The Effects of Vietnam-Era Military Service on the Long-Term Health of Veterans: A Bounds Analysis¹

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> Global Labor Organization Virtual Seminar October 1, 2020

¹ The findings and conclusions in this paper are those of the author(s) and do not necessarily represent the views of the Research Data Center, the National Center for Health Statistics (NCHS), or the Centers for Disease Control and Prevention \circ \circ \circ

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 - Recent studies have analyzed the increased transfers: Angrist et al. (2010), Autor et al. (2011), Singleton (2009)
- Yet, the literature estimating causal impacts of military service on veteran's health is inconclusive
 (e.g., Hearst et al., 1986; Angrist et al., 1996; Bedard and Deschênes, 2006; Dobkin and Shabani, 2009; Eisenberg and Rowe, 2009)

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 - These studies find weak or no evidence of health effects from military service
 - Since effects are likely heterogeneous, those studies focus on the subpopulation of "compliers" (who comprise about 1/4 of veterans)

This Paper

- We analyze the short- and long-term effects (up to 40 years after the conflict) of Vietnam-era military service on a comprehensive list of health outcomes and behaviors
 - Employ restricted-use data from the US National Health Interview Surveys (NHIS)
- While we estimate the effects on compliers, we go beyond and estimate nonparametric bounds on the corresponding effects for volunteers
- Also estimate nonparametric bounds on the effects for the population of Vietnam-era veterans (the "treated group")
- We assess the validity of the draft lotteries IV in the context of health outcomes

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 Meaningful effects: estimated lower bounds for white volunteers indicate military service increases Activity Limitation by at least 7.1 pp (57%) and 5.8 pp (30.1%) up to 24 and 40 yrs. after the conflict, resp.

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 Meaningful effects: estimated lower bounds for white volunteers indicate military service increases Activity Limitation by at least 7.1 pp (57%) and 5.8 pp (30.1%) up to 24 and 40 yrs. after the conflict, resp.
- Estimated bounds on the same effects for all veterans also show clear stat. significant detrimental health effects that appear over time

- Vietnam-era draft lotteries and the data
- Econometric approach
- Results
- Discussion
- Conclusion

Vietnam-era draft lotteries



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- Men born in the years 1944-1950 were subjected to the Vietnam-era draft lotteries (1969, 1970, and 1971), implemented using random sequence numbers (RSNs) based on day of birth
- Conscription happened based on order of those RSNs until manpower requirements met
- The last lottery numbers called became the ex-post draft eligibility cutoffs
- Importantly, being eligible to draft does not equal military service:
 - Males could volunteer to serve when their lottery numbers were high
 - Draft-eligible males were subjected to medical, physical, and mental examinations to determine qualifications for military service
 - Other draft avoidance behaviors existed (e.g., college attendance, marriage/fertility, incarcerations)

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- Restricted version of NHIS 1974-2013
 - Main cross-sectional data source on health in the U.S.
- Due to changes in the survey design over time, we focus on survey periods: 1974-1981 (up to 8 yrs after the end of the conflict), 1982-1996 (9 to 23 yrs), 1997-2005 (24 to 32 yrs), and 2006-2013 (up to 40 yrs)
 - Not all outcomes are available in all time periods
- Focus on the 1948 to 1952 birth cohorts (earlier cohorts impacted by local drafts), broken down by white and nonwhite
- Four groups of outcomes: general health (e.g., activity limitations, self-reported health), health behaviors (smoking, drinking), activity-limiting chronic conditions, and other chronic conditions
 - All outcomes are binary: = 1 if condition present
 - Important to use multiple outcomes (testing) procedures

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Preliminaries

- Consider the same setting as in Angrist, Imbens and Rubin (AIR; 1996):
 - D_i : military service indicator; served (= 1) or not (= 0)
 - Z_i : binary draft eligibility status IV; eligible (= 1) or not (= 0)
 - Y_i : health outcome (or behavior); has condition (= 1) or not (= 0)
 - $D_i(z)$: potential military service status unit would receive if Z = z
 - $Y_i(d)$: potential health outcome as a function of D; i.e., the health outcome unit would experience if D = d
 - $Y_i(z, d)$: potential outcome unit would experience if Z = z and D = d
 - Observe $\{Z_i, D_i(Z_i), Y_i(Z_i, D_i(Z_i))\}$
- Today, I will skip the details on how we assess the validity of the draft eligibility status IV (details and references in the paper)

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Principal Stratification in AIR (1996)

- AIR partition the population into groups such that, within each group, individuals have the same values of the vector {D_i (0), D_i (1)}
 - These groups are called "principal strata" (Frangakis and Rubin, 2002)

- The current setting has four (latent) principal strata:
 - $\{D_i\left(0
 ight), D_i\left(1
 ight)\} = \{1,1\}$: the "always takers" $(at) \longrightarrow \underline{volunteers}$
 - $\{D_i(0), D_i(1)\} = \{0, 0\}$: the "never takers" $(nt) \longrightarrow \underline{draft avoiders}$
 - $\{D_i(0), D_i(1)\} = \{0, 1\}$: the "compliers" (c)
 - $\left\{ D_{i}\left(0
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 ight\} =\left\{ 1,0
 ight\} :$ the "<u>defiers</u>" (d)

Parameters of Interest

• The average effect of military service on the health outcomes and behaviors for compliers (LATE_c):

$$LATE_c = E[Y(1)|c] - E[Y(0)|c]$$

• The average effect of military service on the health outcomes and behaviors for volunteers (LATE_at):

$$LATE_{at} = E[Y(1)|at] - E[Y(0)|at]$$

• The average effect of military service on the health outcomes and behaviors for <u>all veterans</u> (*ATT*):

$$ATT = E[Y(1)|D = 1] - E[Y(0)|D = 1]$$

Standard IV Assumptions (AIR, 1996)

- Assumption A1 (*Randomized Instrument*) {*Y*(0,0), *Y*(0,1), *Y*(1,0), *Y*(1,1), *D*(0), *D*(1)} is independent of *Z*
- Assumption A2 (Nonzero Average Effect of Z on D) $E[D(1) - D(0)] \neq 0$
 - Instrument has a non-zero average effect on the treatment:
- Assumption A3 (Individual-Level Monotonicity of Z on D) $D_i(1) \ge D_i(0)$ for all i
 - It rules out defiers, so only 3 strata left: always takers (*at*), never takers (*nt*), and compliers (*c*)
- Assumption A4 (Exclusion Restriction) $Y_i(0, d) = Y_i(1, d) = Y_i(d), d \in \{0, 1\}$ for all i
 - Effect of the instrument on the outcome works only through D

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- We follow Chen et al. (2018) to bound these two parameters

The Average Treatment Effect for Volunteers (1)

- We use two additional assumptions to bound the effects for volunteers and veterans, the first of which (A5) is trivially satisfied since all outcomes are binary
- Assumption A5 (Bounded Outcome): $Y(1), Y(0) \in [y', y^u]$
- Under A1 to A5 we can partially identify *LATE_{at}*, although these "worst-case" bounds are typically uninformative

• Let
$$\overline{Y}^{zd} = E[Y|Z = z, D = d]$$
 and note $E[Y(1)|at] = \overline{Y}^{01}$, then:
 $\overline{Y}^{01} - y^{u} \leq LATE_{at} \leq \overline{Y}^{01} - y'$.

The Average Treatment Effect for Volunteers (2)

- The second assumption is a mean weak monotonicity condition **Assumption A6**: $E[Y(0)|nt] \ge E[Y(0)|at]$
- Implies that, in the absence of military service, the average potential health outcomes of draft avoiders are no better than those of volunteers
- This assumption tightens the lower bound:

$$\overline{Y}^{01} - \overline{Y}^{10} \leq LATE_{at} \leq \overline{Y}^{01} - y'.$$

I justify A6 below...

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- Let $q_1 = Pr(Z = 1)$, $r_1 = Pr(D = 1)$, and $p_{1|0} = Pr(D = 1|Z = 0)$; ATT can be written as (Angrist, 2004):

$$ATT = \frac{1}{r_1} [q_1(E[Y|Z=1] - E[Y|Z=0]) + p_{1|0}(\overline{Y}^{01} - E[Y(0)|at])]$$

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• The worst-case bounds (under A1-A5) are given by:

$$\frac{1}{r_1} [q_1(E[Y|Z=1] - E[Y|Z=0]) + p_{1|0}(\overline{Y}^{01} - y^u)]$$

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While the bounds that add A6 are:

$$\frac{1}{r_1} [q_1(E[Y|Z=1] - E[Y|Z=0]) + p_{1|0}(\overline{Y}^{01} - \overline{Y}^{10})]$$

$$\leq ATT \leq \frac{1}{r_1} [q_1(E[Y|Z=1] - E[Y|Z=0]) + p_{1|0}(\overline{Y}^{01} - \underline{y}')]$$

Results

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Discussion of Standard IV Assumptions

- A1: RA of draft-eligibility IV holds by design (conditional on birth month-by-year indicators)
- A2: Draft-eligibility has a significant average effect on military service (between 0.13 and 0.15 across survey periods)
- A3: Nobody serves in the military if ineligible-to-draft but does not serve if eligible-to-draft: **no defiers**
 - Plausible since individuals who prefer enlistment when ineligible-to-draft would also prefer enlistment when they are eligible-to-draft
- A4: Draft-eligibility has an effect on health outcomes only through military service
 - It could fail because of draft-avoidance behaviors (e.g., continued education, paternity, incarcerations)
 - Our assessment of the validity of the IV does not suggest its failure

Preliminary Estimates: Strata Proportions

- Under A1 to A3 the strata proportions can be estimated
- The largest estimated stratum proportion is draft avoiders: 64-66% of the population across survey periods)
- \bullet Estimated proportion of compliers is between 13% to 15%
 - $\bullet\,$ For whites is 13% to 15% while for nonwhites is 7% to 9%
- \bullet Estimated proportion of volunteers in the population is between 21% to 23%
 - For nonwhites is 17% to 21%
- Given that the veteran population proportion is between 27% to 29%, volunteers represent about 75% of all the Vietnam-era veterans

Selected OLS and ITT Estimates

	Whites		Nonwhites	
NHIS 1974-1981	OLS	ITT	OLS	ITT
Activity Limitation	-0.0036	0.0108***	-0.0072	-0.0017
Fair and Poor Health	0.0007	-0.0011	0.0063	-0.0036
Current Smoker	0.1310***	-0.0007	0.1442***	0.0361
NHIS 1982-1996				
Activity Limitation	0.0111***	0.0063*	0.0368***	0.0108
Fair and Poor Health	0.0042	-0.0020	-0.0007	0.0060
Work Limit	0.0110	0.0040	0.0259***	0.0057
Current Smoker	0.1000***	-0.0036	0.1014	0.0248
NHIS 1997-2005				
Activity Limitation	0.0436***	-0.0103**	0.0514***	0.0013
Fair and Poor Health	0.0167***	-0.0128***	0.0220	0.0021
Work Limit	0.0360***	-0.0111**	0.0510***	0.0037
Current Smoker	0.0938***	-0.0088	0.0747***	-0.0162
NHIS 2006-2013				
Activity Limitation	0.0407***	-0.0025	0.0947	-0.0053
Fair and Poor Health	0.0282***	0.0132	0.0385**	-0.0227
Work Limit	0.0365***	-0.0016	0.0771***	-0.0032
Current Smoker	0.0677***	-0.0066	0.1060***	-0.0442**

Military Service Effect for Compliers (1)

- The point-estimated effects for compliers are mostly statistically insignificant
- No consistent pattern: some stat. sig. effects indicate detrimental impacts, others beneficial impacts
- Our results are in line with prior studies focusing on compliers
 - Angrist et al. (2010): no or small effects using Census 1 in 6 file
 - Dobkin and Shabani (2009): no effects using NHIS until 2004
 - Eisenberg and Rowe (2009): effects on smoking that disappear over time, using NHIS until 2005

Military Service Effect for Compliers (2)





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Military Service Effect for Compliers (3)





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- "Half of registrants in 1970 failed the pre-induction examinations, and 20% of those who passed were eliminated by physical inspections at induction" (Angrist, 1990, 1991)
- "From 1967 to 1973, the failure rate for the pre-induction physical exam was 47%" (Baskir and Strauss, 1978)

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- We also gather indirect evidence based on two avg. pre-draft characteristics correlated with health outcomes for the two stratum

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Indirect Evidence on Assumption A6

Pre-Draft Characteristics	Draft Avoiders (nt)	Volunteers (at)	Difference at-nt
NHIS 1974-1981: Whites			
High School Incompletion	0.1548	0.1191	-0.0356***
	[0.0033]	[0.0052]	[0.0057]
Activity limitations before 1965	0.0222	0.0064	-0.0158***
	[0.0012]	[0.0014]	[0.0017]
NHIS 1974-1981 · Nonwhites			
High School Incompletion	0.2746	0.1297	-0.1449***
6	[0.0088]	[0.0155]	[0.0169]
Activity limitations before 1965	0.0199	0.0023	-0.0176***
	[0.0027]	[0.0025]	[0.0034]
NHIS 1982-1996: Whites			
High School Incompletion	0.1357	0.0819	-0.0538***
	[0.0022]	[0.0034]	[0.0034]
NHIS 1982-1990: Nonwhites	0.0520	0.0705	0 1 7 2 7 * * *
Fign School incompletion	0.2532	0.0795	-0.1/3/***
	[0.0057]	[0.0097]	[0.0099]

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Clear Pattern:

- For the first survey period (up to 8 years after the conflict), no statistically significant effects: est. bounds and their CIs include zero
- After that, statistically significant and economically important effects
- Illustration using Activity Limitation for whites
 - No stat. sig. effect in 1974-1981
 - 1982-1996: detrimental effect of **at least** 1.1 pp (9.2% of nonveteran mean)
 - 1997-2005: detrimental effect of **at least** 7.1 pp (57%)
 - 2006-2013: detrimental effect of at least 5.1 pp (30.1%)
- Recall: a conservative multiple testing procedure is employed for different families of health outcomes

Military Service Effect for Volunteers (2)





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Military Service Effect for Volunteers (3)





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Other Outcomes with Similar Patterns:

- General health outcomes: Work Unable
- Health behavior: Current Drinker
- Activity-limiting chronic conditions: Musculoskeletal, Arthritis, Back/Neck, Fracture, Diabetes, Heart, Cancer, and Depression
- Other chronic conditions: Emphysema, Hearing, Joints, Liver, Neck Pain, Lower Back Pain, Cancer, Loss of Teeth, Hypertension, Ulcer, Diabetes
- Illustration using Activity-limiting Depression for nonwhites (correlated to PTSD)
 - 1997-2005: detrimental effect of **at least** 2.3 pp (11%)
 - 2006-2013: detrimental effect of at least 4.5 pp (11.5%)

- The results for all veterans show the same patterns as those for volunteers: stat. and economically significant detrimental effects of military service, particularly in the long-run
 - May not be surprising: volunteers account for 3 out of 4 veterans
 - Also, naturally, magnitudes and precision decrease somewhat
- Illustration using Activity Limitation for whites
 - No stat. sig. effect in 1974-1981
 - 1982-1996: detrimental effect of at least 1.7 pp (14.6%)
 - 1997-2005: detrimental effect of at least 4 pp (32.3%)
 - 2006-2013: detrimental effect of at least 4.2 pp (22%)

Military Service Effect for Veterans (2)





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Military Service Effect for Veterans (3)





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Discussion (1)

- Mortality
 - Mortality linkage to NHIS—variable used is mortality by 2011 (cohorts aged 59-63 by then)
 - In 1985-1996 survey, stat. sig. mortality effects for volunteers and veterans, but not for compliers—consistent with results above
 - Potential mortality bias renders our long-term results for volunteers and veterans as *conservative*: military service effects likely more detrimental
- Why different results for compliers & volunteers?
 - The analysis of pre-draft average characteristics between compliers and volunteers reveal that *compliers* had statistically lower high-school incompletion rate
 - Higher pre-draft high-school completion may have helped compliers attain additional schooling via the GI Bill (e.g., Angrist and Chen, 2011)
 - The increased college attainment may have allowed compliers to offset the detrimental health effects of military service (or adjust better to civilian life)

Some Implications

- Results relevant to explain the recent rise in VDC compensations paid to Vietnam-era veterans
- Results consistent with jump in claims for diabetes (Singleton, 2009), PTSD (Autor et al., 2011), musculoskeletal conditions (Angrist et al., 2010)
- Results reconcile the above with prior findings of no detrimental health effects of Vietnam-era military service (*on compliers!*)
- Results for smoking behavior represent a potential mediator for the detrimental effect of military service on some chronic conditions (e.g., emphysema, hypertension)
- Policies aiming to curb smoking in the military (e.g., minimum smoking age; cessation programs) can potentially ameliorate the detrimental health effects of service and their costs

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Conclusion

- We analyze the short- and long-term effects of Vietnam-era military service on health outcomes and behaviors
- Employ the Vietnam-era draft lotteries as exogenous source of variation and conduct stat. inference on compliers, volunteers, and veterans
- Results for compliers largely indicate no stat. significant effects, in line with prior literature
- For volunteers and veterans, our estimated bounds indicate stat. and economically significant effects
 - The bounds rely on the assumption that, in the absence of military service, the *average* potential health outcomes of draft avoiders are no better than those of volunteers
 - We argue this is easily justified given the stringent medical, physical, and mental examinations that occurred before enlistment

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Summary Statistics

		Whites			Nonwhites	
Variable	Veterans	Nonveterans	Difference	Veterans	Nonveterans	Differenc
NHIS 1974-1981						
Sample size	8586	19771		994	2914	
Draft-eligible	0.5731	0.3791	0.1940***	0.5315	0.4108	0.1207**
	[0.0057]	[0.3791]	[0.0067]	[0.0168]	[0.0093]	[0.0192]
Fair or Poor Health	0.0111	0.0111	0.0000	0.0201	0.019	0.0011
	[0.0012]	[0.0007]	[0.0014]	[0.0048]	[0.0027]	[0.0055]
Activity Limitation	0.0830	0.0793	0.0037	0.0972	0.0888	0.0083
	[0.0032]	[0.0020]	[0.0037]	[0.0102]	[0.0054]	[0.0115]
Activity Unable	0.0130	0.0115	0.0014	0.0294	0.0258	0.0037
	[0.0014]	[0.0008]	[0.0016]	[0.0058]	[0.0030]	[0.0065]
Current Smoker	0.4369	0.3059	0.1310^{***}	0.4516	0.3074	0.1442**
	[.0126]	[0.0085]	[0.0150]	[0.0345]	[0.0220]	[0.0407
NHIS 1982,1996						
Sample size	12972	25977		1931	5425	
Draft_eligible	0.5608	0.3854	0.1744***	0.5399	0.4272	0.1127**
	[0.00.49]	[0.0032]	[0.0058]	[0.0135]	[0.0072]	0.0153
Fair or Poor Health	0.0589	0.0551	0.0028	0.1354	0.126	0.0094
	0.0025]	[0.0016]	[0.0030]	[0.0090]	[0.0048]	0.0102
Activity Limitation	0.1326	0.1188	0.0138***	0.1759	0 1317	0.0443**
	0 0033	[0.0021]	[0.0040]	[0.0108]	[0.0050]	[0.0119
Activity Unable	0.0392	0.0363	0.0028	0.0932	0.0656	0.0277**
Activity Unable	0.0031	[0.0012]	0.00231	0.0303	[0.0035]	0.0040
	0.0000	0.0012	0.0117888	0.1441	0.1007	0.007484
Work Limitation	0.0909	0.0852	0.0117	0.1441	0.1001	0.0374
Week Weekle	0.0029	0.0018]	0.0034	0.0037	0.0043	0.0301#
work Unable	0.0409	0.0379	0.0030	0.0973	0.0074	0.0301
	[0.0020]	[0.0013]	[0.0023]	0.0083	[0.0035]	0.0090
Current Smoker	0.4062	0.3062	0.1000****	0.4057	0.3043	0.1014
	[0.0212]	[0.0139]	[0.0253]	0.0030	[0.0299]	[0.0617
NHIS 1997-2005						
Sample size	5454	14069		989	3280	
Draft-eligible	0.5575	0.3902	0.1673^{***}	0.5199	0.4222	0.0978**
	[0.0069]	[0.0044]	[0.0083]	[0.0154]	[0.0093]	[0.0170
Fair or Poor Health	0.1235	0.1019	0.0217^{***}	0.2054	0.1824	0.0230
	[0.0051]	[0.0031]	[0.0056]	[0.0145]	[0.0076]	[0.0156
Activity Limitation	0.1726	0.1238	0.0487***	0.2082	0.1515	0.0566**
	[0.0054]	[0.0037]	[0.0063]	[0.0136]	[0.0074]	[0.0160
Work Limitation	0.1404	0.0992	0.0412***	0.1831	0.1277	0.0555**
	[0.0051]	[0.0031]	[0.0058]	[0.0127]	[0.0069]	[0.0145
Work Unable	0.0807	0.0613	0.0194***	0.0907	0.0560	0.0347**
	[0.0038]	[0.0020]	[0.0043]	[0.0103]	[0.0046]	[0.0113
Current Smoker	0.2759	0.1822	0.0938***	0.2538	0.1791	0.0747**
	[0.0102]	[0.0059]	[0.0118]	[0.0216]	[0.0116]	0.0248
Current Drinker	0.6249	0.5915	0.0333***	0.6446	0.5669	0.0777**
	[0.0095]	[0.0061]	[0.0114]	[0.0214]	[0.0123]	[0.0251
NH15 2006-2013						
Sample size	3871	9448		817	2552	
Draft-eligible	0.5527	0.3850	0.1677***	0.5169	0.4088	0.1081**
	[0.0084]	[0.0053]	[0.0096]	[0.0222]	[0.0102]	0.0247
Fair or Poor Health	0.2016	0.1653	0.0363***	0.2895	0.2452	0.0443*
	[0.0071]	[0.0048]	[0.0083]	[0.0180]	[0.0101]	[0.0201]
Activity Limitation	0.2430	0.1915	0.0515^{***}	0.3317	0.2325	0.0992**
	[0.0075]	[0.0052]	[0.0087]	[0.0192]	[0.0097]	0.0206
Work Limitation	0.2111	0.1649	0.0462***	0.2885	0.2065	0.0821**
	[0.0071]	[0.0046]	[0.0080]	[0.0180]	[0.0094]	[0.0190
Work Unable	0.0865	0.0696	0.0169**	0.1009	0.0625	0.0384*
to an a madde	[0.0060]	[0.0035]	[0.0069]	[0.0138]	[0.0073]	0.0158
		[[oregona]	forewood.	[mail of the	1-0100
Current Smoker	0.2191	0.1514	0.0577***	0.2495	0.1435	111111111111111111111111111111111111111
Current Smoker	0.2191	0.1514	0.0677***	0.2495	0.1435	0.1060**
Current Smoker	0.2191 [0.0107] 0.6116	0.1514 [0.0063] 0.6261	0.0677*** [0.0124] -0.0145	0.2495 [0.0219] 0.6829	[0.0122] 0.5917	0.1060**

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