

Flame Retardant Concentrations in House Dust: Before and After Replacing Upholstered Furniture

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Motivation

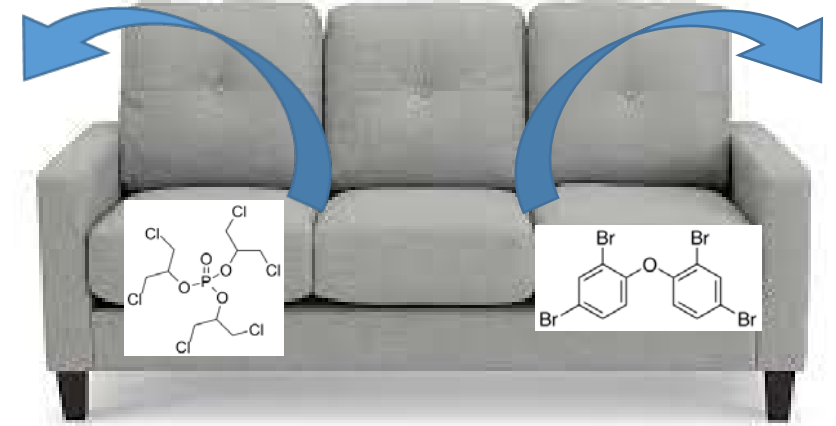
California revised the state's furniture flammability standard (TB117), which can now be met without adding flame retardants to foam (TB117-2013). As a result, flame retardant-free couches are available.

Study Goals

- Determine whether flame retardant concentrations in dust decrease when couches or seat cushion foam are replaced
- Collaborate with Biomonitoring California to measure flame retardants in blood and urine from a subset of participants (FREES: Foam Replacement Environmental Exposure Study)

Flame Retardants

- Polybrominated Diphenyl Ethers (PBDEs)
- Firemaster 550 (FM550)
- Organophosphate Flame Retardants (OPFRs)



1975

TB 117

PBDEs

2005

2015

TB 117-2013

OPFRs/FM550

THE UPHOLSTERY MATERIALS
IN THIS PRODUCT:

_____ CONTAIN ADDED FLAME
RETARDANT CHEMICALS

☒ CONTAIN NO ADDED
FLAME RETARDANT CHEMICALS

Two Groups Recruited

Bay Area/Sacramento Area

- Currently owned a couch likely to contain flame retardants
- Planning to replace couch OR foam within 1 year of recruitment
- Willing to replace couch OR foam with a flame retardant-free option
- Participants responsible for couch or foam replacement -> time to replace couch varied

San Jose

- Currently owned a couch likely to contain flame retardants
- Lived in one of two low-income apartment complexes
- Willing to have couch replaced with a flame retardant-free couch supplied by study
- All homes were on same timeline for home visits and couch replacements

Study Timeline

- Dust sample collected
- No sample collected



Study Timeline

- Dust sample collected
- No sample collected

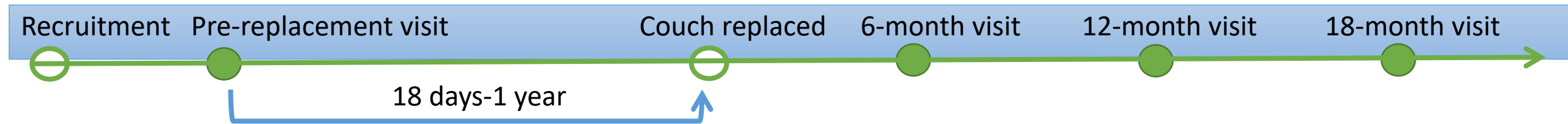


Bay Area/Sacramento

July 2015-
August 2016

Study Timeline

- Dust sample collected
- No sample collected



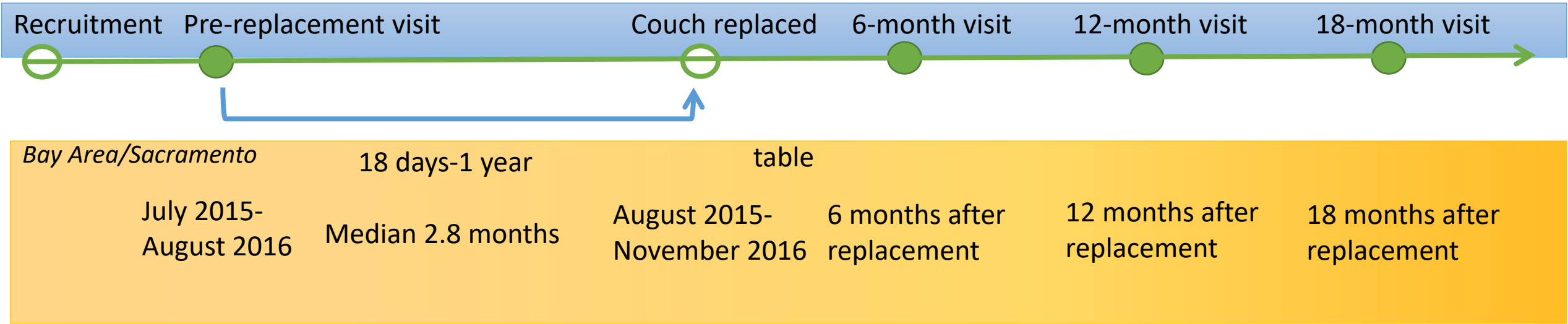
Bay Area/Sacramento

July 2015-
August 2016

27% 1 month or less
50% 2-6 months
23% 7-12 months
Median 2.8 months

Study Timeline

- Dust sample collected
- No sample collected



Study Timeline

- Dust sample collected
- No sample collected



San Jose

May 2016

All initial visits done
at same time and all
furniture replaced at
same time

July 2016

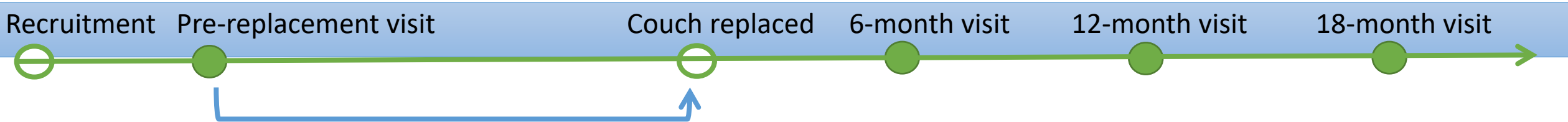
January 2017

July 2017

February 2018

Study Timeline

- Dust sample collected
- No sample collected



Bay Area/Sacramento		18 days-1 year			
July 2015- August 2016	Median 2.8 months	August 2015- November 2016	6 months after replacement	12 months after replacement	18 months after replacement

San Jose					
May 2016	2 months	July 2016	January 2017	July 2017	February 2018

Household Retention

Bay Area/Sacramento Area

	Completed	Moved/Dropped out
Consent	28	--
Initial Visit	28	0
6-month Visit	22	6
12-month Visit	21	1
18-month Visit	21	0



Replacement Type	Total
Couch	8
Foam	12
Removal	2

San Jose

	Activity Completed	Lost to follow-up/ Moved/Dropped out
Consent	14	--
Initial Visit	13	1
6-month Visit	11	2
12-month Visit	11	0
18-month Visit	8	3



Replacement couch
provided by study

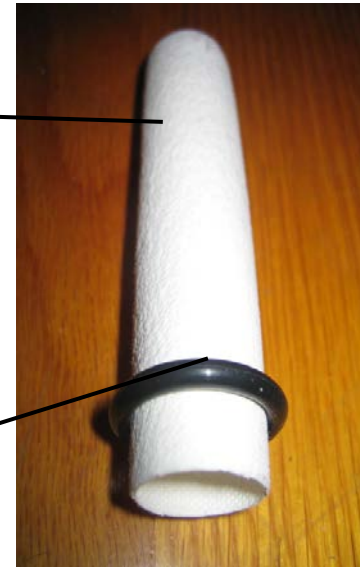
Study Dust Collection: Mighty-Mite Vacuum Method

Crevice tool attachment



Thimble

O-ring



Crevice tool attachment



*Photos from Joe Allen

Dust Sample Collection



- Main living area
- NO upholstered furniture
- Equivalent of room's floor surface area
- NOT under furniture

Dust Analytical Methods

Extraction Method



Sieve, measure 100 mg



3:1 hexane:acetone



Sonication



Repeat once with acetone



Evaporation and Filtration



Instrumental Analysis:

- Agilent 7200B GC-qTOF-MS
- Column: HP-5MS (30m x 0.25 mm, 0.25 μ m)
- Temperature: gradient, linear increase 35 – 325 $^{\circ}$ C
- Data Acquisition: 80 minutes, EI mode (70 eV)

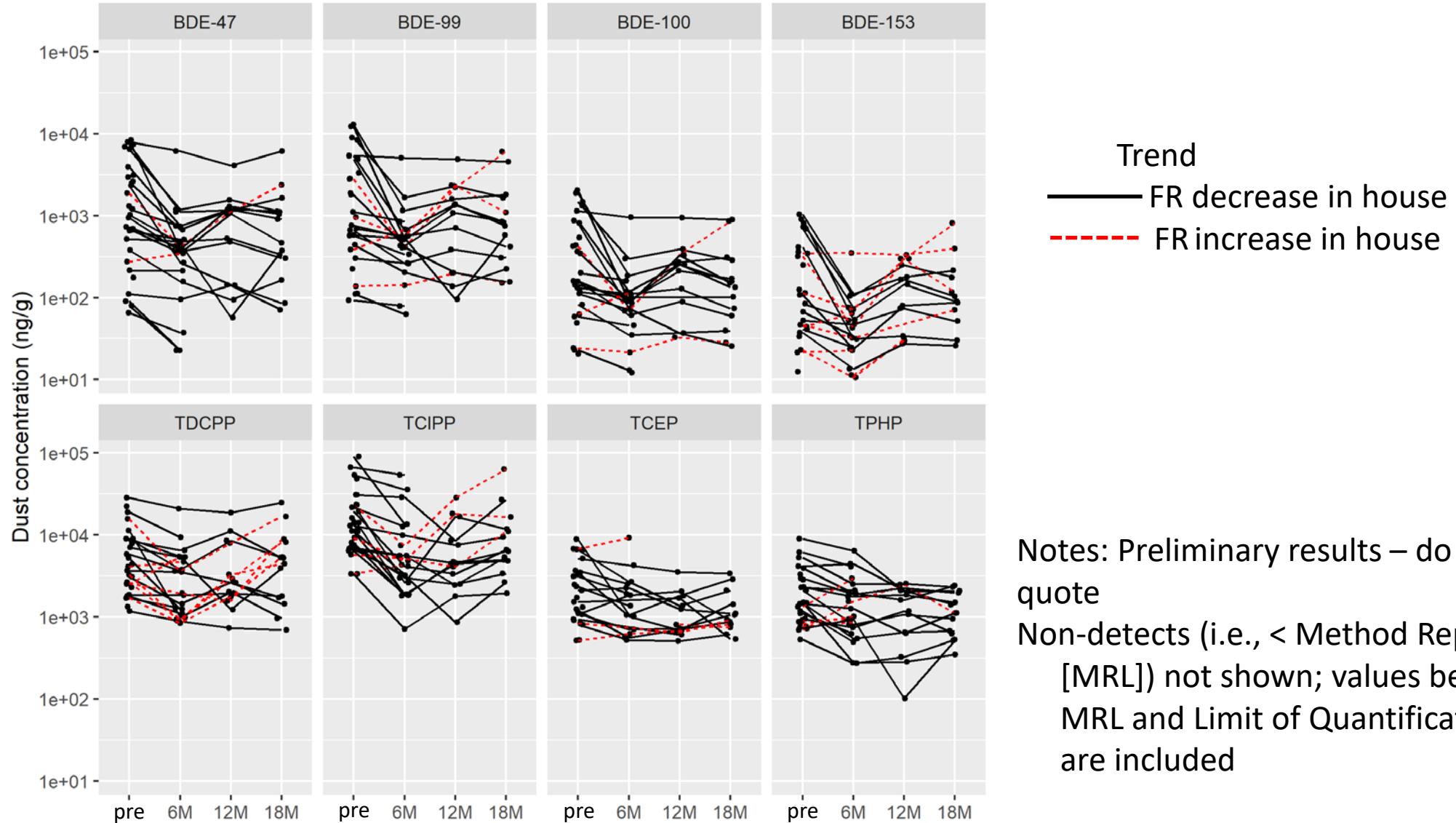
Target Compound Analysis:

- 7 Brominated flame retardants (BDEs)
- 7 Non-brominated flame retardants

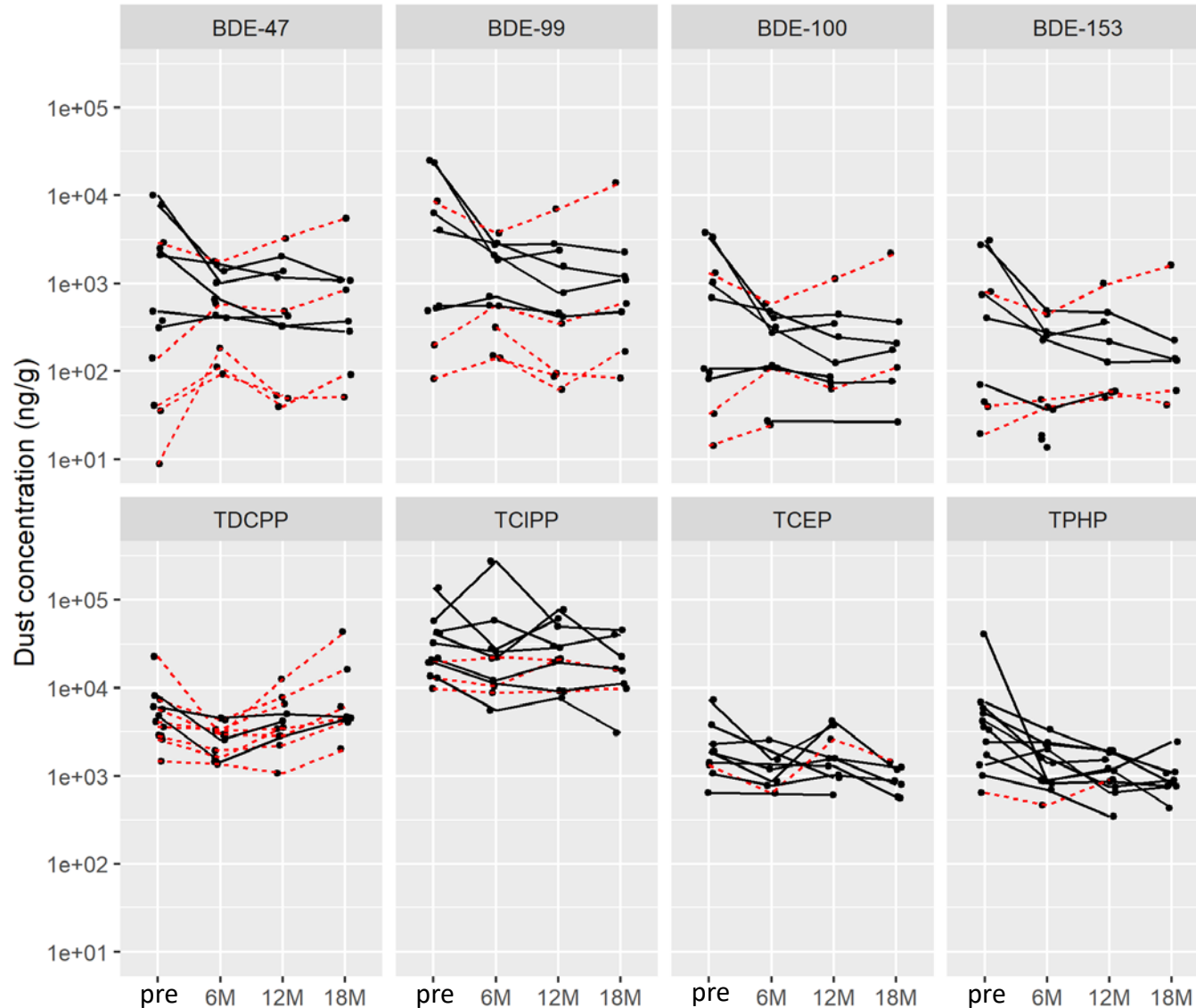
Flame Retardant Chemicals Analyzed

Class	Compound Name	Abbreviation
PBDEs	2,2',4,4'-Tetrabromodiphenyl ether	BDE-47
	2,2',4,4',5-Pentabromodiphenyl ether	BDE-99
	2,2',4,4',6-Pentabromodiphenyl ether	BDE-100
	2,2',4,4',5,5'-Hexabromodiphenyl ether	BDE-153
OPFRs	Tris (1-chloro-isopropyl) phosphate	TCIPP
	Triphenyl phosphate	TPHP
	Tris(2-chloroethyl) phosphate	TCEP
	Tris(1,3-dichloro-2-propyl) phosphate	TDCPP

Bay Area/Sacramento Results: Flame Retardant Levels Over Time



San Jose Results: Flame Retardant Levels Over Time



Trend
— FR decrease in house
- - - FR increase in house

Notes: Preliminary results – do not cite or quote
Non-detects (i.e., < Method Reporting Limit [MRL]) not shown; values between the MRL and Limit of Quantification (LOQ) are included

Foam Sample Collection

- Bay Area/Sacramento
 - Small pieces of seat cushion foam
 - If participant was willing and foam was accessible
- San Jose
 - Large block of seat cushion foam
 - Arm rest foam
 - Fabric: seat, arm rest, backing, and decking

Location	Foam collected from existing couch
Bay Area/Sacramento	13/22
San Jose	11/11

Detections of flame retardants in existing couches - Bay Area/Sacramento

		TCEP	TCIPP	TDCIPP	TPHP	BDE-47	BDE-99	BDE-100	BDE-153
A	cushion			X					
B	cushion				X				
C	cushion				X				
D	cushion			X					
E	cushion	X	X	X					
F	cushion			X					
G	cushion				X				
H	cushion				X	X	X	X	X
I	cushion				X	X	X	X	X
J	cushion		X						
K	cushion			X	X				
L	cushion				X	X	X	X	X
M	cushion			X					
Percent Detect		8%	15%	46%	54%	23%	23%	23%	23%

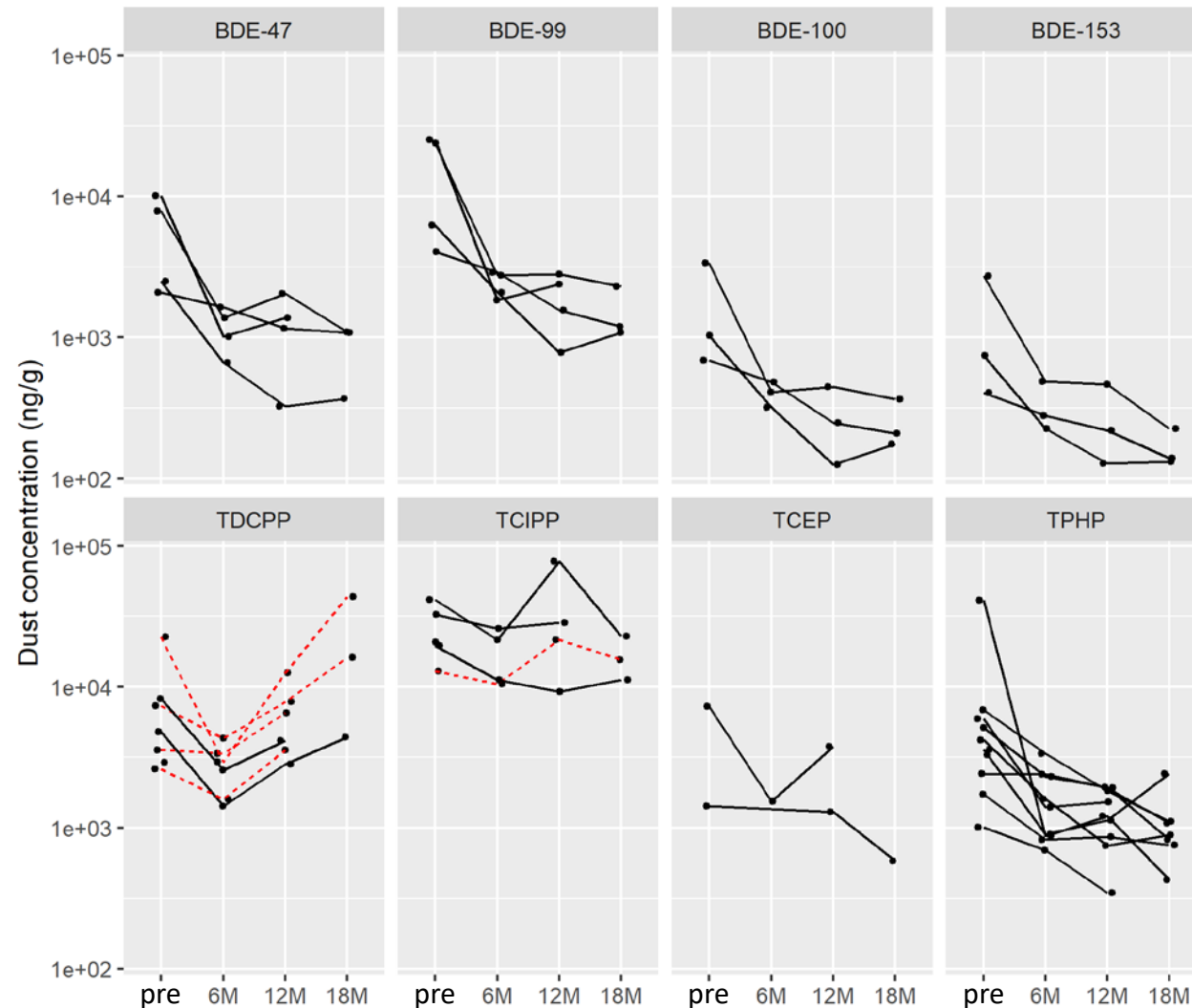
Detections of flame retardants in existing couches- San Jose



Not found in seat cushion sample, but found in other samples taken from couch

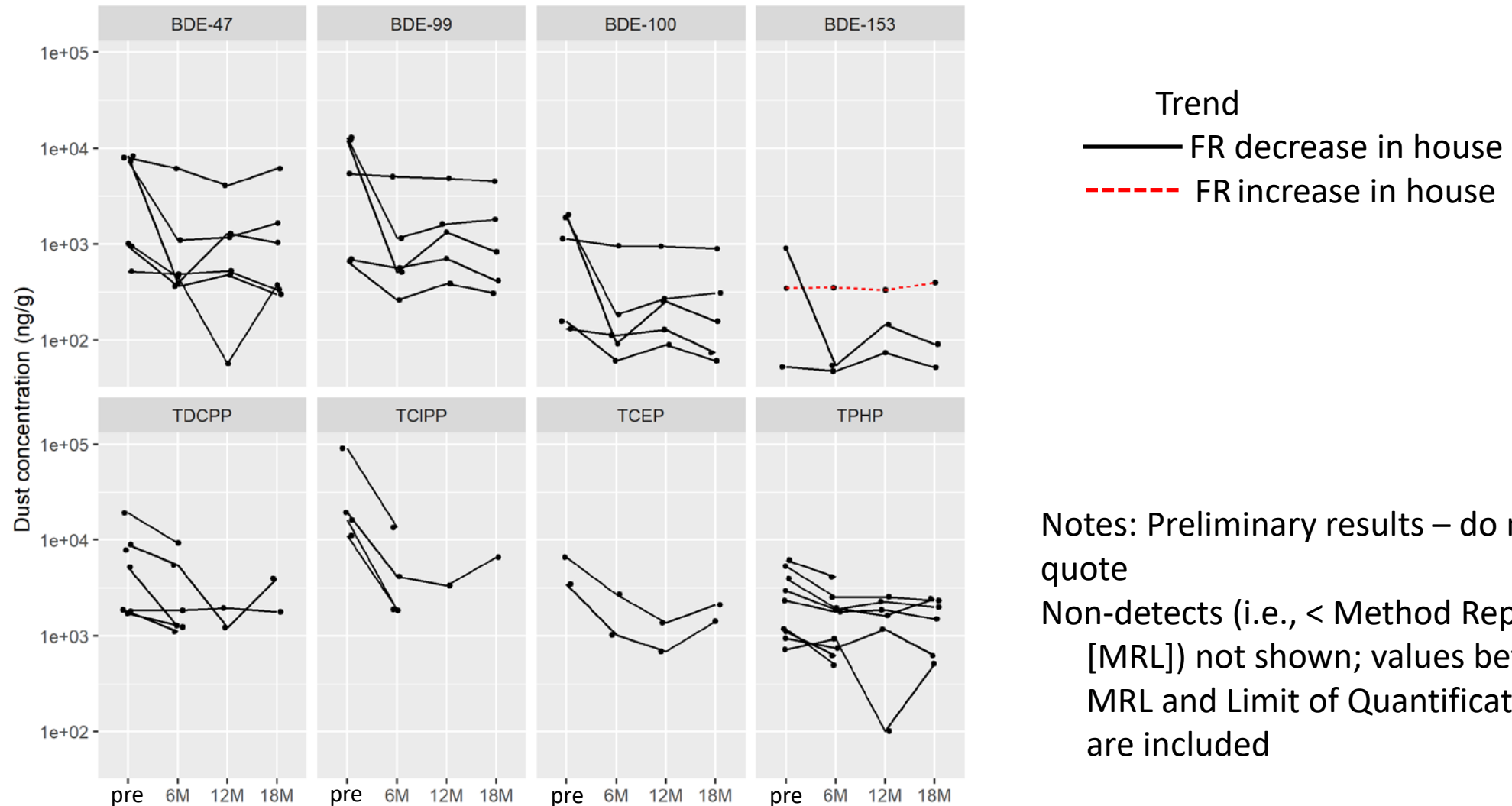
		TCEP	TCIPP	TDICPP	TPHP	BDE-47	BDE-99	BDE-100	BDE-153
A	cushion				X				
	other				X	X	X	X	X
B	cushion	X			X				
	other	X	X		X				
C	cushion				X				
	other				X				
D	cushion				X				
	other		X	X	X				
	cushion				X				
	other			X	X				
E	cushion			X	X				
	other			X					
F	cushion				X				
	other		X	X	X	X	X	X	X
G	cushion	X							
	other	X		X					
H	cushion			X	X				
	other			X	X				
I	cushion	X	X	X					
	other	X	X	X	X				
	cushion				X	X	X	X	X
	other				X	X	X	X	X
J	cushion				X				
	other				X				
K	cushion				X				
	other		X	X	X	X	X		
Percent Detect		23%	38%	62%	92%	31%	31%	23%	23%

San Jose Results: Flame Retardants Found in Couch



Notes: Preliminary results – do not cite or quote
Non-detects (i.e., < Method Reporting Limit [MRL]) not shown; values between the MRL and Limit of Quantification (LOQ) are included

Bay Area/Sacramento Results: Flame Retardants Suspected in Couch



Conclusions

- Timing for people to replace foam or purchase couch was variable and complicated logistics
- Good completion rates for the homes that replaced foam or bought own couch
- Overall decreases in dust concentrations after homes replaced couch or foam
- Incorporating flame retardants detected in couches helps interpret data
 - limited by the samples collected from couches in the Bay Area/ Sacramento group, as the more detailed foam and fabric analysis in the San Jose group indicated different compounds were used in different couch components
- Unexpected increases in some homes; we will further investigate home surveys to identify other potential sources of flame retardants

Thank You!

- Participants
- Myrto Petreas
- June-Soo Park
- Arlene Blum
- Katya Roudneva
- Tasha Stoiber
- Veronica Chin

