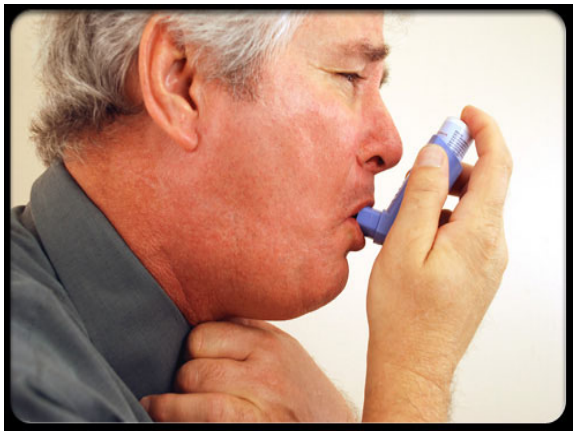
Longitudinal Changes in Residential VOCs in Older Adults with Asthma



Asthma in Older Adults: Identifying Phenotypes and Factors Impacting Outcomes

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For older adults with asthma we will:

1. Develop and systematically implement a phenotyping algorithm,
2. Longitudinally investigate the effects of (a) asthma phenotypes and (b) Volatile Organic Compounds (VOCs) exposures on asthma control.
3. Develop a predictive model of asthma quality of life.

- **This presentation**:
  - Identify participant factors contributing to reducing residential exposures to VOCs in older adults with asthma.

Design and Sample

- Descriptive longitudinal study
- Recruit and retain 188 older adults with asthma for 18 months

- **Inclusion Criteria**
  - Diagnosed with asthma
  - 60+ years of age
  - Non-smoker
  - No other lung disease
- **Exclusion Criteria**
  - Over 20 pack year history of smoking
  - Recent history of MI, stroke, other major illness
  - Living in a skilled nursing facility

- **Recruitment efforts**:
  - University of Louisville clinics
    - Pulmonary
    - Family & Geriatrics
    - Internal Medicine
  - Referrals from physician offices/ clinics
  - Media: TV, Radio, print media, social media, bus ads

Baseline Procedures

- **Initial Enrollment visit at Clinical Trials Unit**:
  - Consented
  - Questionnaire Packet
  - Pulmonary function testing
  - Vitamin D
  - Allergy testing
    - Skin prick testing (14 local respiratory allergens)
    - Immunoglobulin E (IgE, total and specific)
  - Sputum Induction
- **Home Environmental Assessment**
  - Completed within 30 days of Enrollment visit
- $150 Gift Card for completing baseline data collection

Baseline Questionnaire Data

- Demographics:
  - Age, sex, education, race & ethnicity, employment, insurance, health care utilization
- Tobacco use/exposure
- Co-morbidities
- Medications (prescribed, OTC)
- BMI
- Employment history
- Environmental exposures at home/work
- Asthma triggers
- Asthma Self-Management Knowledge Questionnaire (Schaffer, et al., 2007)
- Asthma Self-Efficacy (Krieger, et al., 2009)
- Asthma Control Test (Juniper, et al., 1999)
- Mini Asthma Quality of Life Questionnaire (Juniper, et a.=l., 2000)
- Functional status (SF-12) (Ware, et al., 1996)
- Nutritional Assessment (Kaiser, et al., 2009)

9 & 18 Month Follow-Up Procedures

- **9 month home visit ($25 gift card)**
  - ✓Medication management check
  - ✓Medication Literacy Assessment
  - ✓Asthma Control Test
  - ✓Asthma Quality of Life
  - ✓Home spirometry
  - ✓Sleep assessment
  - ✓Barriers to asthma care
- **18 month home visit ($25 gift card)**
  - ✓Baseline Questionnaire repeated
    - ✓Changes made since baseline in medications, asthma trigger exposures, etc.
  - ✓Medication Literacy Assessment
  - ✓Home Environmental Assessment
    - ✓Changes in environmental exposures
  - ✓Home spirometry

We are also able to provide some supplies to reduce asthma triggers: allergen pillow protective covers; furnace filters, cleaning supplies

Home Environmental Assessments- :Baseline & 18 months

- Asthma Home Environmental Checklist (HEC)
  - Outdoor condition observed
  - Participant report
    - Dust & cleaning
      - How often, type of products
    - Ventilation & Moisture
      - Open windows, fan, dryer
    - Pets & Pests
    - Heating & Cooling
      - Observe furnace filters
  - Home Walk-Through
    - Kitchen, Bedroom, Living Room, Bathroom, Basement
      - Type of floor covering, windows, furniture, dust, odors, moisture, pests,

- Home Monitoring
  - Pests (cockroaches, mice, rats)
  - Moisture in walls
  - 24 hour monitoring:
    - Fine particulates
    - Temperature
    - Relative humidity
    - **84 Volatile Organic Compounds (indoor & outdoor)**
    - Carbon monoxide
    - Carbon dioxide
    - Nitrogen dioxide

Volatile Organic Compounds Data Collection

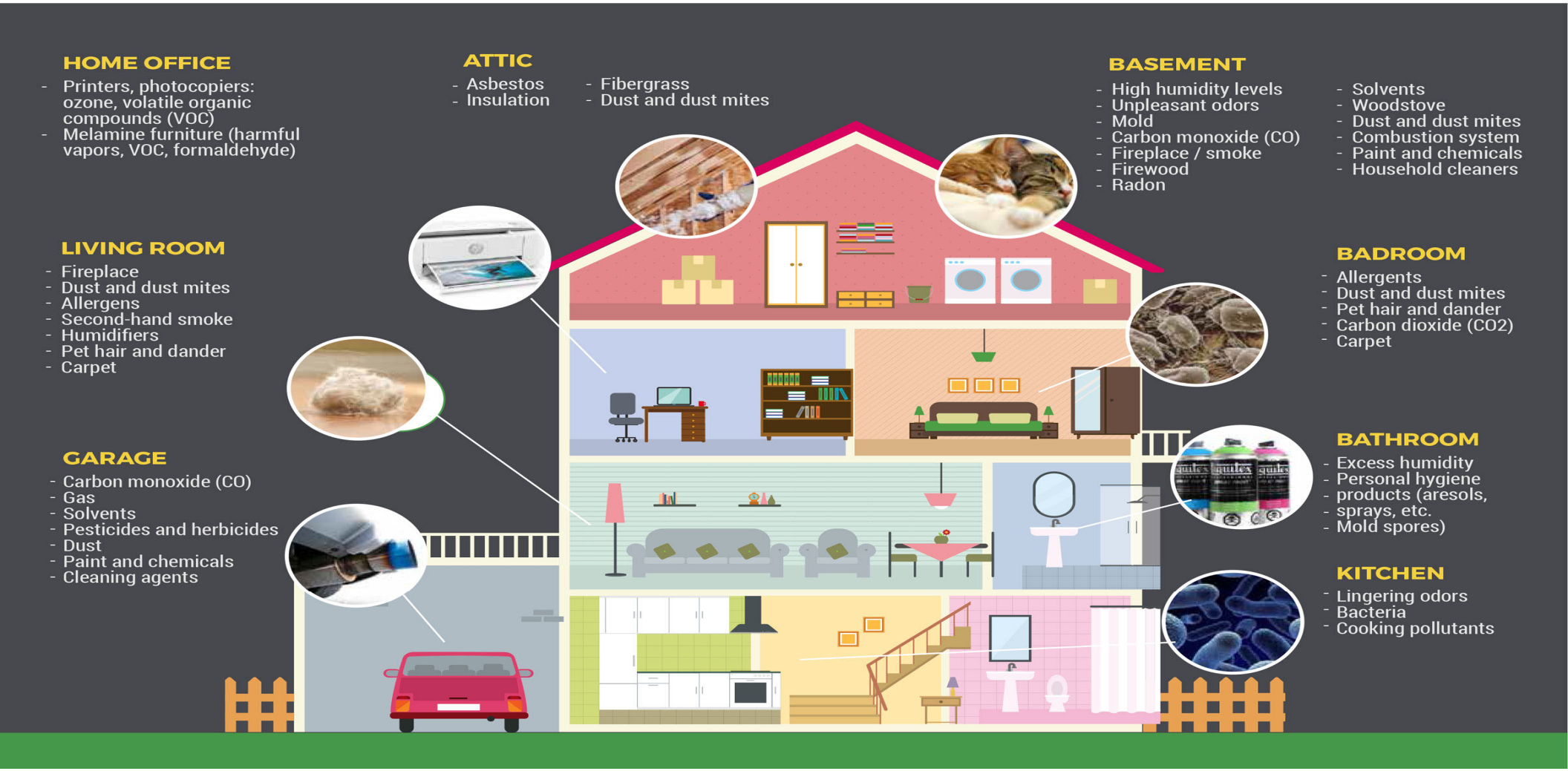
VOCs – Organic Chemicals are emitted as gases from certain solids or liquids.

- Data on 84 indoor and outdoor VOCs collected using pre-evacuated canisters.
- Canisters use flow controllers to allow the pre-evacuated canister to fill slowly over a 24-hour period. Sampling initiated by electronic timer that opens a solenoid valve and allows air to flow into the canister at a flow rate of 3.5±10% sec/m.
- After the 24-hour sampling interval, timer closes the solenoid valve sealing the cylinder. Flow rate adjusted to allow about 5100 cc of air to be collected in the 6000cc canister during the 24 h.
- Indoor samples taken 1 meter off the floor in rooms where participants spend majority of time.
- VOC samples analyzed in a mass spectrometer using EPA TO15 protocols.

Participants receive a report VOCs in their homes at 9 month follow-up & after completion of data collection

	Volatile Organic Compounds – Specific Chemicals	Screening Level (ppb)	Outdoor Level (ppb)	Indoor Level (ppb)	Potential sources
1	Freon 22	61.39	0.26	0.33	refrigerant (phased out 2020), aerosol propellant
2	Freon 12	0.01	0.53	0.5	refrigerant (banned 1996), aerosol propellant, Silly String, office printers
3	Chloromethane	0.09	0.6	0.67	refrigerant (phased out), , production of silicone polymers and butyl rubber, petroleum refining
4	Freon 114	NA			refrigerant (banned 1996)
5	Vinyl Chloride	0.17			vinyl, vinyl acetate, cigarettes
6	1.3 Butadiene	0.002			synthetic rubber, wood burning, cigarettes, auto exhaust, cooking oils
7	Bromomethane	0.0056			fumigant for rats and insects
8	Chloroethane	16.46			treatment of cellulose insulation, auto starting fluid
9	Acetone	56.68	1.17	28.1	nail polish removal, varnish, wood filler, adhesive, spray paint, markers, art supplies
10	Freon 11	0.11	0.21	0.25	refrigerant (banned 1996), office printer
11	Acrylonritrile	0.004			synthetic carpets/upholstering, plastic elastomer
12	1,1 Dichloroethane	NA			co-monomer in the polymerization of vinyl chloride, acrylonitrile, and acrylates

PRIMARY SOURCES OF INDOOR AIR POLLUTION



HOME OFFICE

- Printers, photocopiers: ozone, volatile organic compounds (VOC)
- Melamine furniture (harmful vapors, VOC, formaldehyde)

ATTIC

- Asbestos
- Insulation
- Fibergrass
- Dust and dust mites

BASEMENT

- High humidity levels
- Unpleasant odors
- Mold
- Carbon monoxide (CO)
- Fireplace / smoke
- Firewood
- Radon
- Solvents
- Woodstove
- Dust and dust mites
- Combustion system
- Paint and chemicals
- Household cleaners

LIVING ROOM

- Fireplace
- Dust and dust mites
- Allergens
- Second-hand smoke
- Humidifiers
- Pet hair and dander
- Carpet

BADROOM

- Allergents
- Dust and dust mites
- Pet hair and dander
- Carbon dioxide (CO2)
- Carpet

GARAGE

- Carbon monoxide (CO)
- Gas
- Solvents
- Pesticides and herbicides
- Dust
- Paint and chemicals
- Cleaning agents

BATHROOM

- Excess humidity
- Personal hygiene
- products (aresols,
- sprays, etc.
- Mold spores)

KITCHEN

- Lingering odors
- Bacteria
- Cooking pollutants

Sources of Indoor Air Pollutants

Outdoor air

- Air pollutants
- Automobile exhaust
- Residual chemicals
- Pollen and molds

Activities

- Cooking
- Breathing
- Burning fossil fuels and wood (unvented)
- Smoking cigarettes
- Showering and boiling water

Building Materials and Furnishing

- Plywood and Particle board
- Carpets
- Flame retardants on cloth furniture, varnished wood
- Lead paint

Consumer Products

- Paints, paint strippers and other solvents
- Wood varnishes, preservatives
- Aerosol sprays
- Cleansers and disinfectants
- Stored fuels and automotive products
- Hobby supplies
- Dry-cleaned clothing
- Pesticides and moth balls
- Copiers and printers, correction fluids
- Glues and adhesives, permanent markers
- Candles
- Dryer sheets
- Air fresheners and fragrances

Other

- Mold when Humidity levels (>55%)
- Radon
- Biological, pet dander

Results

Preliminary Descriptive Results (N=129)

- Age
  - M (SD): 67.5 (5.9); Min-Max: 60-88 years
- Female – 72%
- Race (may choose >1):
  - White: 76.2%
  - Black/African American: 17.7%
  - American Indian/Alaskan Native: 4.6%
  - Asian: 0.8%
  - Mixed race 0.8%
- Employment
  - Employed: 28.9%
  - Not employed/retired: 71.1%
- # Comorbidities
  - M (SD): 3.8 (1.8), Min-Max: 0-10
- Education
  - <High School: 5.4%
  - High School: 16.1%
  - Some College: 32.3%
  - College Degree or more: 46.2%
- Living situation:
  - Own home: 80.6%
  - Rent: 19.4%
- Have health insurance: 100%
  - Private insurance: 32.3%
  - Medicaid: 10.8%
  - Medicare: 56.9%
  - Other: 40%

VOCs detected in 90%+ of homes at **Baseline**

Those underlined– Median concentrations exceed health reference standards

Those in red bold – found in 99-100% of homes

Italics—median below health reference standards

 RfC < 0.01 ppb

Blue – no reference standard concentration

Freon 11	**Methyl Ethyl Ketone**	**o Xylene**	*Ethylbenzene*
Freon 12	**Toluene**	1,2,4 Trimethyl-benzene	*Methylene Chloride*
Benzene	**Acetone**	Chloroform	Methyl Acetate
Chloromethane	***Freon 22***	Carbon Tetrachloride	
m or p Xylene	Acrolein	*Hexane*	

VOCs detected in 90%+ of homes at 18 months

Those underlined– Median concentrations exceed health reference standards

Those in red bold – found in 99-100% of homes

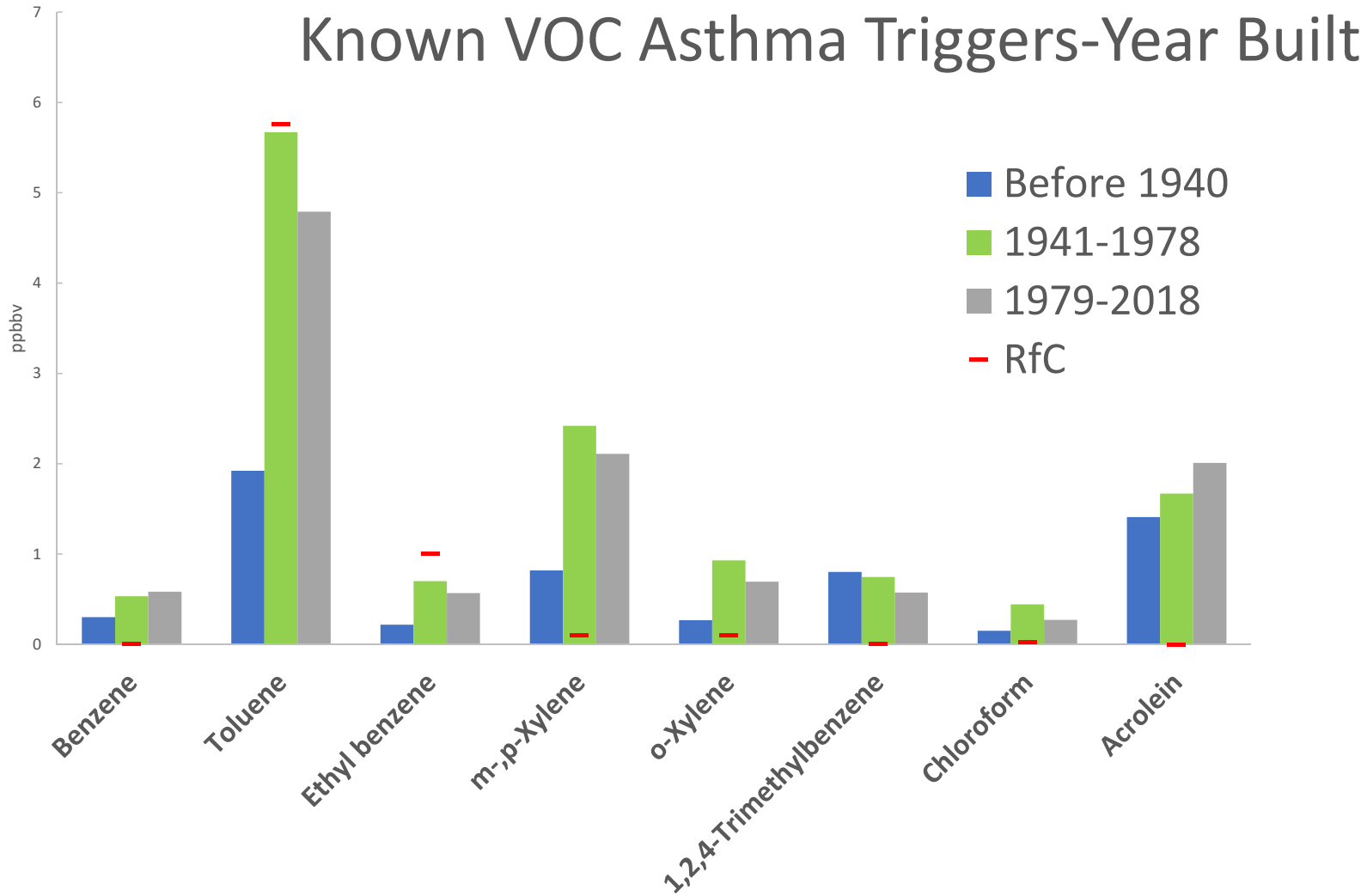
Italics—median below health reference standards

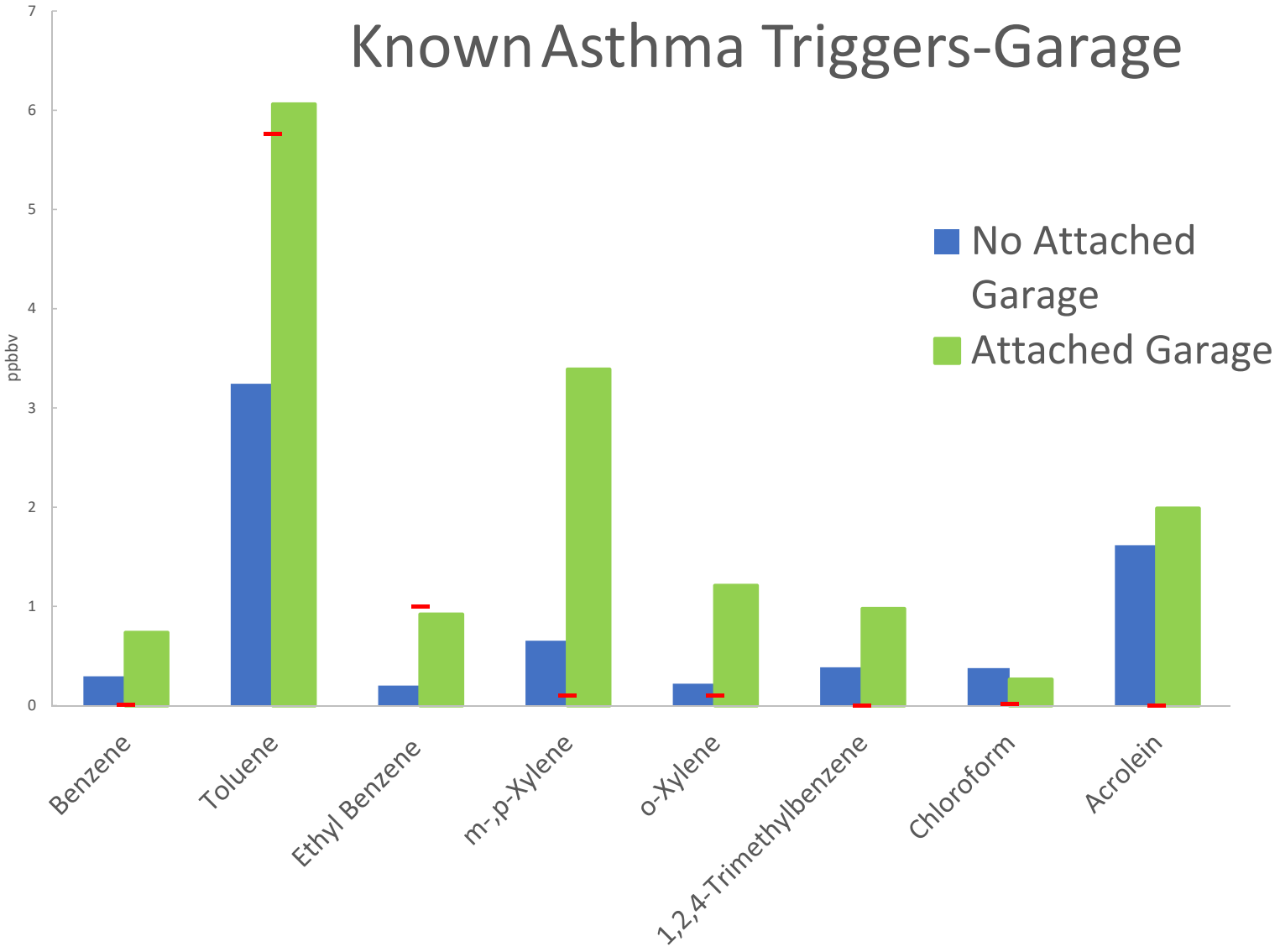
 RfC ≤0.01 ppb

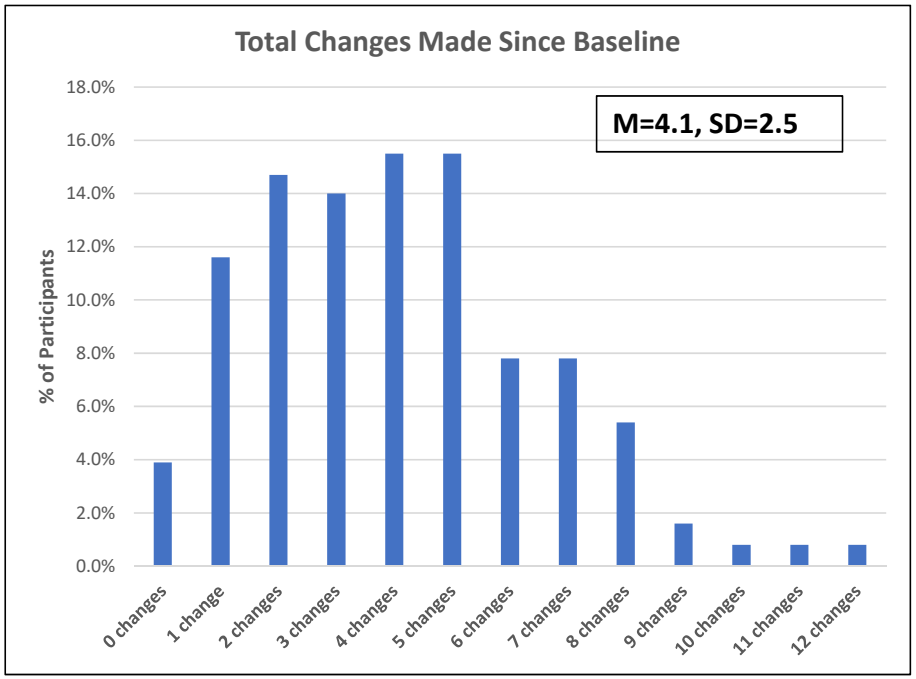
Blue – no reference standard concentration

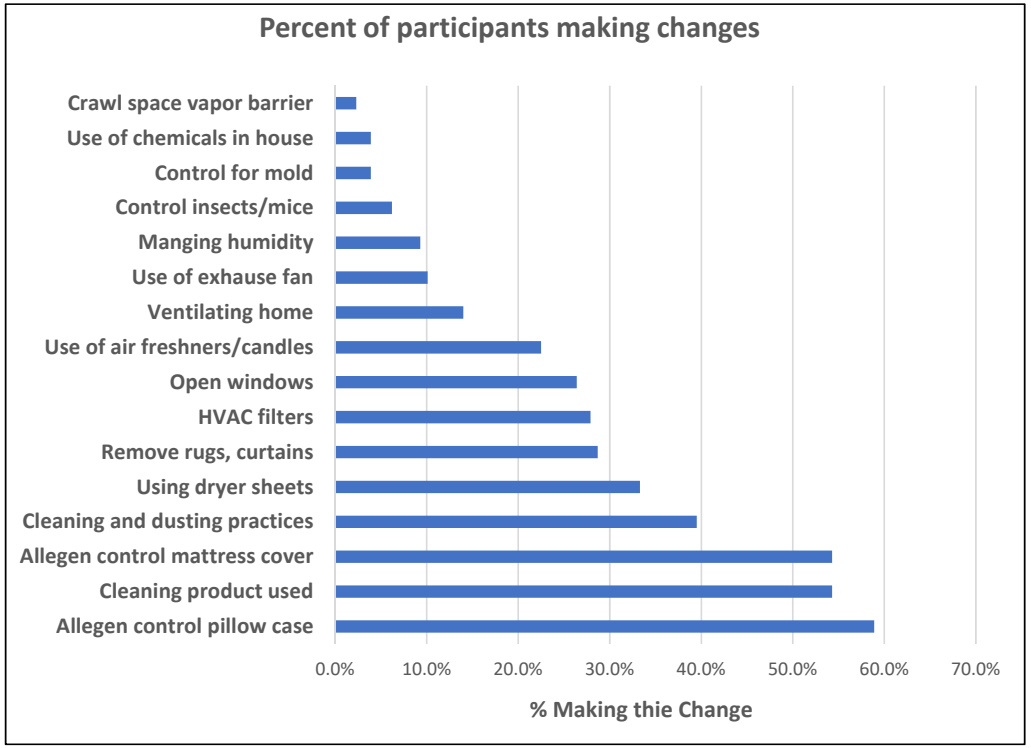
Freon 11	**Methyl Ethyl Ketone**	o Xylene	*Ethylbenzene*
Freon 12 	**Toluene**		*Methylene Chloride*
Benzene 	**Acetone**	Chloroform 	Methyl Acetate
Chloromethane 	***Freon 22***	Carbon Tetrachloride 	
m or p Xylene 	**Acrolein** 	*Hexane* 	

Chemical	Health Risk & Sources
Freon 12	Dizziness, drowsiness, confusion; tremor, unconsciousness, asphyxia, cardiac arrhythmias • Phased out 1996. Residual in outdoor air, residual aerosol? Asthma inhalers
Chloromethane	Slurred speech, confusion, lethargic, liver, kidney, and spleen toxicity • Refrigerant, air conditioning, phased out
Freon 11	Alcohol-like intoxication, reduced coordination, lightheadedness, headaches, tremors, convulsions • Phased out 1996. Residual in outdoor air, asthma inhalers
Chloroform	Probable liver and kidney carcinogen, depression, irritability, asthma • Chlorinated tap water, bleach, solvents
Benzene	Known human carcinogen, asthma • Auto exhaust, gasoline, cigarette smoke, scented candles, scatter rugs, carpet glue
1,2,4 Trimethyl-benzene	Nervousness, tension, and asthma • Gasoline, auto exhaust, dyes, perfume, resins
Acrolein	Irritation of the nose, throat and lungs, potential heart and lung problems, asthma • Cooking oil, animal fat, herbicide, cigarette smoke
Carbon tetrachloride	Headache, nausea, vomiting, liver and kidney damage • Aerosol propellant, dry cleaning, varnish, lacquer, plastic glue, plastic bonder

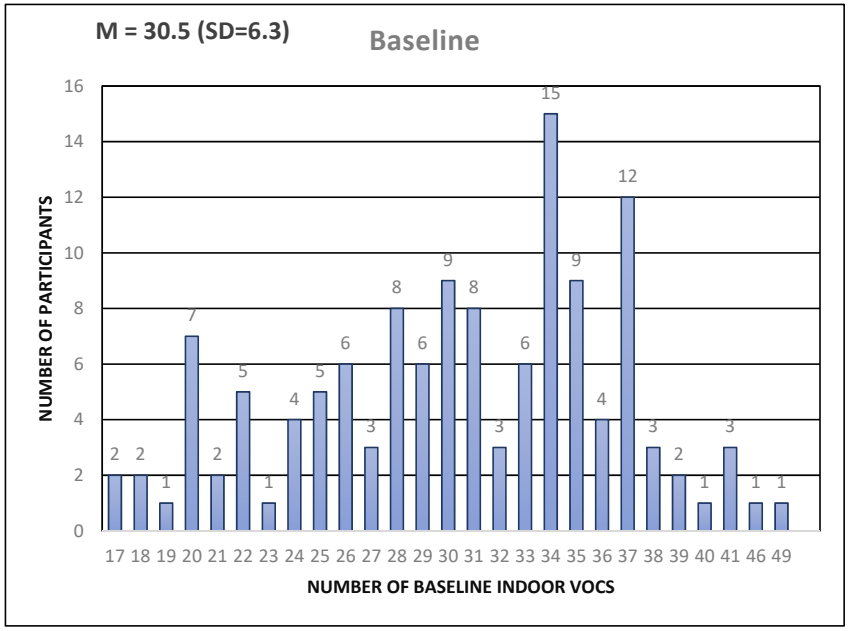

Known VOC Asthma Triggers-Year Built
ppbv
0
1
2
3
4
5
6
7
Before 1940
1941-1978
1979-2018
RfC
Benzene
Toluene
Ethyl benzene
m-,p-Xylene
o-Xylene
1,2,4-Trimethylbenzene
Chloroform
Acrolein


Known Asthma Triggers-Garage
ppbv
7
6
5
4
3
2
1
0
No Attached Garage
Attached Garage
Benzene
Toluene
Ethyl Benzene
m-,p-Xylene
o-Xylene
1,2,4-Trimethylbenzene
Chloroform
Acrolein


Total Changes Made Since Baseline
M=4.1, SD=2.5
% of Participants
18.0%
16.0%
14.0%
12.0%
10.0%
8.0%
6.0%
4.0%
2.0%
0.0%
0 changes
1 change
2 changes
3 changes
4 changes
5 changes
6 changes
7 changes
8 changes
9 changes
10 changes
11 changes
12 changes

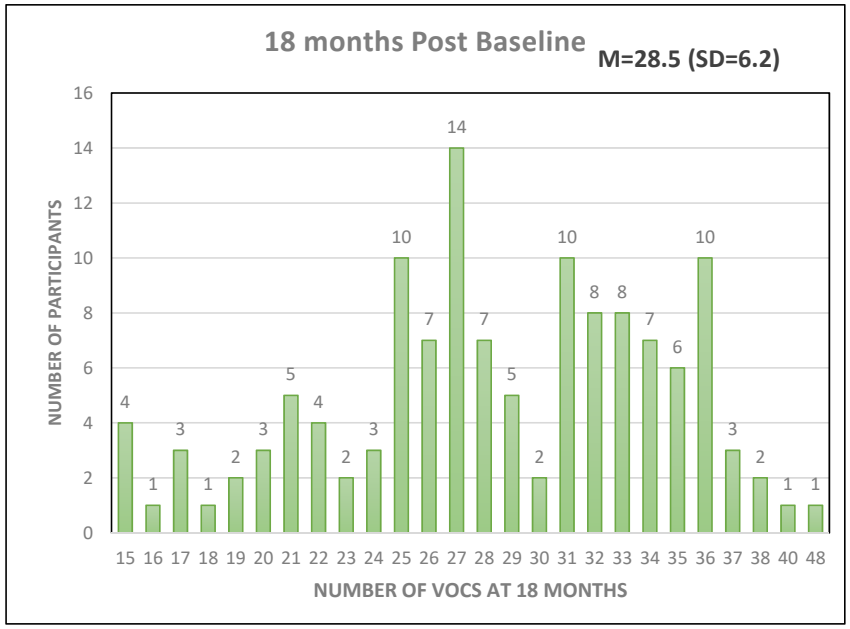

Percent of participants making changes
Crawl space vapor barrier
Use of chemicals in house
Control for mold
Control insects/mice
Manging humidity
Use of exhause fan
Ventilating home
Use of air freshners/candles
Open windows
HVAC filters
Remove rugs, curtains
Using dryer sheets
Cleaning and dusting practices
Allegen control mattress cover
Cleaning product used
Allegen control pillow case
0.0%
10.0%
20.0%
30.0%
40.0%
50.0%
60.0%
70.0%
% Making thie Change

of Volatile Organic Compounds Detected in Participant Homes



17-49 different VOCs found in homes at baseline

72 different VOCs detected

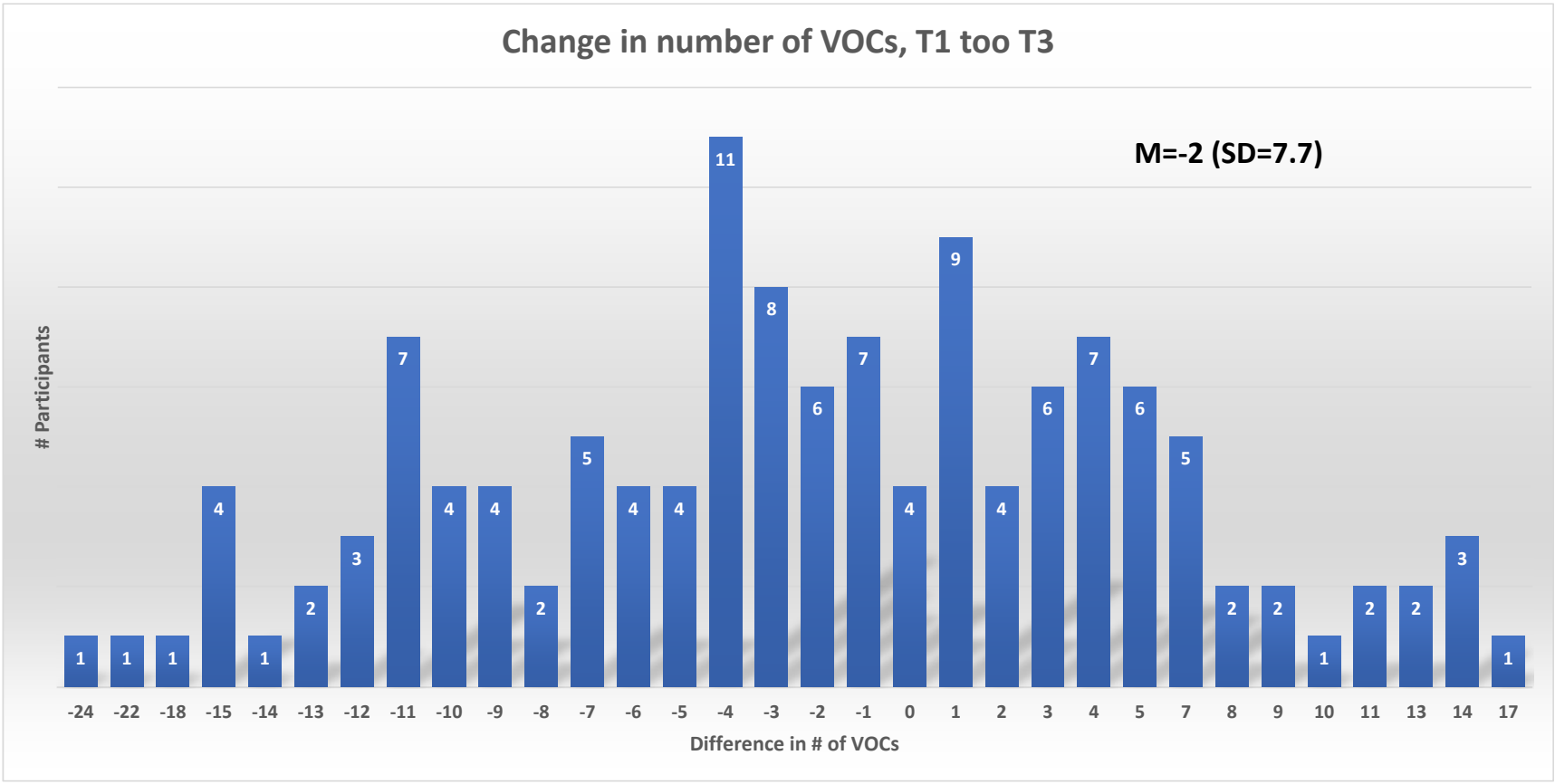


15-48 different VOCs found in homes at 18 months

65 different VOCs detected

Total number of VOCs sig. decreased at 18 months ($p < .001$)

Concentrations indoors approximately 7.5 times outdoor concentrations



58% decreased # VOCs; 3.1% no change; 39% increased

Volatile Organic Compounds ppb Detected in Participant Homes

Total ppb for 84 VOCs	M (SD)	Median
Total VOCs ppb Baseline	85.1 (9.1)	49.6
Total VOCs ppb 18 months	59.3 (6.5)	38.7
Difference in ppb (T3-T1)	-25.9 (10.4)	-11.9

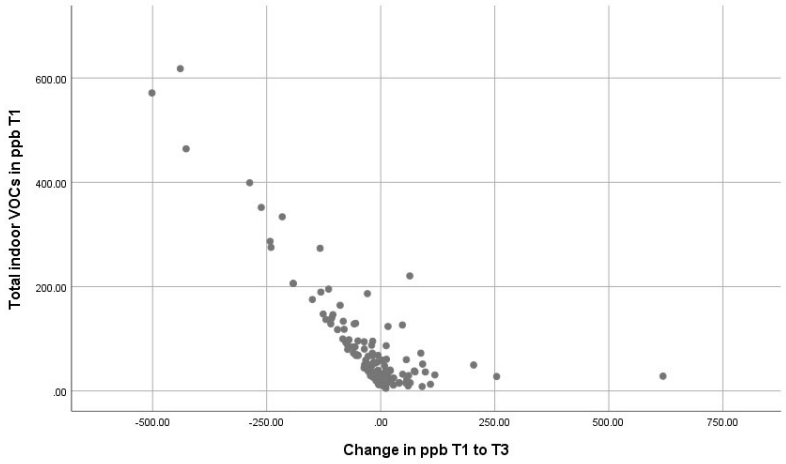
VOCs ppb significantly decreased from Baseline to 18 month ($p<.001$)

Predictors of Changes in Volatile Organic Compounds ppb

- Predictors of difference in VOCs (log) from baseline to 18-months
  - Total number of self-reported comorbidities (β = -.091 p=.042)
  - VOC ppb at baseline (log) (β=-.745, p<.001)

  (Controlling for Asthma Quality of Life, Asthma Control, age, education, race, number of changes made since baseline, self-efficacy, health, FEV1%).

  R^2 = .442



VOCs and Older Adults with Asthma

- **Baseline:**
- **Asthma Control** negatively related to (log):
  - Chloroform, r=-.234, p=.009
  - Methylene Chloride, r=-.224, p=.014
  - Chloromethane, r=-.187, p=.036

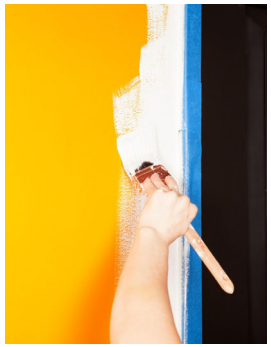
- **Asthma Quality of Life**, negatively related to:
  - Chloroform, r=-.309, p= <.001
  - Methylene Chloride, r= -.219, p=.016
  - Chloromethane, r=-.211, p=.017
  - Carbon Tetrachloride, r=-.227, p=.01

Chloroform - Chlorinated tap water, bleach, solvents

Methylene Chloride – Solvent, paint stripping, pharmaceuticals, metal cleaning, degreasing

Chloromethane -Refrigerant, air conditioning, phased out

Carbon Tetrachloride - Aerosol propellant, dry cleaning, varnish, lacquer, plastic glue, plastic bonder



So what VOCs are in your Home?