Secondhand Smoke from Marijuana: The Return of a Familiar Problem

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4/24/18

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The Bad Ol’ Days

The Bad Ol’ Days

Typical day
in 2016

Back to the Future: CA, 2018?

Denver 2014

Photo: Brennan Linsley / Associated Press

"Partygoers dance and smoke pot April 19, the first of two days of the annual 4/20 marijuana festival in Denver. The 4/20 event was the first one since Colorado legalized recreational marijuana in January."

What To Expect At This Year's 420 Day Celebration

Mon. April 16, 2018, 12:28pm

by Nathan Falstreau
@NFalstreau

420 Day celebration at Golden Gate Park. | Photo: J. Wylie/Flickr

Neighborhoods
Cole Valley, Golden Gate Park, Inner Richmond, Inner Sunset, NoPa, Upper Haight

Location
Robin Williams Meadow, San Francisco, CA

GOLDEN GATE PARK

5:04 57°

Show

Already: SF, 2017… REALLY!!!

"NOW SERVING CANNABIS FOR BRUNCH
In S.F., gourmet fare infused with artisanal weed offers medicated spreads to new connoisseurs"
– SF Chronicle 1/22/17

Secondhand smoke (SHS)

- Smoking causes over 140,000 cardiovascular deaths in the US per year
- Secondhand smoke is estimated to cause ~50,000 US deaths/year, mostly from cardiovascular disease
- Smoking bans in public places lead to reduction in frequency of heart attacks

Secondhand smoke (SHS)

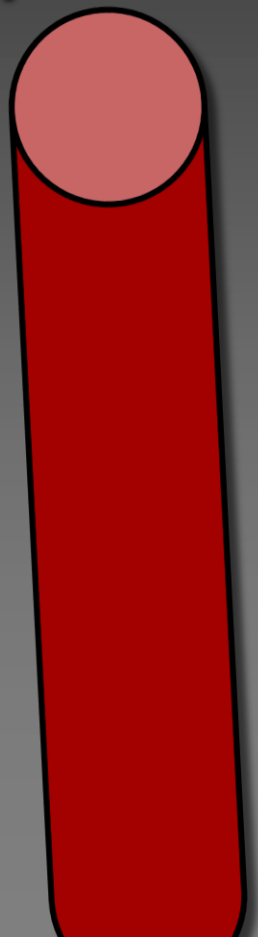
Longterm secondhand smoke exposure impairs *vascular endothelial function*

“blood vessel function”

Tobacco secondhand smoke exposure impairs ability of arteries to *vasodilate* when they need to pass more blood

(**Vasodilation**: Arteries grow in diameter when necessary)

Important: Impairment is temporary, but repeated exposures lead to long-term impairment



Brachial artery FMD gets lower with increasing cardiovascular risk factors

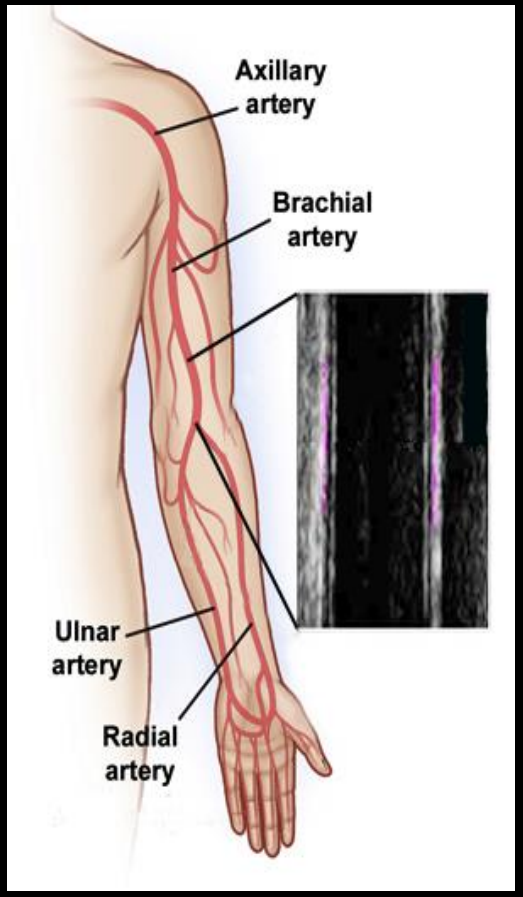
Dilation of coronary arteries in response to increased coronary blood flow gets lower with increasing cardiovascular risk factors
(Nabel, Selwyn, and Ganz, 1990)

Improves FMD:
Dark chocolate, green tea, red wine, *etc*.

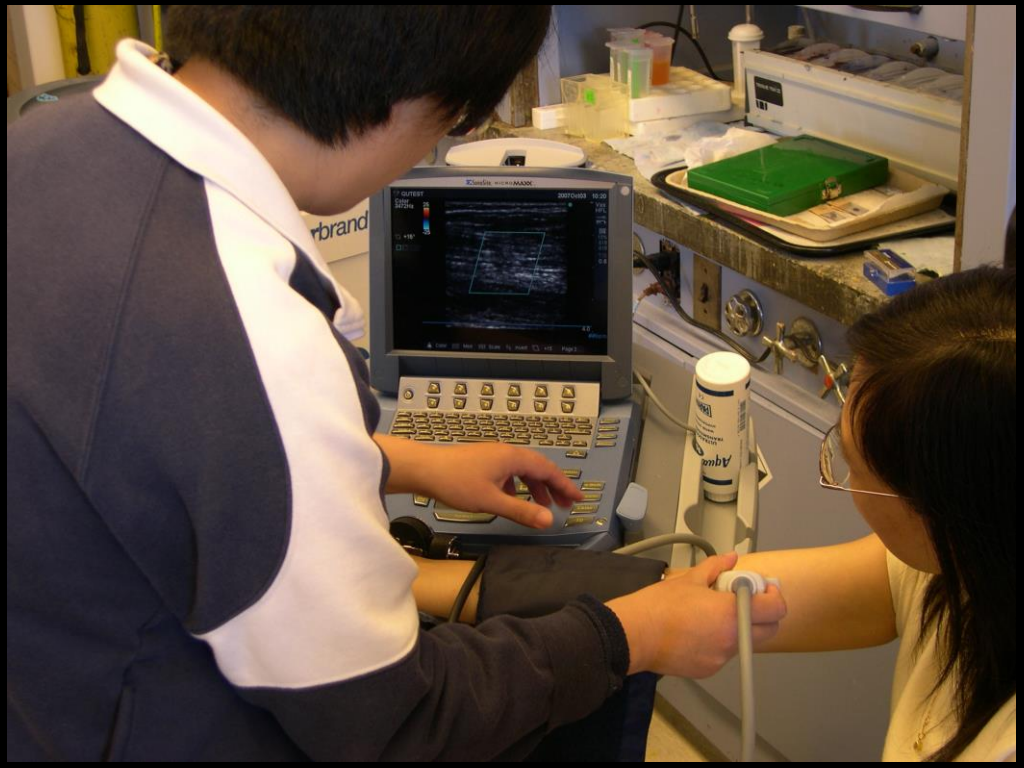
Impairs FMD:
Age, smoking, secondhand smoke, *etc*.

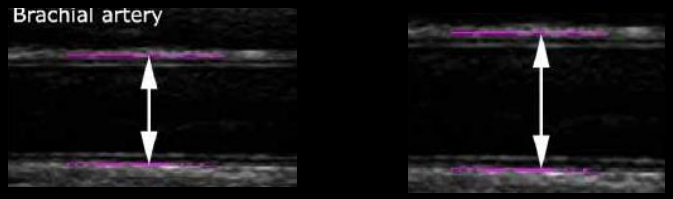
Measuring Endothelial Function

"Flow-Mediated Dilation" (FMD)



Celermajer NEJM 1992





4.0 mm 4.4 mm

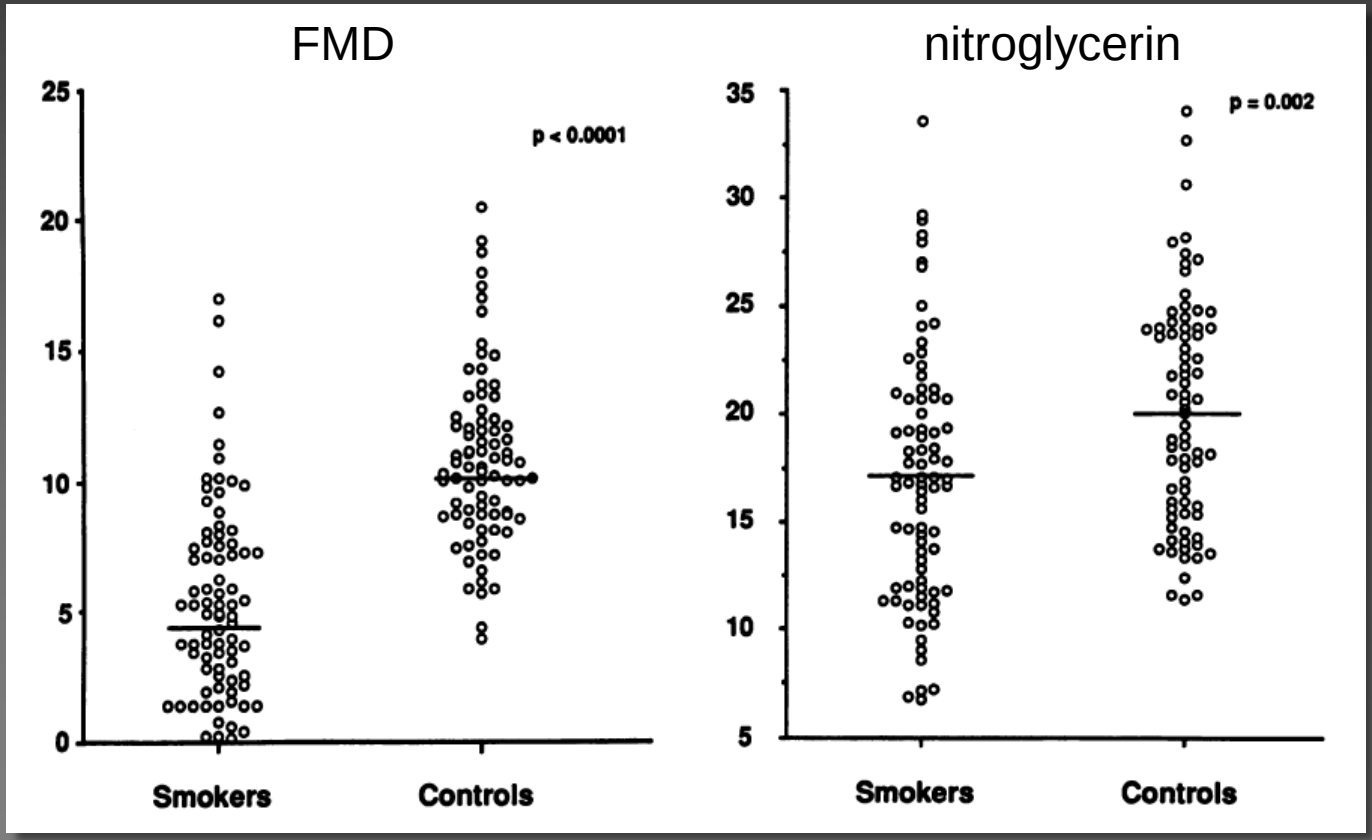
FMD=10%

Cigarette smoking is associated with dose-related and potentially reversible impairment of endothelium-dependent dilation in healthy young adults

DS Celermajer, KE Sorensen, D Georgakopoulos, C Bull, O Thomas, J Robinson and JE Deanfield

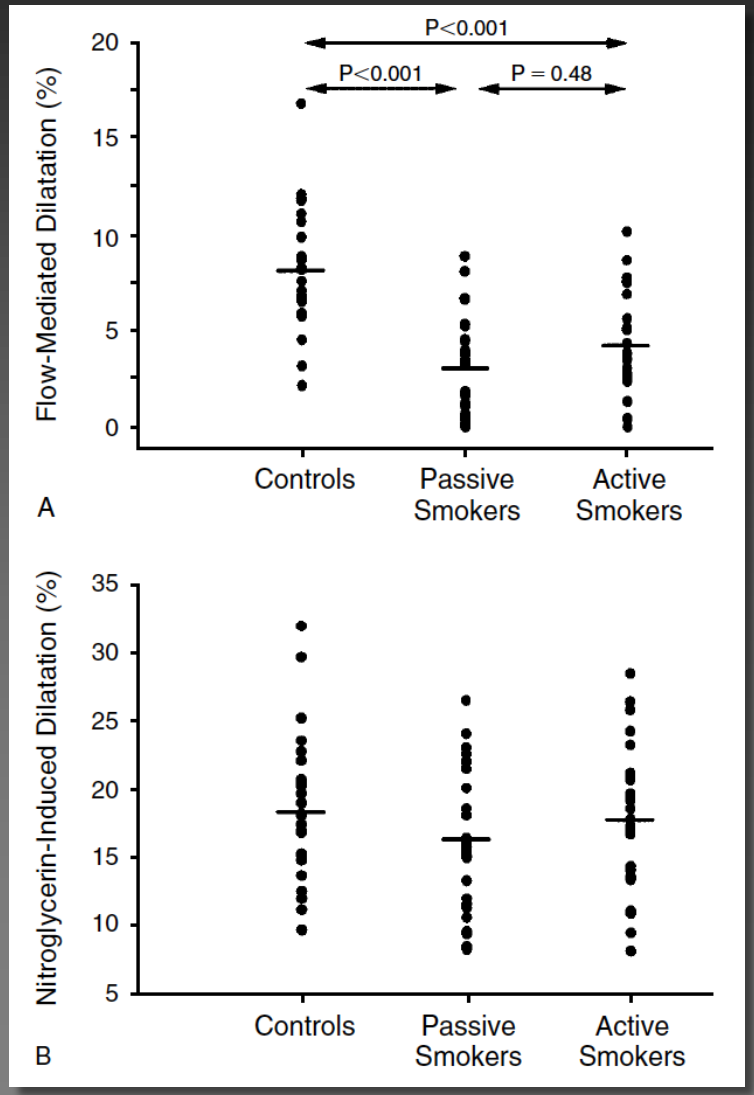
Circulation 1993;88;2149-2155

...that is, smoking impairs FMD



PASSIVE SMOKING AND IMPAIRED ENDOTHELIUM-DEPENDENT ARTERIAL DILATATION IN HEALTHY YOUNG ADULTS

DAVID S. CELERMAJER, PH.D., MARK R. ADAMS, M.B., B.S., PETER CLARKSON, M.B., B.S., JACQUI ROBINSON, R.N., ROBYN MCCREDIE, B.SC., ANN DONALD, AND JOHN E. DEANFIELD, M.B., CH.B.



Several years of secondhand smoke exposure impairs FMD

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Brief Secondhand Smoke Exposure Depresses Endothelial Progenitor Cells Activity and Endothelial Function

Sustained Vascular Injury and Blunted Nitric Oxide Production

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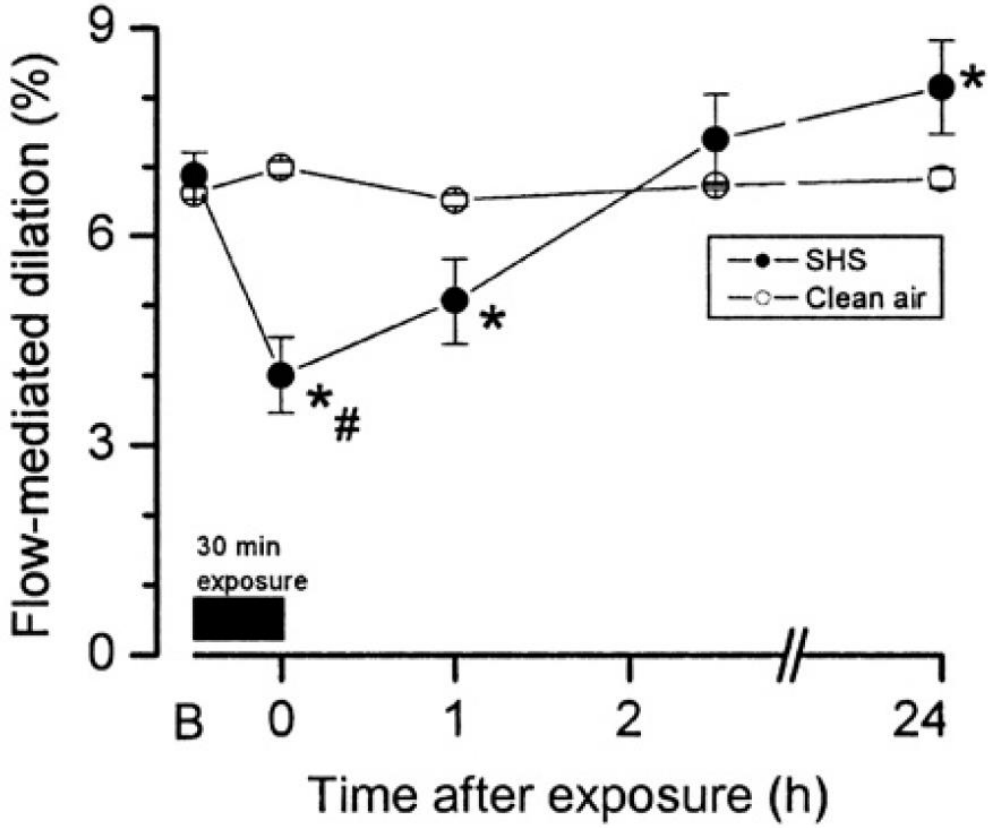
San Francisco and Berkeley, California

Christian Heiss

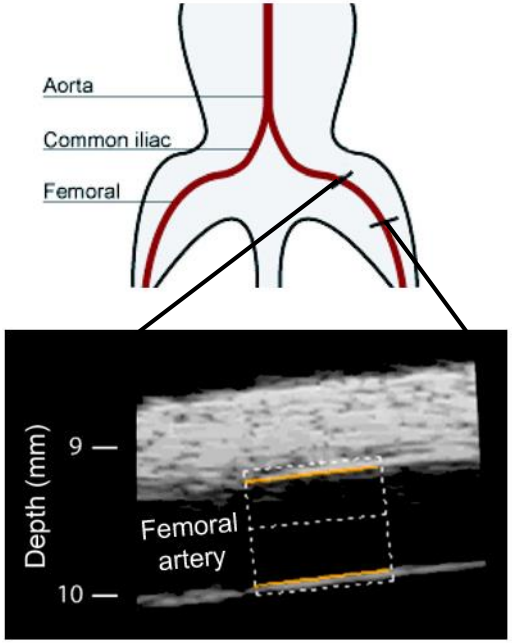
30 min SHS exposure impairs FMD

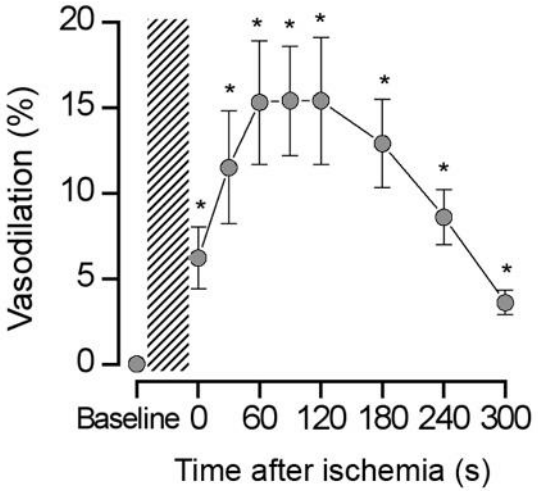
376 ± 43 µg/m³ RSP, constant sidestream smoke



Heiss et al., 2008
Bars = SEM

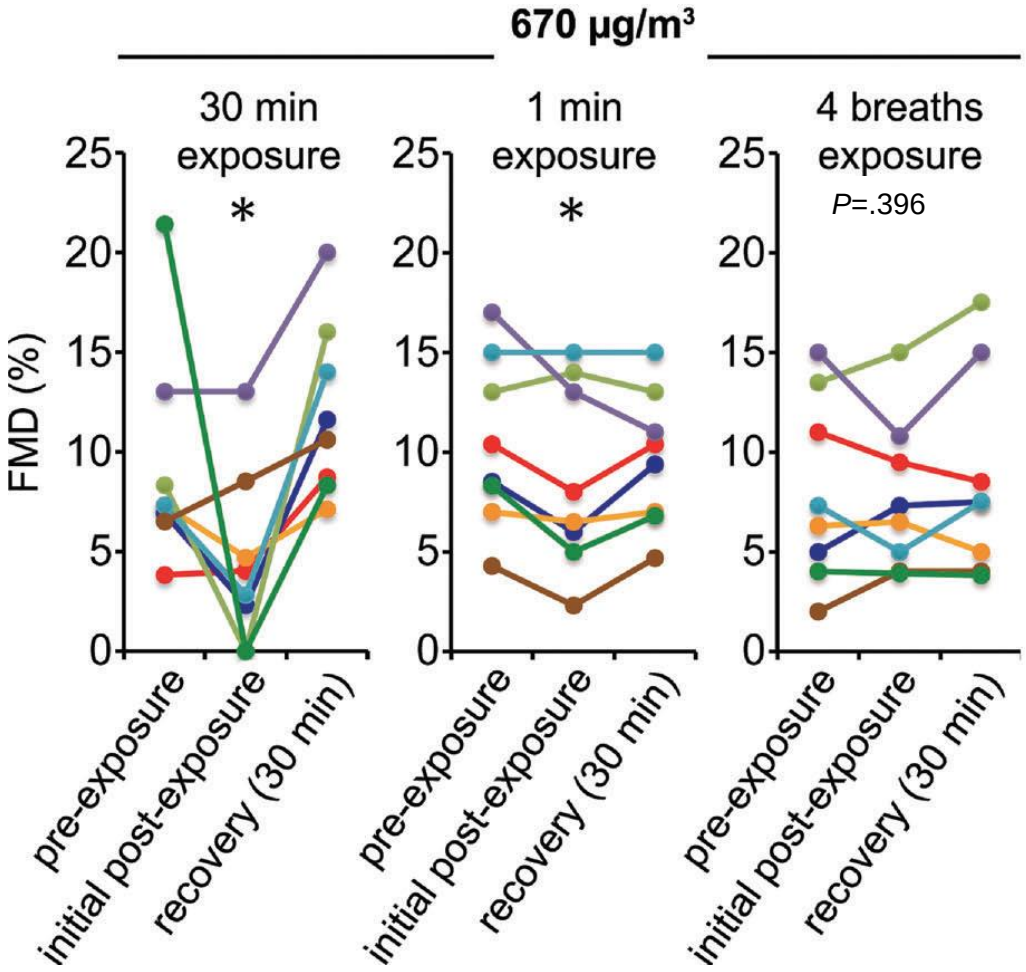
FMD measured in rat hindlimb using micro-ultrasound






LUBRICATE MOVING PARTS WITH DRY TEFLON SPRAY
ORDER FROM MCMASTER CARR DOT COM
TWIST TO LOCK
DANGER
KEEP HANDS CLEAR
WEIGHT
DANGER
CIG SWITCH MUST BE ON FOR LIGHTER TO WORK
FAN ON OFF
CIG SUC OFF ON
ON
ON
OFF
CIG PUSH
ACCOUNT FOR POINT 1 FOR A REV
POINT 1 EQUALS 6 SECONDS
PUMP SPEED CONTROL
RESPIRATION RATE/MINUTE
POWER REQUIREMENTS
110-120 VOLTS 50-60 CPS
MAXIMUM POWER 110 WATTS
FOR EXPERIMENTAL USE ONLY ON LABORATORY ANIMALS
THIS MACHINE IS NOT EXPLOSION PROOF
HARVARD APPARATUS CO
DOVER, MASS

1 minute of secondhand smoke (tobacco) exposure was enough to impair vascular endothelial function



n=8 for all groups

*P<.01 impairment vs. mean of pre-exposure and recovery

Nicotine & Tobacco Research, Volume 16, Number 5 (May 2014) *584–590*

ORIGINAL INVESTIGATION

Brief Exposure to Secondhand Smoke Reversibly Impairs Endothelial Vasodilatory Function

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It's not enough simply to minimize public exposure to secondhand smoke; it's important to prevent exposure

Impairment of Endothelial Function by Little Cigar Secondhand Smoke

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Xiaoyin Wang, MD
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Tobacco Regulatory Science. 2016;2(1):56-63

Jiangtao Liu

Inhalation of Heat-Not-Burn Tobacco Aerosol Impairs Vascular Endothelial Function

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(AHA 2017 Scientific Sessions)

Introduction: "Heat-not-burn" (HNB) tobacco devices heat tobacco at temperatures that avoid combustion but cause the nicotine to aerosolize, leaving the leaf material intact but depleted of volatile substances. A new HNB product, iQOS, from Philip Morris, has been test marketed in several non-US countries and has been considerably more successful than previously introduced HNB products[1]. Despite harm reduction claims by the tobacco industry[2], the health effects of HNB products are incompletely understood. Notably, industry-supported studies of potential cardiovascular consequences of HNB aerosol exposure published to date[3] have not included some common measures of adverse effects of smoke exposure, such as vascular endothelial function tested in vivo[4].

Figure 1. iQOS. *iQOS is composed of three main parts: HeatStick, holder, and pocket charger. HeatSticks are inserted in the holder, which contains an electronic heating blade to heat tobacco and release aerosol. HeatSticks contain strips of processed and reformed tobacco. (Photo: M. Springer)*

Methods: We exposed rats (n=8/group) via nose cone to iQOS aerosol, Marlboro cigarette mainstream smoke, or clean air as a control, ten times over 5 min to approximate the consumption of a single iQOS HeatStick. Exposure conditions were 15 seconds and 5 seconds twice per minute. To generate the aerosol and mainstream smoke, we used a manual system for the 15-second and an analytical vaping machine for the 5-second exposure (Figure 2). Arterial flow-mediated dilation (FMD) was quantitated pre- and post-exposure by measuring femoral artery diameter with micro-ultrasound before and after 5 min of transient surgically induced ischemia, and expressed as the percent vasodilation[5,6] (Figure 3). Serum samples were collected after the exposure and assessed for nicotine and cotinine levels.

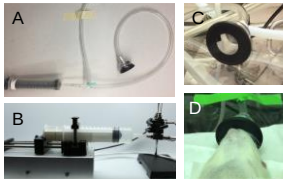

Figure 2. Aerosol generator and exposure systems. *A. Manual exposure system; B. Analytical vaping machine made by Gram Research Technology; C. iQOS aerosol coming out of nose cone; D. Rat's nose placed in the nose cone.*

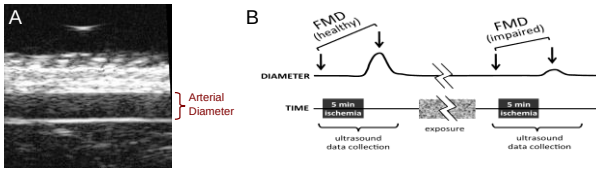

Figure 3. Arterial Flow-Mediated Dilation. *A. Ultrasound imaging of rat femoral artery; B. FMD experimental design.*

Results: FMD was impaired comparably by 5-second exposures to iQOS aerosol (9.6±1.0(SD)% pre-exposure vs. 3.8±2.6% post-exposure, p=.0001 by 2-tailed paired t-test) and cigarette smoke (11.2±2.6% pre-exposure vs. 4.2±2.3% post-exposure, p=.0005). 15-second exposures to iQOS aerosol and cigarette smoke impaired FMD to a similar extent (10.6±2.9% pre-exposure vs. 4.5±1.9% post-exposure, p=.0008; and 10.6±2.0% pre-exposure vs. 4.6±1.3% post-exposure, p=.0004, respectively). FMD was not affected in the clean air control group (8.3±1.9% vs. 8.8±4.5%, p=.82) (Figure 4). The percent FMD impairment was not significantly different in groups exposed for 5 seconds compared to 15 seconds (p=.27).

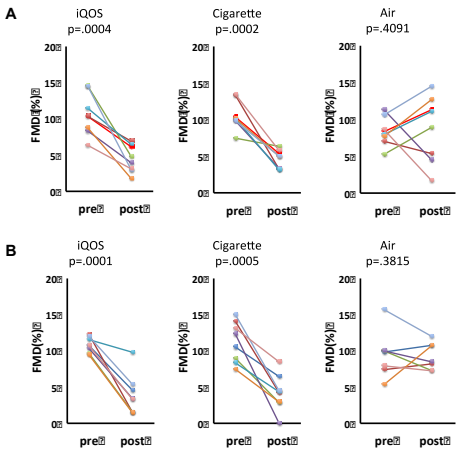

Figure 4. FMD was impaired by mainstream cigarette smoke and iQOS aerosol. *A. Ten 15-second exposures. B. Ten 5-second exposures.*

Results (continue
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exposure conditions
Serum nicotine and
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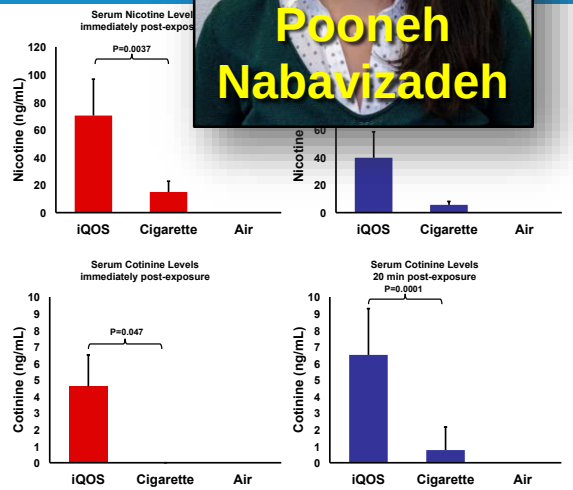

Figure 5. Serum nicotine and cotinine levels immediately and 20 min post-exposure.

Conclusion: We conclude that acute exposure to iQOS aerosol at doses relevant to real world use can substantially impair endothelial function in rats comparably to cigarette smoke despite the absence of combustion. Use of HNB tobacco products does not necessarily avoid the adverse cardiovascular effects of smoking cigarettes.

Funding: This work was supported by grant R01HL120062 from the National Heart, Lung, and Blood Institute at the National Institutes of Health (NIH) and the US Food and Drug Administration (FDA) Center for Tobacco Products. The content is solely the responsibility of the authors and does not necessarily represent the official views of the NIH or the FDA.
Disclosures: none

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3. Smith, M.R. et al. *Regul Toxicol Pharmacol* S17-S26 (2016).
4. Heiss, C. et al. *J Am Coll Cardiol*. 51:1760-71 (2008).
5. Heiss, C. et al. *AJP. Heart Circ. Physiol.* 294:H1086-H1093. (2008).
6. Wang, X. et al. *J. Am. Heart Assoc.* 5:e003858 (2016).

Problem: General public avoids tobacco SHS but many think marijuana SHS is ok

"There's no nicotine"

"It's natural"

"It's medicinal"

"No one said it ISN'T ok"

Table 4. Various Analytes Including Tobacco-Specific Compounds and Heavy Metals Determined in Sidestream Smoke from Tobacco and Marijuana under Two Smoking Conditions[a]

	ISO		extreme	
	tobacco	marijuana	tobacco	marijuana
tar (mg/cig)	24.3 ± 1.8	49.7 ± 2.5*	17.2 ± 1.8	30.8 ± 1.6*
NO (μg/cig)	1101 ± 47	2087 ± 152*	1419 ± 124	2631 ± 241*
NOx (μg/cig)	1172 ± 44	2284 ± 229*	1521 ± 153	2880 ± 323*
CO (mg/cig)	61.7 ± 2.0	54.0 ± 3.7*	61.6 ± 2.9	50.6 ± 3.9*
nicotine (mg/cig)	4.77 ± 0.26	0.065 ± 0.018*	3.11 ± 0.23	0.074 ± 0.029*
ammonia (μg/cig)	5568 ± 322	14270 ± 472*	3919 ± 327	10743 ± 675*
HCN (μg/cig)	83.8 ± 7.8	685 ± 29*	103 ± 10	678 ± 72*
NNN	41 ± 4.8	<0.634*	28 ± 2.0	0.634−2.0*
NAT	17.4 ± 1.4	<2.34*	10.2 ± 1.1	<2.34*
NAB	2.71 ± 0.52	<0.793*	0.79−2.5	<0.793
NNK	92 ± 11.7	<4.65*	61 ± 5.1	<4.65*
mercury	8.32 ± 0.57	<4.40*	6.31 ± 0.61	<4.40*
cadmium	478 ± 19	4.0−13.4*	360 ± 20	4.0−13.4*
lead	34.5−115	<34.5	34.5−115	<34.5
chromium	31.0−103	31.0−103	<31.0	31.0−103
nickel	35.5−118	35.5−118	<35.5	<35.5
arsenic	<11.3	<11.3	<11.3	<11.3
selenium	<17.5	<17.5	<17.5	<17.5

[a] Values are provided ± standard deviations. For tar, nicotine, and CO, $n = 20$. For all others, $n = 7$. Units are ng/cigarette unless noted differently. *$P < 0.05$ vs tobacco. Values shown with "<" were below the limit of detection; values shown as a range were above the limit of detection but below the limit of quantitation.

Table 5. Miscellaneous Organics Determined in Mainstream and Sidestream Smoke from Tobacco and Marijuana under Two Smoking Conditions[a]

	ISO		extreme	
	tobacco	marijuana	tobacco	marijuana
		mainstream		
pyridine	31.1 ± 1.7	34.6 ± 4.3	59 ± 4.9	93.0 ± 8.9*
quinoline	1.31 ± 0.08	1.06 ± 0.26*	2.22 ± 0.22	2.68 ± 0.34*
1,3-butadiene	64.8 ± 2.2	79.5 ± 7.4*	124 ± 7	138 ± 17
isoprene	286 ± 15	74.0 ± 6.5*	540 ± 18	132 ± 19*
acrylonitrile	13 ± 1.2	36.6 ± 4.3*	24 ± 0.9	66.9 ± 9.5*
benzene	62.2 ± 3.5	58.3 ± 5.9	94.6 ± 2.6	84.4 ± 8.9*
toluene	103 ± 6	124 ± 15*	169 ± 3	199 ± 25*
styrene	15 ± 0.6	17.2 ± 2.3*	28.6 ± 2.0	44.7 ± 4.2*
		sidestream		
pyridine	265 ± 11	307 ± 14*	225 ± 9	278 ± 22*
quinoline	9.94 ± 0.92	11.3 ± 0.7*	8.53 ± 0.54	9.82 ± 1.10*
1,3-butadiene	372 ± 12	412 ± 27*	269 ± 13	420 ± 22*
isoprene	1459 ± 82	656 ± 40*	1153 ± 51	614 ± 31*
acrylonitrile	102 ± 4	295 ± 21*	73.8 ± 4.7	273 ± 17*
benzene	290 ± 11	341 ± 12*	203 ± 11	328 ± 18*
toluene	516 ± 20	704 ± 29*	393 ± 32	729 ± 28*
styrene	105 ± 10	162 ± 10*	85.2 ± 10.6	175 ± 9*

[a] Values are provided ± standard deviations; $n = 7$. Units are μg/cigarette. *$P < 0.05$ vs tobacco.

marijuana was ammonia. In marijuana smoke, ammonia was found at levels about 20-fold those in tobacco in mainstream smoke (Table 3) and about 3-fold greater in sidestream smoke (Table 4), although the absolute values were very much greater in sidestream smoke. The amount of ammonia produced during combustion of tobacco has been related to the amount of nitrate fertilizer applied during growth (*30*). The simplest explanation for the very high levels of ammonia found in marijuana smoke may be that the marijuana used for this study contained more nitrate than the tobacco sample. The marijuana plants were grown on soil-less growth medium. All fertilizers were commercially available and consisted of water-soluble hydroponic vegetable fertilizers used for horticulture and contained nitrogen

Table 6. Aromatic Amines Determined in Mainstream and Sidestream Smoke from Tobacco and Marijuana under Two Smoking Conditions[a]

	ISO		extreme	
	tobacco	marijuana	tobacco	marijuana
		mainstream		
1-aminonaphthalene	24.9 ± 2.6	84.4 ± 13.2*	35.1 ± 5.7	178 ± 17*
2-aminonaphthalene	9.38 ± 0.62	33.6 ± 3.5*	12.9 ± 1.2	66.3 ± 6.8*
3-aminobiphenyl	2.22 ± 0.18	9.15 ± 0.63*	3.68 ± 0.44	18.8 ± 1.8*
4-aminobiphenyl	1.56 ± 0.13	6.17 ± 0.44*	2.54 ± 0.17	13.5 ± 1.5*
		sidestream		
1-aminonaphthalene	195 ± 16	305 ± 21*	144 ± 8	266 ± 23*
2-aminonaphthalene	136 ± 7	177 ± 19*	79.4 ± 7.4	139 ± 12*
3-aminobiphenyl	33 ± 2.1	50.4 ± 3.7*	19.7 ± 1.6	40.6 ± 2.4*
4-aminobiphenyl	23.2 ± 1.8	31.2 ± 2.8*	13.9 ± 1.3	27.3 ± 2.2

[a] Values are provided ± standard deviations; $n = 7$. Units are ng/cigarette. *$P < 0.05$ vs tobacco.

Table 7. Selected Carbonyl Compounds Determined in Mainstream and Sidestream Smoke from Tobacco and Marijuana under Two Smoking Conditions[a]

	ISO		extreme	
	tobacco	marijuana	tobacco	marijuana
		mainstream		
formaldehyde	200 ± 28	25.1 ± 2.7*	543 ± 91	66.5 ± 11.8*
acetaldehyde	872 ± 101	448 ± 44*	1555 ± 222	1021 ± 99*
acetone	454 ± 44	237 ± 23*	826 ± 93	514 ± 32*
acrolein	125 ± 13	54.3 ± 4.5*	251 ± 32	148 ± 13*
propionaldehyde	72.1 ± 8.1	32.3 ± 3.2*	97.8 ± 14.4	74.0 ± 6.4*
crotonaldehyde	62.9 ± 7.3	23.1 ± 1.5*	127 ± 17	56.7 ± 7.7*
methyl ethyl ketone	135 ± 16	62.4 ± 5.5*	265 ± 27	140 ± 7*
butyraldehyde	47.1 ± 5.7	46.5 ± 3.8	77.1 ± 10.0	110 ± 8*
		sidestream		
formaldehyde	886 ± 47	383 ± 27*	662 ± 29	202 ± 34*
acetaldehyde	1587 ± 45	1170 ± 69*	1383 ± 37	896 ± 112*
acetone	828 ± 22	566 ± 34*	720 ± 22	405 ± 54*
acrolein	437 ± 10	304 ± 20*	316 ± 12	179 ± 24*
propionaldehyde	121 ± 6	120 ± 6	116 ± 5	93.4 ± 11.7*
crotonaldehyde	106 ± 3	49.9 ± 3.8*	97.5 ± 8.7	42.9 ± 4.7*
methyl ethyl ketone	222 ± 9	160 ± 11*	202 ± 17	116 ± 13*
butyraldehyde	67.1 ± 2.7	173 ± 12*	60.2 ± 1.7	139 ± 13*

[a] Values are provided ± standard deviations; $n = 7$. Units are μg/cigarette. *$P < 0.05$ vs tobacco.

in the form of both nitrate and ammoniacal nitrogen. However, it is not known to what extent the differences in the growing conditions between the marijuana and the tobacco, including the types of fertilizers used, influenced the levels of nitrates in the plants. The temperature of combustion can also influence the production of ammonia. Burning tobacco results in a reduction of nitrate to ammonia, which is released to a greater extent during sidestream smoke formation (*31*), suggesting that lower combustion temperatures favor the production of ammonia. Combustion temperature differences between marijuana and tobacco may have also contributed to the differences in ammonia yield, but this was not verified.

Tobacco-specific nitrosamines were not found in the marijuana smoke (Tables 3 and 4). This result was expected, given that these compounds are derived from nicotine. Arsenic and lead were also noticeably absent from the marijuana smoke, which is consistent with the certificate of analysis provided with the plant material (data not shown). Again, this could be a function of the relatively controlled growth conditions.

NO and NO_x were significantly elevated in the marijuana smoke under both smoking regimes and in mainstream (Table 3) and sidestream smoke (Table 4). A logical explanation would be that these are arising from the nitrate present in the fertilizer and would be consistent with the very high ammonia yields.

Table 9. PAHs and Aza-arenes Determined in Mainstream Smoke from Tobacco and Marijuana under Two Smoking Conditions[a]

		ISO		extreme	
no.		tobacco	marijuana	tobacco	marijuana
1	naphthalene	2907 ± 159	2070 ± 290*	4908 ± 456	4459 ± 646
2	1-methylnaphthalene	2789 ± 176	2057 ± 302*	4888 ± 491	4409 ± 604
3	2-methylnaphthalene	2093 ± 137	1292 ± 189*	3666 ± 374	2917 ± 477*
4	acenaphthylene	385 ± 22	235 ± 31*	711 ± 51	459 ± 60*
5	acenaphthene	172 ± 10	91.2 ± 10.2*	309 ± 22	213 ± 48*
6	fluorene	769 ± 42	366 ± 37*	1369 ± 100	659 ± 64*
7	phenanthrene	293 ± 14	273 ± 23	515 ± 32	476 ± 45
8	anthracene	91.8 ± 5.4	70.9 ± 6.7*	162 ± 13	136 ± 9*
9	fluoranthene	96.8 ± 3.7	65.6 ± 6.5*	171 ± 11	117 ± 12*
10	pyrene	88.8 ± 4.3	45.6 ± 4.4*	154 ± 12	82.3 ± 11.2*
11	benzo(a)anthracene	30.5 ± 2.5	26.2 ± 3.4*	52 ± 5.8	43.1 ± 7.9*
12	chrysene	38.8 ± 2.3	26.2 ± 1.4*	61.7 ± 7.4	56.3 ± 7.9
13	benzo(b)fluoranthene	10.8 ± 0.6	7.18 ± 1.12*	21.9 ± 3.1	16.2 ± 3.6*
14	benzo(k)fluoranthene	3.42 ± 0.32	1.52 ± 0.26*	7.45 ± 1.47	4.54 ± 0.96*
15	benzo(e)pyrene	11 ± 0.6	6.15 ± 0.37*	19.2 ± 1.3	12.6 ± 2.7*
16	benzo(a)pyrene	14.3 ± 1.2	8.67 ± 1.12*	25.1 ± 2.5	15.5 ± 2.9*
17	perylene	3.9 ± 0.46	3.72 ± 0.79	10.8 ± 2.3	6.10 ± 0.82*
18	indeno(1,2,3,-cd)pyrene	4.58 ± 0.89	3.60 ± 0.48*	10.1 ± 0.9	8.65 ± 3.11
19	dibenz(a,h)anthracene	1.15 ± 0.21	1.41 ± 0.19*	4.84 ± 1.05	2.83 ± 0.59*
20	benzo(g,h,i)perylene	3.77 ± 0.66	2.56 ± 0.36*	7.17 ± 1.02	6.03 ± 2.34
21	5-methylchrysene	<0.035	<0.035	<0.071	<0.071
22	benzo(b)fluoranthene	11.5 ± 1.4	6.47 ± 0.86*	19.1 ± 1.7	17.6 ± 1.4
23	benzo(j)fluoranthene	5.81 ± 0.44	4.27 ± 0.83*	13.3 ± 1.8	12.2 ± 2.1
24	dibenz(a,h)acridine	<0.314	<0.314	<0.628	<0.628
25	dibenz(a,j)acridine	<0.260	<0.260	<0.519	<0.519
26	7*H*-dibenzo(c,g)carbazole	<0.139	<0.139	<0.278	<0.278
27	dibenz(a,l)pyrene	<0.317	<0.317	<0.634	<0.634
28	dibenz(a,e)pyrene	0.531 ± 0.198	0.156−0.522	<0.313	<0.313
29	dibenz(a,i)pyrene	0.987 ± 0.145	0.164−0.548*	2.55 ± 0.60	<0.329*
30	dibenz(a,h)pyrene	0.177−0.589	<0.177	<0.354	<0.354

[a] Values are provided ± standard deviations; $n = 7$. Units are ng/cigarette. *$P < 0.05$ vs tobacco. Values shown with "<" were below the limit of detection; values shown as a range were above the limit of detection but below the limit of quantitation.

Table 10. PAHs and Aza-arenes Determined in Sidestream Smoke from Tobacco and Marijuana under Two Smoking Conditions[a]

		ISO		extreme	
no.		tobacco	marijuana	tobacco	marijuana
1	naphthalene	6861 ± 419	16748 ± 2396*	10111 ± 758	14398 ± 2614*
2	1-methylnaphthalene	6265 ± 365	14812 ± 1511*	7115 ± 787	11016 ± 2954*
3	2-methylnaphthalene	6513 ± 306	11832 ± 1078*	7137 ± 778	9030 ± 2236
4	acenaphthylene	2684 ± 184	4056 ± 452*	2171 ± 123	2876 ± 571*
5	acenaphthene	960 ± 31	1345 ± 101*	791 ± 51	873 ± 163
6	fluorene	1429 ± 71	1073 ± 72*	1242 ± 56	873 ± 67*
7	phenanthrene	2818 ± 112	4932 ± 306*	2117 ± 98	3113 ± 477*
8	anthracene	755 ± 38	1135 ± 75*	542 ± 26	693 ± 111*
9	fluoranthene	699 ± 26	952 ± 61*	520 ± 24	619 ± 78*
10	pyrene	528 ± 35	609 ± 60*	377 ± 25	398 ± 38
11	benzo(a)anthracene	159 ± 8	245 ± 16*	113 ± 7	170 ± 21*
12	chrysene	401 ± 21	488 ± 28*	291 ± 18	331 ± 27*
13	benzo(b)fluoranthene	98.4 ± 8.4	114 ± 7*	79.8 ± 4.3	80.3 ± 8.0
14	benzo(k)fluoranthene	25.8 ± 4.1	27.3 ± 2.8	19.3 ± 3.1	19.7 ± 2.2
15	benzo(e)pyrene	94.9 ± 6.9	87.9 ± 7.5	72.9 ± 3.8	63.1 ± 6.2*
16	benzo(a)pyrene	91.7 ± 7.1	101 ± 9*	62.7 ± 4.2	69.7 ± 6.3*
17	perylene	23.6 ± 2.9	26.4 ± 4.7	16.4 ± 1.7	19.9 ± 2.7*
18	indeno(1,2,3,-cd)pyrene	41.7 ± 5.7	45.9 ± 6.8	32.8 ± 6.6	27.4 ± 3.3
19	dibenz(a,h)anthracene	13.8 ± 3.1	15.6 ± 3.2	13.9 ± 2.8	10.8 ± 1.2*
20	benzo(g,h,i)perylene	44.7 ± 8.0	41.8 ± 9.6	32.8 ± 7.2	30 ± 5.0
21	5-methylchrysene	<0.354	<0.354	<0.354	<0.354
22	benzo(b)fluoranthene	118 ± 9	102 ± 11*	90.4 ± 5.6	86.7 ± 12.5
23	benzo(j)fluoranthene	102 ± 7	120 ± 16*	72.3 ± 6.2	124 ± 14*
24	dibenz(a,h)acridine	<3.138	<3.138	<3.138	<3.138
25	dibenz(a,j)acridine	<2.597	<2.597	<2.597	<2.597
26	7*H*-dibenzo(c,g)carbazole	<1.389	<1.389	<1.389	<1.389
27	dibenz(a,l)pyrene	<3.172	<3.172	<3.172	<3.172
28	dibenz(a,e)pyrene	<1.565	<1.565	<1.565	<1.565
29	dibenz(a,i)pyrene	<1.644	<1.644	<1.644	<1.644
30	dibenz(a,h)pyrene	<1.768	<1.768	<1.768	<1.768

[a] Values are provided ± standard deviations; $n = 7$. Units are ng/cigarette. *$P < 0.05$ vs tobacco. Values shown with "<" were below the limit of detection.

Dried plant smoke: similar chemicals in varied proportions

Sample comparisons of components of tobacco and marijuana secondhand smoke

	tobacco	marijuana
tar (mg/cig)	24.3 ± 1.8	49.7 ± 2.5*
NO (μg/cig)	1101 ± 47	2087 ± 152*
CO (mg/cig)	61.7 ± 2.0	54.0 ± 3.7*
nicotine (mg/cig)	4.77 ± 0.26	0.065 ± 0.018*
ammonia (μg/cig)	5568 ± 322	14270 ± 472*
HCN (μg/cig)	83.8 ± 7.8	685 ± 29*
pyridine (μg/cig)	265 ± 11	307 ± 14*
benzene (μg/cig)	290 ± 11	341 ± 12*
toluene (μg/cig)	516 ± 20	704 ± 29*
styrene (μg/cig)	105 ± 10	162 ± 10*

	tobacco	marijuana
naphthalene (ng/cig)	6861 ± 419	16748 ± 2396*
formaldehyde (μg/cig)	888 ± 47	383 ± 27*
acetaldehyde (μg/cig)	1587 ± 45	1170 ± 69*
acrolein (μg/cig)	437 ± 10	304 ± 20*
methyl ethyl ketone (μg/cig)	222 ± 9	160 ± 11*
phenol (μg/cig)	264 ± 13	260 ± 11
m + *p*-cresols (μg/cig)	64.6 ± 2.5	104 ± 6*
pyrene (ng/cig)	528 ± 35	609 ± 60*
benzo(e)pyrene (ng/cig)	94.9 ± 6.9	87.9 ± 7.5
anthracene (ng/cig)	755 ± 38	1135 ± 75*

From Moir *et al.*, 2008. Subset of 65 components analyzed under standard tobacco smoking conditions

Inhaling a whole chemistry lab...

U.S. Department of Justice Drug Enforcement Administration

Office of Diversion Control

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General Instructions.

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Your business activity is: RESEARCHER (I)

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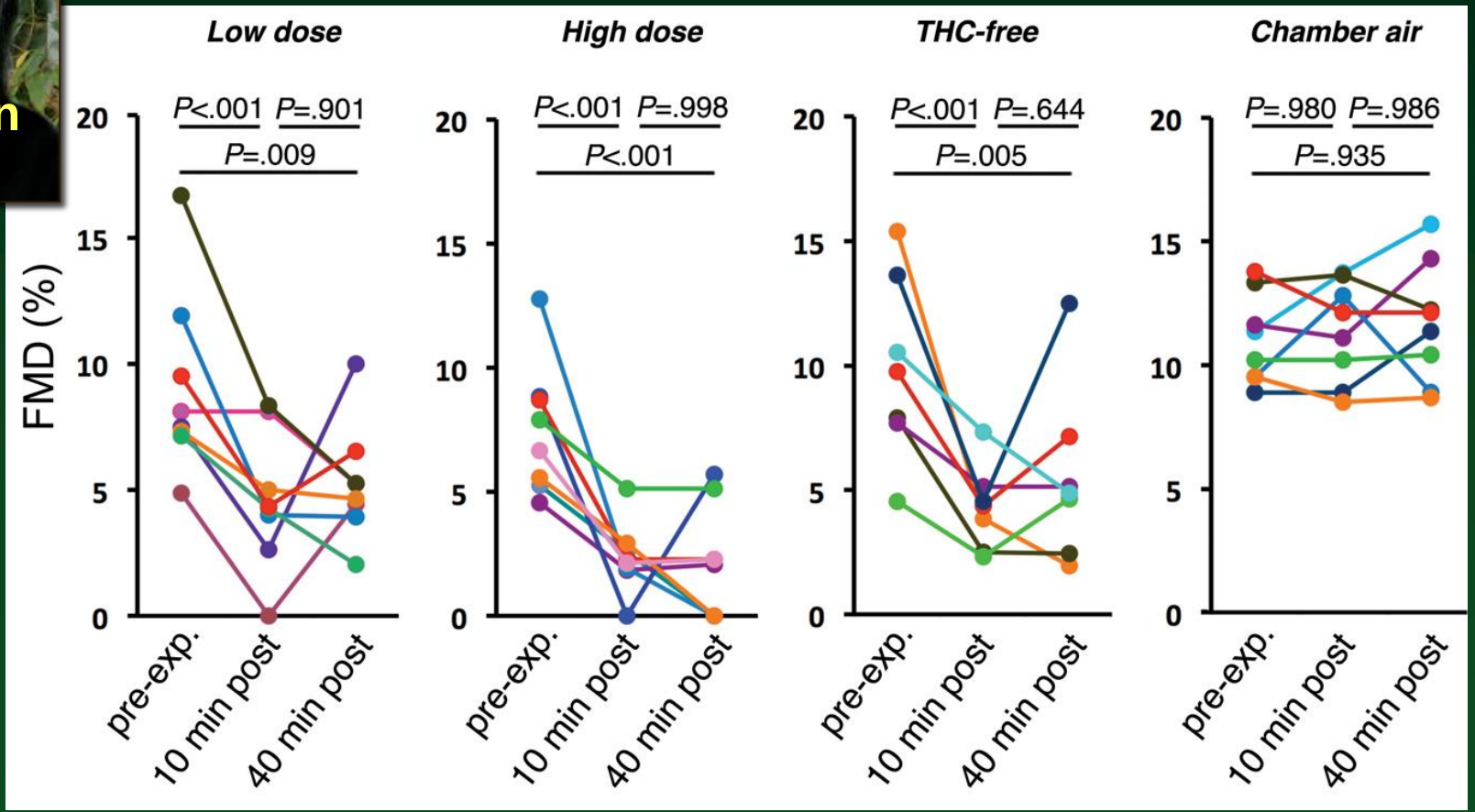
One Minute of Marijuana Secondhand Smoke Exposure Substantially Impairs Vascular Endothelial Function

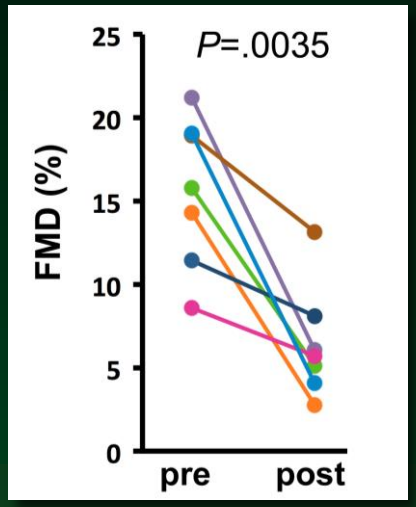
Xiaoyin Wang, MD; Ronak Derakhshandeh, MS; Jiangtao Liu, MD; Shilpa Narayan, BS;* Pooneh Nabavizadeh, MD; Stephenie Le, BA;† Olivia M. Danforth, BS;‡ Kranthi Pinnamaneni, MD; Hilda J. Rodriguez, AS; Emmy Luu, BS; Richard E. Sievers, BS; Suzaynn F. Schick, PhD; Stanton A. Glantz, PhD; Matthew L. Springer, PhD

(*J Am Heart Assoc.* 2016;5:e003858 doi: 10.1161/JAHA.116.003858)



“30 minutes is kind of long, how about shorter times?”

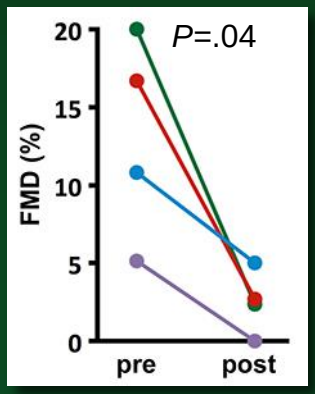
marijuana 1 min



59% drop in FMD

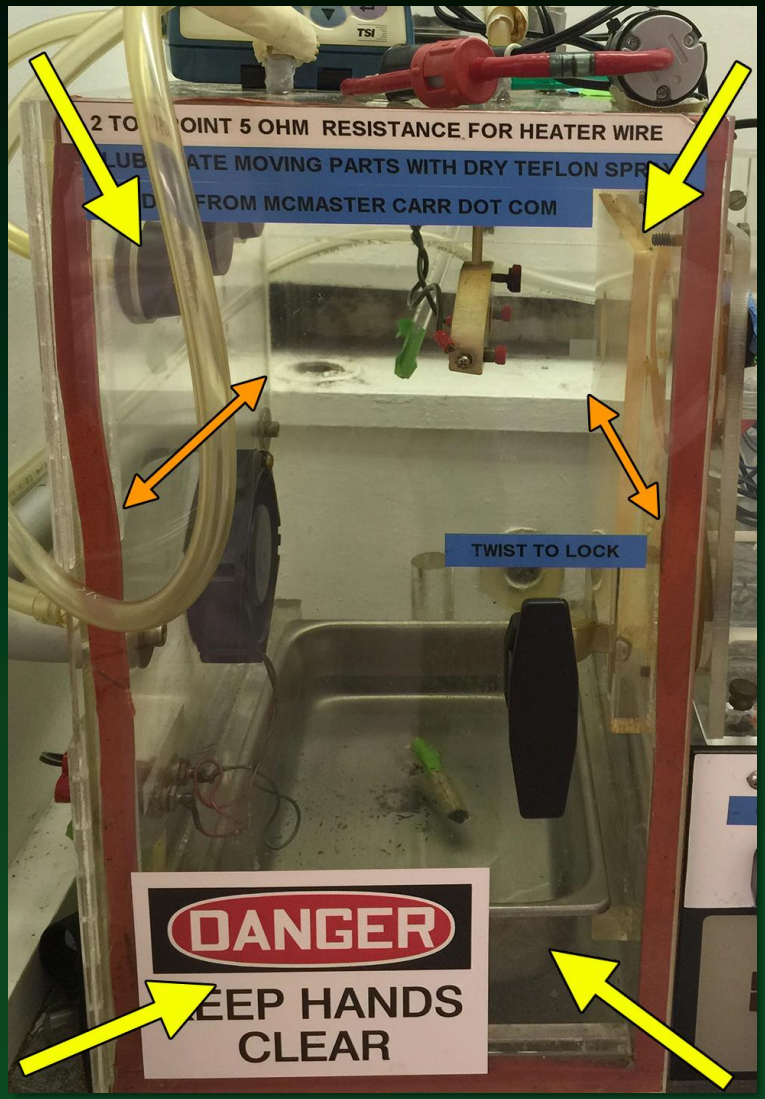
Marijuana SHS for 1 minute lowered FMD

“Could the impairment in FMD be caused by smoke from the burning paper, rather than tobacco and marijuana?”



SHS from marijuana without paper still impairs FMD

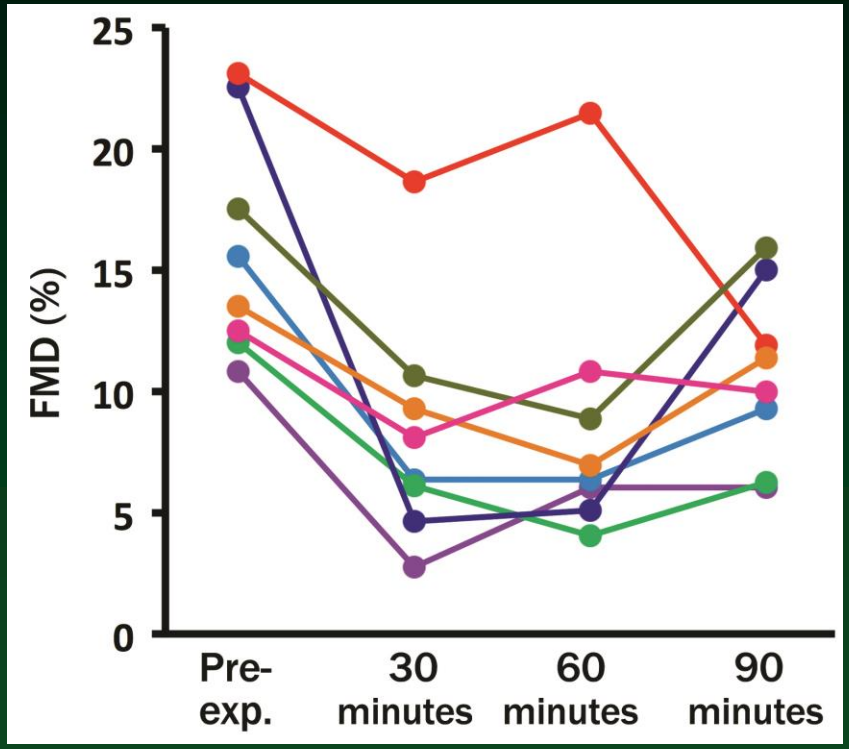
“They totally smoke out the rats”



The smoke was invisible in the exposure chamber

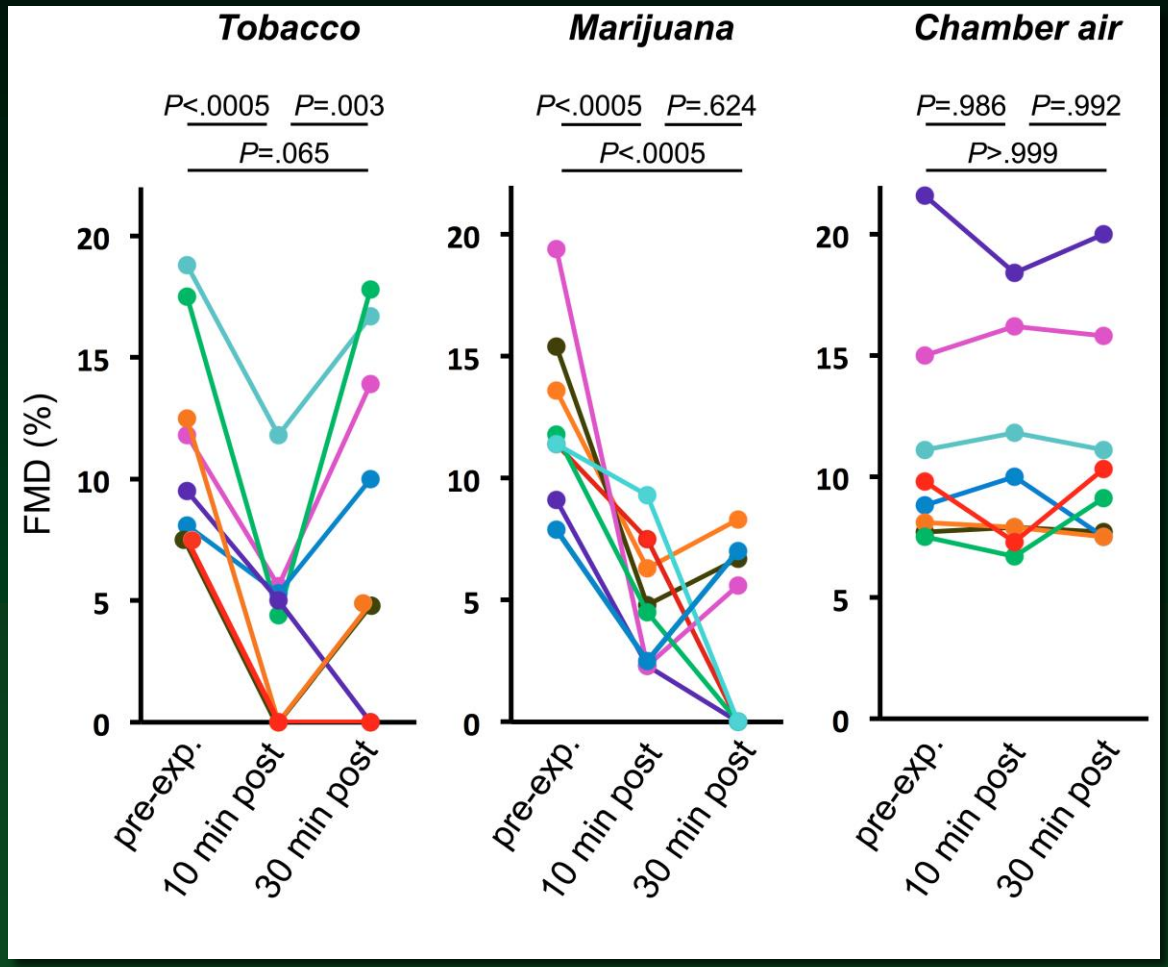
“How long does it take for FMD to recover?”

1 minute exposure (THC-free)



Marijuana SHS for 1 minute lowered FMD for at least 90 minutes

“How do marijuana and tobacco compare in impairment of FMD?”



Impairment from one minute of marijuana SHS persists longer than impairment from tobacco SHS

Summary of marijuana results

Wang et al., 2016, J Am Heart Assoc 5:e003858

Marijuana SHS for one minute substantially impairs vascular endothelial function in rats.

Neither THC nor paper smoke are required for marijuana SHS to impair vascular function.

...nicotine is not required for impairment of vascular function by smoke.

One minute of marijuana SHS exposure impairs vascular function for at least 90 minutes, longer than impairment from tobacco SHS.

Acute and long-term cardiovascular risk is unclear

Risk of MI goes up ~5-fold in the hour after marijuana use (Mittleman, 2001)

Mortality from MI may or may not increase in marijuana users (Mukamal, 2008; Frost, 2013)

No clear correlation between long-term marijuana use and cardiovascular disease later in life (e.g., Reis, 2017 CARDIA study)

…but, increased MI, heart failure, stroke reported for marijuana users relative to non-users (e.g., Kalla et al., Chami et al., 2017 ACC conference)

Physicians

Presented at the Pediatric Academic Societies 2016 Meeting (Dr. Karen Wilson):

One in six infants and toddlers admitted to a Colorado hospital with coughing, wheezing and other symptoms of bronchiolitis tested positive for marijuana exposure.

Regulators and lawmakers

Regulators and lawmakers

Toronto Star 11/25/15:

Using medical marijuana now OK in public places in Ontario under new regulations

The exemption includes everything from movie theatres to restaurants, offices, stadiums, playgrounds full of children and more

Toronto Star 11/26/15:

Ontario government taking medical marijuana plan back to the drawing board

Associate Health Minister Dipika Damerla quickly reversed course Thursday over concerns about exposure to second-hand cannabis smoke in restaurants, theatres, offices and other public spaces where tobacco smoking is banned.

Regulators and lawmakers

California State Assembly bill AB 2300 (Jim Woods)

Clarifies that landlords can prohibit smoking of marijuana even with medicinal ID card in properties where tobacco smoking is banned

- Our 2014 report cited as a major reason for the bill
- Passed State Assembly Judiciary Committee 10-0
- Passed State Assembly 77-0 (3 non-votes)
- Died in State Senate Judiciary Committee

Regulators and lawmakers

Pleasanton Weekly.com

NEWS

Uploaded: Tue, Aug 15, 2017, 11:40 pm

City Council tweaks proposal for smoking restrictions at apartments

Medical marijuana smoking, with doctor's note, would be allowed only in designated area at complexes

by Jeremy Walsh / Pleasanton Weekly

The Pleasanton City Council took another step Tuesday toward establishing new stringent

Regulators and lawmakers

The Pleasanton City Council took another step Tuesday toward establishing new stringent smoking regulations for rental apartment complexes across the city.

Reviewing a proposed ordinance they gave initial support to two months ago, council members left most of the original proposal intact -- including the ban on tobacco smoking in apartment units and common areas -- but they adjusted course to limit medical marijuana smoking at complexes only to designated outdoor smoking areas.

Vice Mayor Jerry Pentin said he supported that option for medical marijuana smoking "so we're not banning it entirely but we're still keeping it away from people who are inside their own rental units and dealing with secondhand smoke."

Regulators and lawmakers

City staff's recommendation was to allow medical marijuana smoking inside apartment units "if tenant provides landlord written documentation that tenant needs it for medical purposes, no alternative means of delivery or ingestion are available and tenant is unable to smoke outside," assistant city attorney Larissa Seto said.

The council's follow-up discussion Tuesday focused on how to reduce the effects of secondhand smoke on neighbors living in close quarters in apartments while accommodating residents who rely on marijuana for legitimate medical reasons but can only smoke it -- and what about residents physically unable to leave their apartments…

Tamiko Johnson of the Alameda County Public Health Department also voiced support for prohibiting medical marijuana smoking indoors.

Regulators and lawmakers

"There's no safe level of secondhand smoke exposure," Johnson told the council. "From experience with other cities, gaining compliance with your smoke-free-housing law and having effective enforcement if you're allowing someone to smoke anything inside their apartment is going to be incredibly difficult for you all."

"I don't have problems with people smoking medical marijuana. I have problems with people who smoke it and then the person next door has to suffer from the secondhand smoke," Pentin said.

"When people take medication, it normally doesn't affect anybody else. And in this case, it does affect other people," Mayor Jerry Thorne added. "I just kind of wonder where you draw the line here. It's kind of darned if you do, darned if you don't."

EXPERT Q&A

Do Researchers Have the Right Marijuana?

by JEANINE BARONE | OCTOBER 25, 2016

Matt Springer, PhD, is a Professor of Medicine at the University of California, San Francisco, who studies the effects of secondhand marijuana smoke. He spoke with us about the implications of the recent announcement by the federal Drug Enforcement Administration that it will lift restrictions on the growing of marijuana to supply researchers.

How will the DEA's announcement affect your research?

Not as much as you might think. I still will not be able to study what I'd like to. I'd like to study real-world cannabis used by real people. UCSF used real-world cigarettes, not research-reference cigarettes, for tobacco studies in the past. But

(Disclosure: Dr. Springer has no financial ties to Myrbetriq, nor does he even have the faintest idea of what it is except that it apparently is not for everyone)

Public Release

Health Effects of Cannabis and Cannabinoids

Current State of Evidence and Recommendations for Research

This report will be available to download as a free pdf: **Nationalacademies.org/CannabisHealthEffects**

The National Academies of
SCIENCES · ENGINEERING · MEDICINE

Cardiometabolic Risk

- The evidence is unclear as to whether and how cannabis use is associated with heart attack, stroke, and diabetes.

Policy Goals:

Public exposure to secondhand smoke should be avoided whether the source is tobacco or marijuana.

Policy Goals:

Change the perception and the dialogue

Policy Goals:

Change the perception and the dialogue

"There's tar and chemicals"

"It's gross"

"It's bad for you"

"No one said it ISN'T ok"

stay tuned

If the FMD impairment by marijuana smoke is caused by the dried plant material combustion smoke, rather than the THC...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180°C
TÜV SÜD

"Smokewar" by Rui Zheng, 2013
(the daughter of Xiaoyin Wang in my lab)