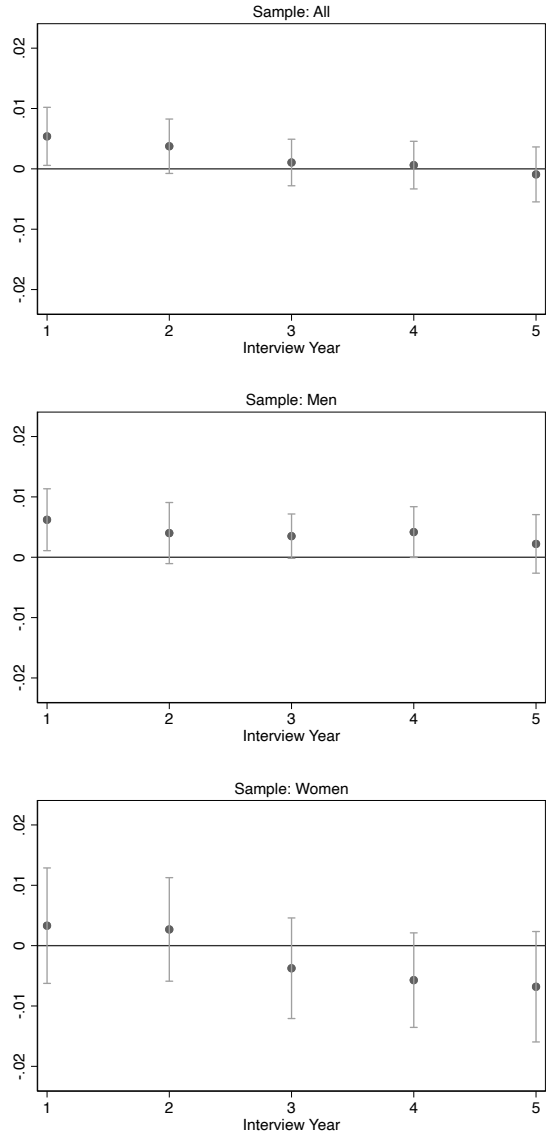
Back

	(1) Distress Scale	(2) Distress: Severe	(3) Anxiolytic	(4) Anti-Dep.
Panel A: Men				
Avg. Cigarettes per Day, Year 1	-0.0161	-0.0004	-0.0001	-0.0002
	(0.0058)	(0.0002)	(0.0003)	(0.0003)
	[0.0054]	[0.0388]	[0.7941]	[0.5351]
Obs.	3,575	3,575	3,575	3,575
Control Mean, Men	1.3804	0.0117	0.0190	0.0112
F-Statistic	71	71	71	71
Panel B: Women				
Avg. Cigarettes per Day, Year 1	-0.0128	-0.0003	0.0000	-0.0004
	(0.0112)	(0.0005)	(0.0008)	(0.0007)
	[0.2514]	[0.4736]	[0.9813]	[0.5608]
Obs.	2,130	2,130	2,130	2,130
Control Mean, Women	2.1940	0.0291	0.0330	0.0255
F-Statistic	27	27	27	27

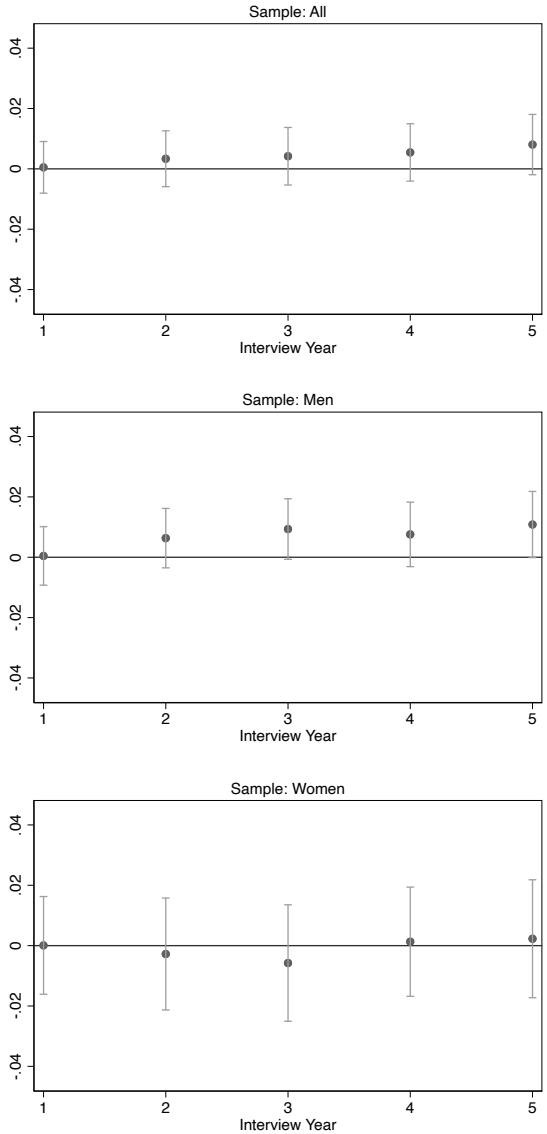
Dynamic Effects of Cessation Program on Distress Scale



Dynamic Effects of Cessation Program on Severe Distress



Dynamic Effects of Cessation Program on Anxiolytic Usage



Dynamic Effects of Cessation Program on Anti-Depressant Usage

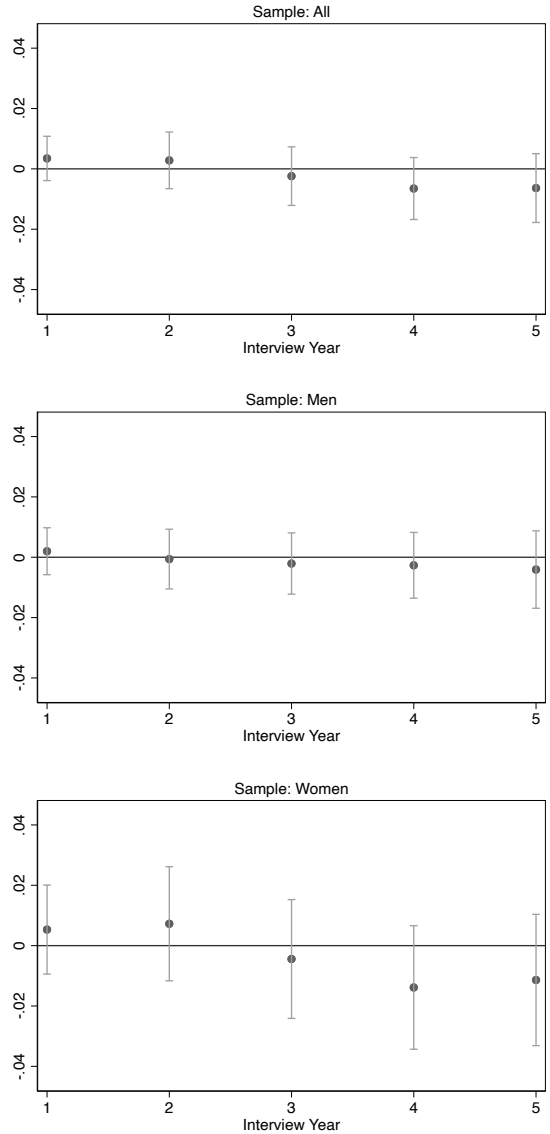


Table: Dynamic Effects of Cessation Program on Mental Health, Pooled Sample

	(1) Distress Scale	(2) Distress: Severe	(3) Anxiolytic	(4) Anti-Depressant
Treatment × Year 1	0.2188	0.0054	0.0005	0.0035
	(0.0697)	(0.0025)	(0.0044)	(0.0037)
	[0.0017]	[0.0283]	[0.9083]	[0.3561]
Treatment × Year 2	0.0075	0.0037	0.0034	0.0028
	(0.0657)	(0.0023)	(0.0047)	(0.0048)
	[0.9089]	[0.1030]	[0.4772]	[0.5569]
Treatment × Year 3	-0.0354	0.0011	0.0042	-0.0024
	(0.0617)	(0.0020)	(0.0049)	(0.0050)
	[0.5665]	[0.5911]	[0.3890]	[0.6271]
Treatment × Year 4	-0.0796	0.0006	0.0054	-0.0065
	(0.0620)	(0.0020)	(0.0049)	(0.0052)
	[0.1995]	[0.7580]	[0.2617]	[0.2138]
Treatment × Year 5	-0.0083	-0.0009	0.0080	-0.0064
	(0.0631)	(0.0023)	(0.0051)	(0.0058)
	[0.8955]	[0.6928]	[0.1146]	[0.2742]
Obs.	27,447	27,555	27,555	27,555
Control Mean	1.3819	0.0155	0.0274	0.0315

Table: Dynamic Effects of Cessation Program on Mental Health, Men

	(1) Distress Scale	(2) Distress: Severe	(3) Anxiolytic	(4) Anti-Depressant
Treatment × Year 1	0.2423	0.0062	0.0004	0.0020
	(0.0805)	(0.0026)	(0.0049)	(0.0040)
	[0.0026]	[0.0174]	[0.9285]	[0.6148]
Treatment × Year 2	0.0063	0.0040	0.0063	-0.0006
	(0.0760)	(0.0026)	(0.0050)	(0.0050)
	[0.9344]	[0.1206]	[0.2072]	[0.9051]
Treatment × Year 3	0.0553	0.0035	0.0093	-0.0021
	(0.0686)	(0.0019)	(0.0051)	(0.0052)
	[0.4199]	[0.0617]	[0.0680]	[0.6881]
Treatment × Year 4	0.0475	0.0042	0.0076	-0.0027
	(0.0695)	(0.0021)	(0.0055)	(0.0056)
	[0.4944]	[0.0517]	[0.1643]	[0.6314]
Treatment × Year 5	0.0599	0.0022	0.0108	-0.0041
	(0.0720)	(0.0025)	(0.0056)	(0.0065)
	[0.4049]	[0.3713]	[0.0527]	[0.5329]
Obs.	17,132	17,199	17,199	17,199

Table: Dynamic Effects of Cessation Program on Mental Health, Women

	(1) Distress Scale	(2) Distress: Severe	(3) Anxiolytic	(4) Anti-Depressant
Treatment × Year 1	0.1462	0.0033	0.0001	0.0053
	(0.1261)	(0.0049)	(0.0083)	(0.0075)
	[0.2463]	[0.4975]	[0.9916]	[0.4794]
Treatment × Year 2	-0.0237	0.0027	-0.0028	0.0072
	(0.1188)	(0.0044)	(0.0095)	(0.0096)
	[0.8416]	[0.5393]	[0.7696]	[0.4524]
Treatment × Year 3	-0.2271	-0.0037	-0.0058	-0.0044
	(0.1166)	(0.0043)	(0.0098)	(0.0100)
	[0.0516]	[0.3787]	[0.5589]	[0.6599]
Treatment × Year 4	-0.3135	-0.0057	0.0013	-0.0139
	(0.1155)	(0.0040)	(0.0092)	(0.0104)
	[0.0067]	[0.1528]	[0.8877]	[0.1845]
Treatment × Year 5	-0.1532	-0.0068	0.0023	-0.0114
	(0.1170)	(0.0047)	(0.0100)	(0.0111)
	[0.1907]	[0.1447]	[0.8186]	[0.3054]
Obs.	10,315	10,356	10,356	10,356
Control Mean	1.8622	0.0256	0.0417	0.0468