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How human presence and activities of daily living influence indoor air quality (IAQ)

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Philip Morris Product S.A., Science & Innovation, Product Research

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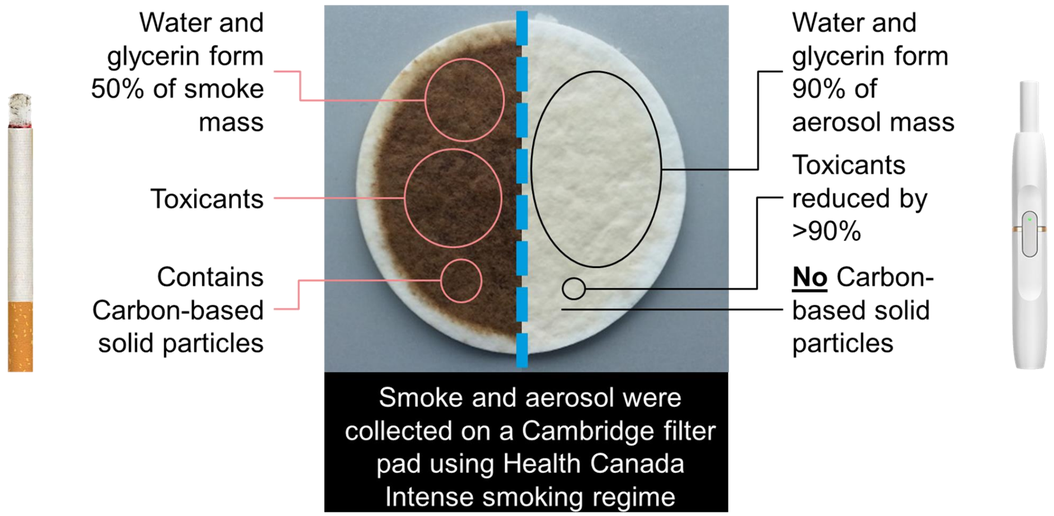
Tobacco Heated System (THS 2.2)

PMI's transformation toward a Smoke-Free Future

"Our stated ambition is to convince all current adult smokers that intend to continue smoking to switch to smoke-free products as soon as possible."

André Calantzopoulos, CEO Philip Morris International , BBC, Nov 2016



	Cigarettes	Cigarettes	THS 2.2
UVPM-THBP	92.9	17.7	
FPM-scopoletin	20.4	4.20	
Nicotine	49.8	8.60	1.15
Acetaldehyde	122	26.2	3.44
Acrolein	12.4	2.75	
Crotonaldehyde	3.57	0.80	
Formaldehyde	58.9	9.71	
Acrylonitrile	5.28	1.23	
Benzene	14.2	3.11	
1,3-Butadiene	17.6	4.17	
Isoprene	164	39.9	
Toluene	25.2	5.15	
TVOC	445	33.4	
Glycerin	10.3	3.2	13.3
Propylene glycol	60.5	15.1	
CO	2920	611	
NO	71.8		
NO_x	94.6		
PM1	687	123	
PM2.5	688	123	

(difference in units)

µg/m³
0
1
3
5
10
15
20
30
50
60
90
120
150
450
650
1500
2000
2990

nm not measured

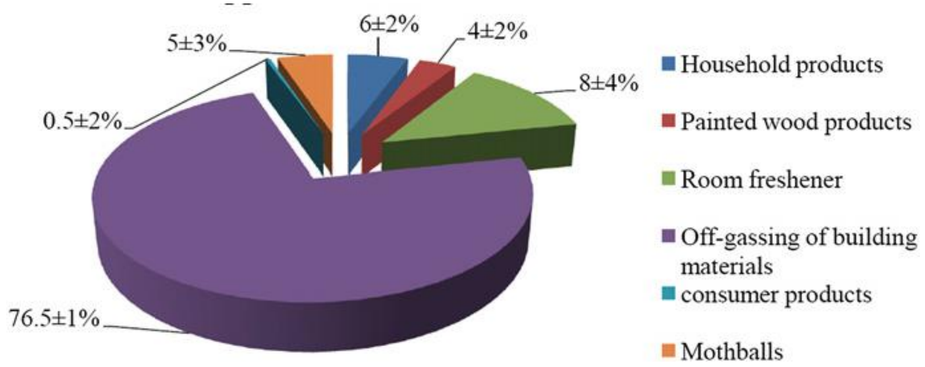
no difference with BKG

> guideline value

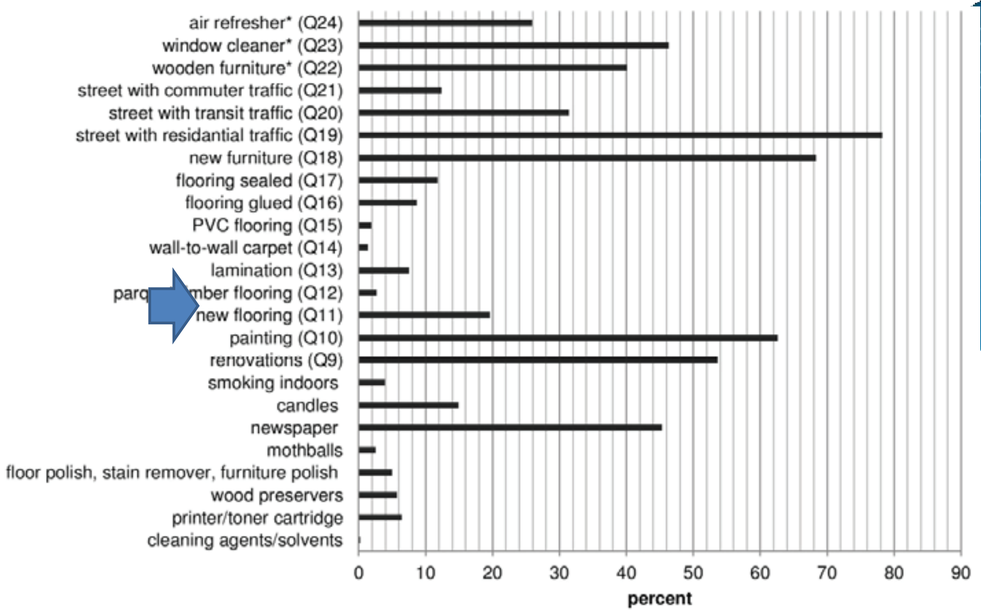
- Reduced-Risk Products ("RRPs") is the term we use to refer to products that present, are likely to present, or have the potential to present less risk of harm to smokers who switch to these products versus continued smoking.
- We have a range of RRPs in various stages of development, scientific assessment, and commercialization.
- THS 2.2 commercialized as *IQOS®* is designed and has been demonstrated to heat tobacco without combustion and to preserve elements of the taste, sensory experience, nicotine delivery profile, and ritual characteristics of cigarettes
- The totality of evidence, which comprises PMI's clinical data, aerosol chemistry and non-clinical data, demonstrated that switching to IQOS completely, while not risk-free, present less risk of harm compared to continuing to smoke cigarette

Relationship between sources and patterns of VOCs in indoor air

Many studies on the influence of sources and patterns of Volatile Organic Compounds (VOCs) on indoor air. For example:

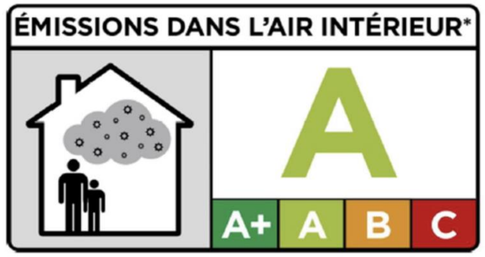


Source: H. Guo, Building and Environment, 2011, Source apportionment of volatile organic compounds in Hong Kong homes



Source: C. Rösch, Atmospheric Pollution Research, 2014, Relationship between sources and patterns of VOCs in indoor air

2013 labels for building material
2020: extension to furniture



Taille minimum 15x30 mm

L'astérisque renvoie au texte suivant à placer librement :*

Information sur le niveau d'émission de substances volatiles dans l'air intérieur, présentant un risque de toxicité par inhalation, sur une échelle de classe allant de A+ (très faibles émissions) à C (fortes émissions)

Indoor levels of airborne constituents

The indoor concentration of an airborne compound depends on

- The rate of generation or release of the pollutant
- The volume of air contained in the indoor space
- The removal rate of the pollutant from the air via reaction or settling
- The air exchange rate with the outside atmosphere
- The outdoor pollutant concentration

Research question

➢**Volatilome or human chemical signature**

- Emissions up to 1,849 volatile organic compounds (VOC) originating from Humans from which 874 emanate from breath and 504 from skin
- Some of these compounds reach quantifiable levels in air

➢**Research question**

How do prolonged human presence and certain activities of daily living influ

carbonyls, VOCs, Total VOC, carbon oxide (CO) and nitrogen oxide (s) (NO, NO_x) indoors?

➢**Parameters studied**

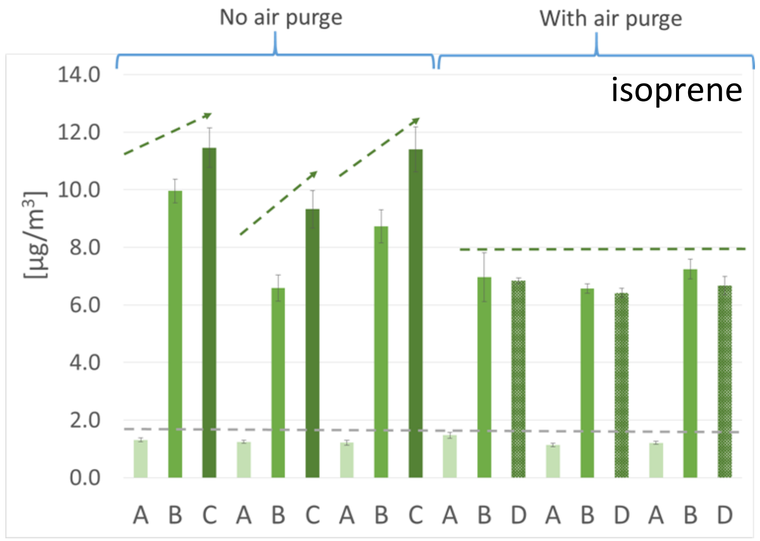
- Emissions from combustion products (candles, incense, cigarettes)
- Emissions from smoke-free products (e-cig, heated tobacco) and cessation product
- Human presence (influence of ventilation)
- Human activities (cooking, doing sport, drinking wine, using cosmetics)

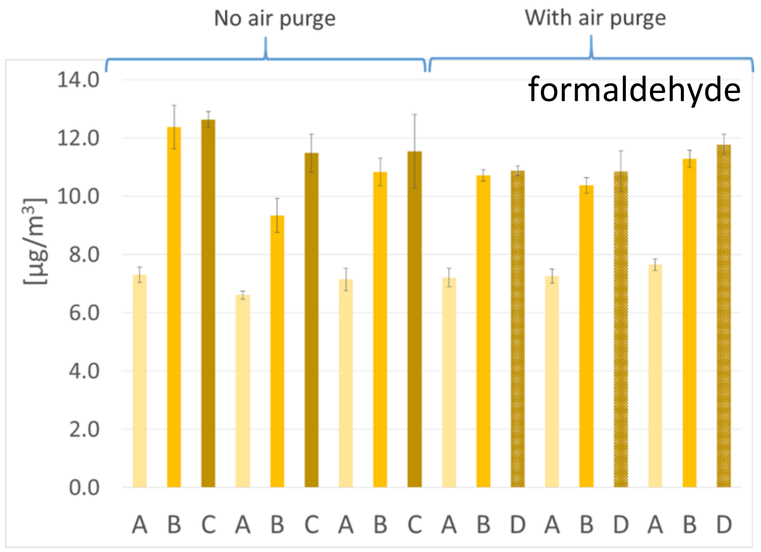
➢**Design of Experiment**

- Controlled Environmental room (IAQ) with panelists
- Portfolio of 29 IAQ constituents available for quantification in air

Do the people make a difference ?

Comparison of isoprene and formaldehyde levels for experiments with influence of prolonged human presence





A: Empty IAQ room. B-D: IAQ room with presence of 3 people

Human presence contributed to the increase of indoor levels of isoprene (by-product of cholesterol biosynthesis).

Several confounding sources (endogenous & exogenous) are likely contributing to airborne formaldehyde concentrations (Salthammer et al, 2010; WHO, 2010).

How do the people influence IAQ?

Long term variability , occupants effect and seasonality phenomenon were analyzed via a “Meta-analysis”

Meta-analysis considers each study as an individual to compute effects with much reliability

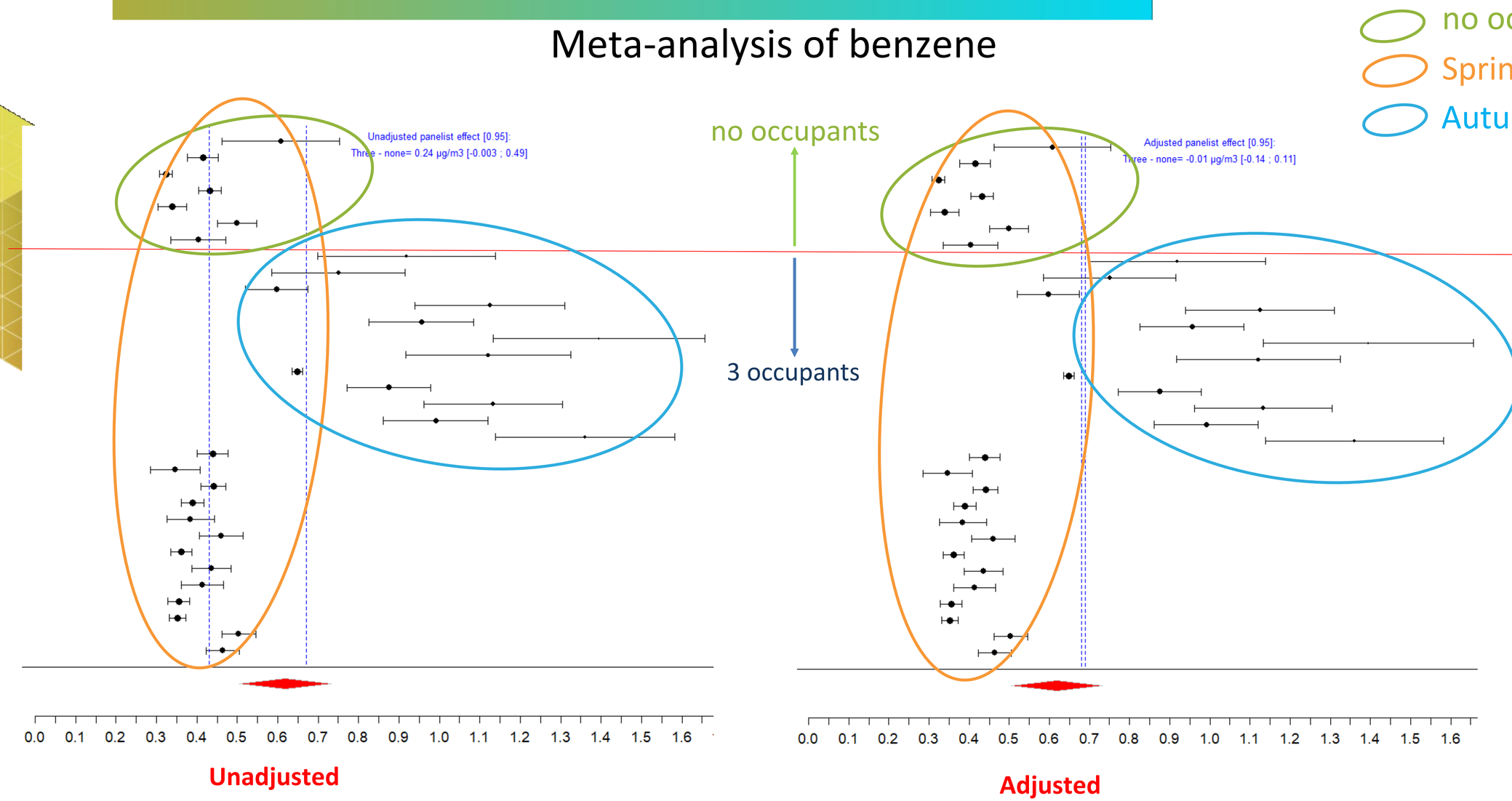
An homogeneous corpus of 32 to 48 studies representing a 2 years period allowed to:

- Assess the study to study variance
- Extract effects of occupants, and effects of occupants adjusted for year and season of experiment.

All the studies followed the same design and were independently performed.

Do the people make a difference ?

Meta-analysis of benzene



Benzene – adjusted mean panellist effect [0.95CI]: –0.01 [–0.14; 0.11] µg/m^3; 1% increase on average with 3 occupants. Equivalent behaviour for toluene

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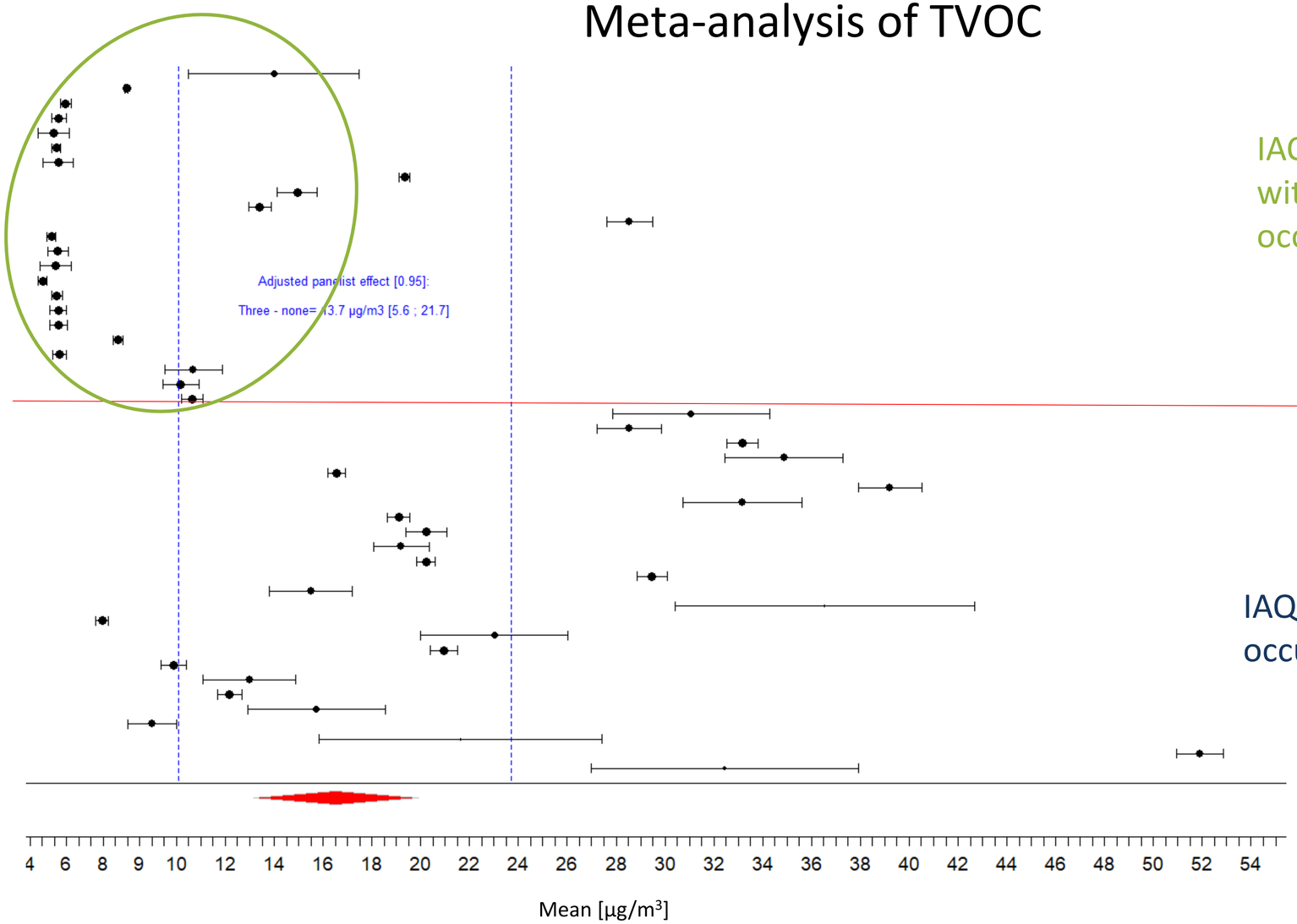
Do the people make a difference ?

Meta-analysis of TVOC



no occupants, spring, autumn Y2

IAQ room with no occupants

IAQ room with 3 occupants

TVOC – adjusted mean panellist effect [0.95CI]: 13.7 [5.6; 21.7] µg/m^3; 128% increase on average with 3 occupants.

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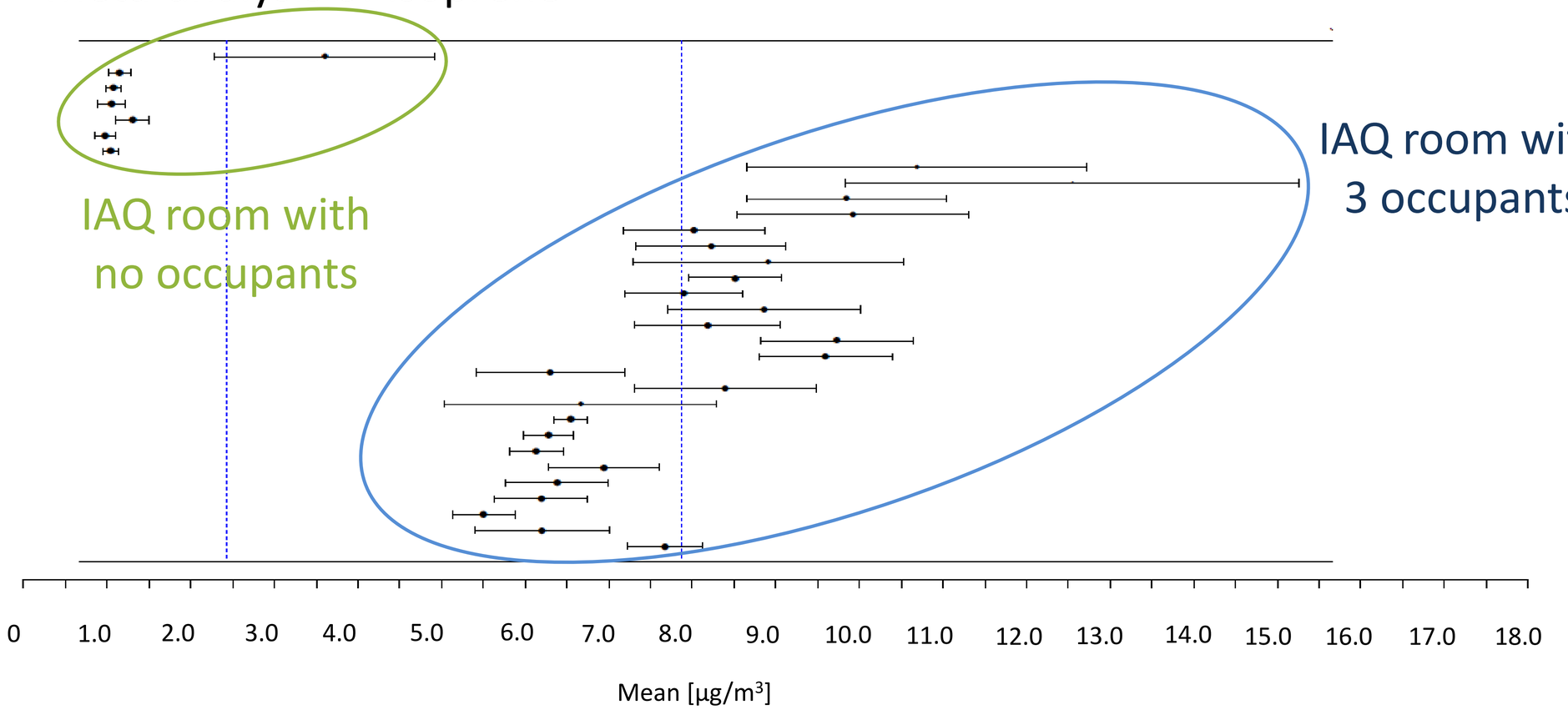
Do the people make a difference ?

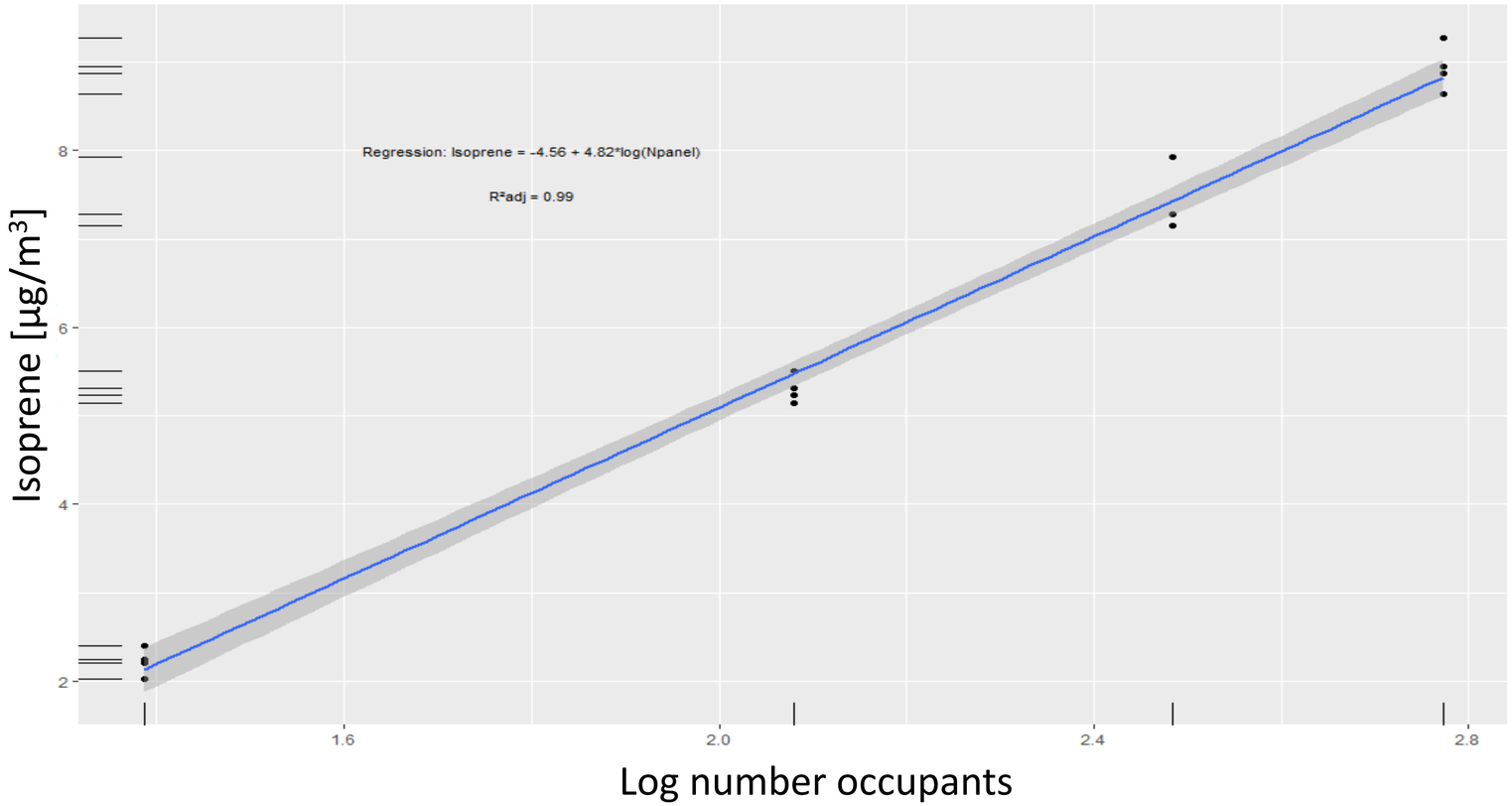
Meta-analysis of isoprene



Isoprene – adjusted mean panellist effect [0.95CI]: 5.58 [4.7 ; 6.4] µg/m^3; 213% increase on average with 3 occupants. Equivalent behaviour for formaldehyde and acetaldehyde

Do the people make a difference ?

Regression of airborne isoprene concentrations to increasing number of occupants



No occupants **4** **8** **12** **16**

Switching from 4 to 8 occupants entering the room causes an increase in isoprene of 3.34 µg/m^3

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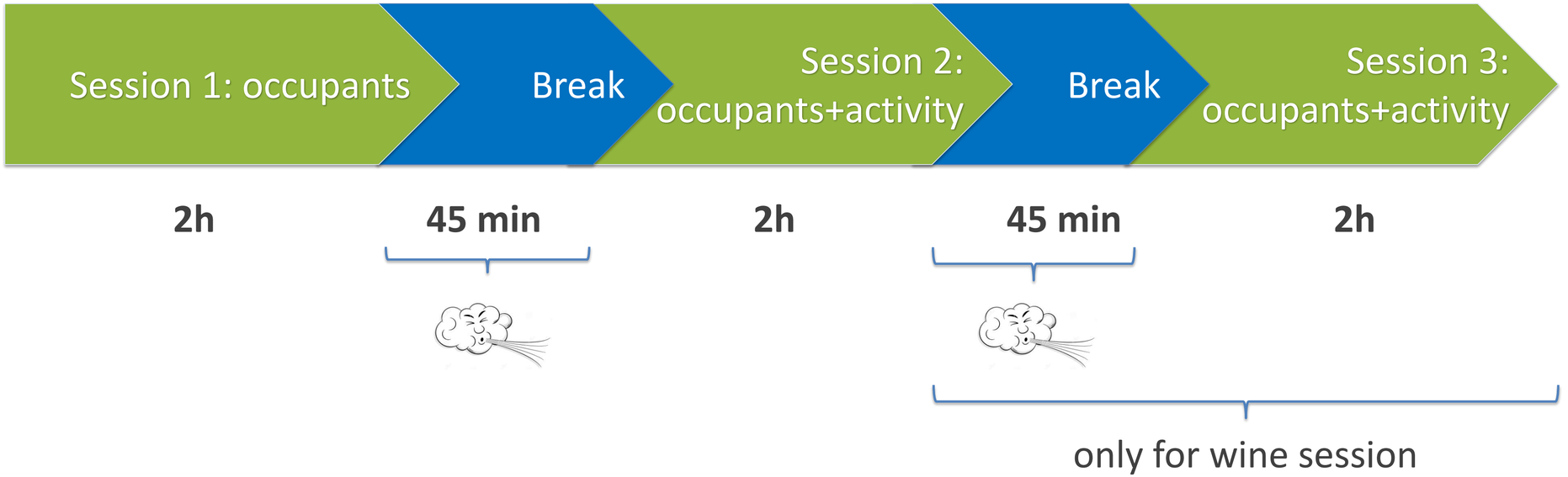
Do human activities make a difference ?

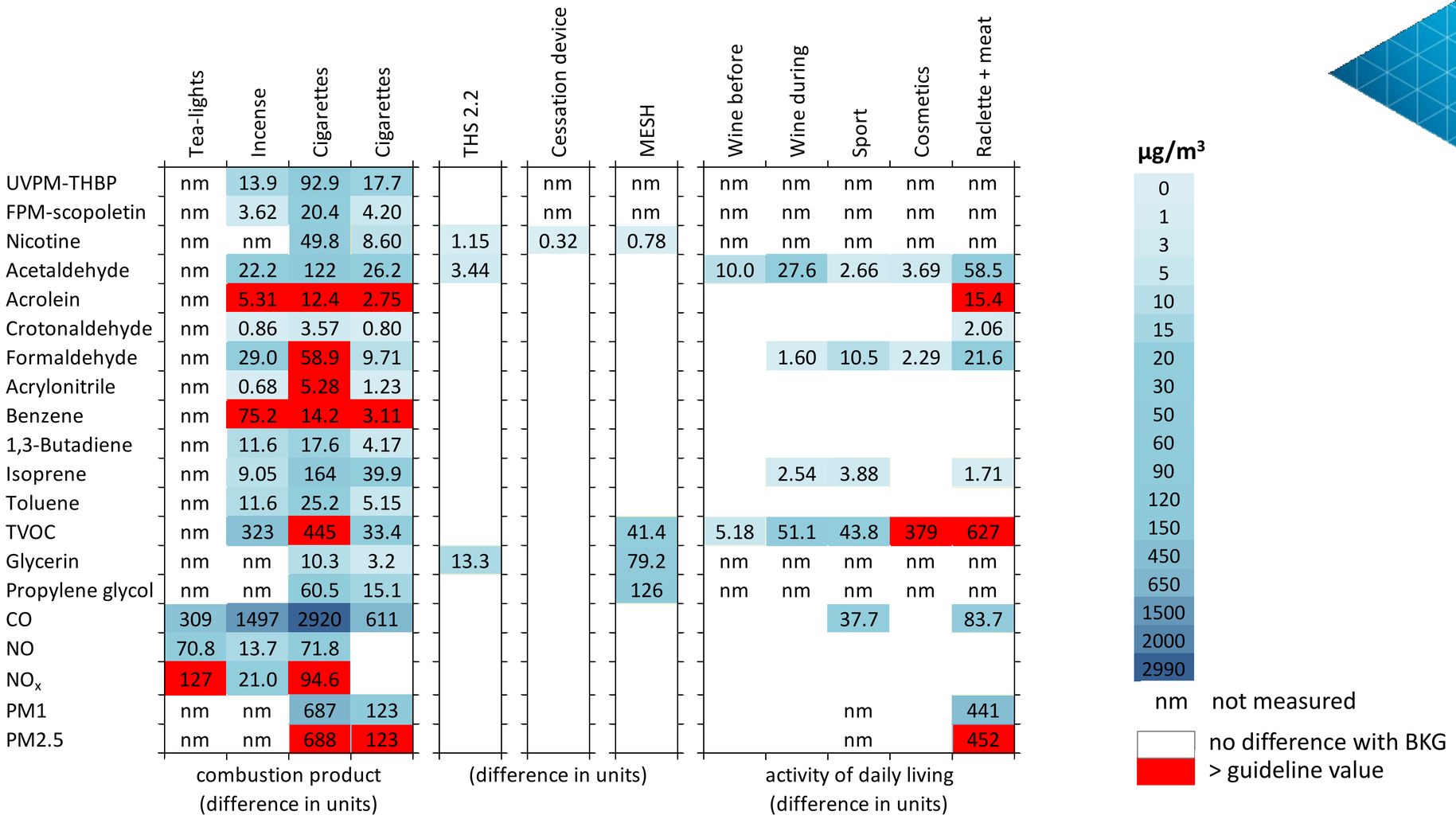


- Screening: one experiment per activity
- 3 occupants, 2-hour sessions, 0.5 air changes/hour
- Selected activities: drinking wine, sport, using cosmetics, and preparing and eating Raclette (grilled cheese & meat)

Impact of common sources on IAQ

How combustion products impact IAQ compared with smoke free products?

How do certain activities of daily living influence IAQ?



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Wrap-up

- Assessing the specific impact of a product or activity requires a controlled environment and strict protocols.
- Many elements contribute to IAQ. Depending on the activity or product, the influence can be significant.
- Human presence influences levels of air pollutants: strong effect for isoprene and TVOC, mild for formaldehyde and acetaldehyde.
- Normal recreational or daily living activities, such as cooking, drinking wine, using cosmetics, or using combustible products indoors, lead to the increase of several harmful airborne constituents.
- Interpretation of the data and sources of variability are critical to draw the right conclusions
- In a real-life environment, the impact on overall IAQ due to the use of smoke-free products as well as any activities performed during measurements have to be monitored carefully for proper identification of the main source of pollution.

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