Potential hazards linked to the use of disinfectants in healthcare: **Health and occupational health risks assessment**

Orianne Dumas, PhD, CR

Inserm
Integrative Respiratory Epidemiology team - CESP
Villejuif, France

Webinar - Promoting safer disinfectants in the global healthcare sector – 23 April 2020

Outline

I. Respiratory health effects of disinfectants and cleaning products (DCP)
   - Chronic respiratory diseases
   - DCP and asthma
   - DCP and COPD / lung function

II. Other potential health effects of DCP

III. Conclusion and pending questions

Outline

I. Respiratory health effects of disinfectants and cleaning products (DCP)
   - Chronic respiratory diseases
   - DCP and asthma
   - DCP and COPD / lung function

II. Other potential health effects of DCP

III. Conclusion and pending questions

Chronic respiratory diseases

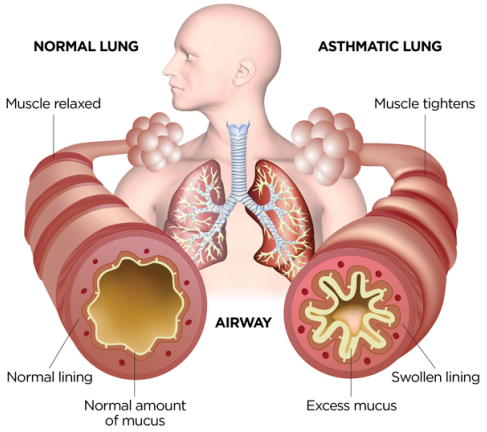
Asthma

Definition / characteristics

- Chronic inflammatory disease of the airways
- Attacks of breathlessness with wheezing
- Chronic respiratory symptoms

Prevalence

- France : children 10-15% ; adults 5-10%
- World : **~270 millions**



Chronic Obstructive Pulmonary Disease (COPD)

Definition / characteristics

- Progressive and largely non-reversible airway obstruction leading to airflow limitation
- Diagnosed by lung function measurements

Prevalence

- France : Adults ≥45 years 5-10%
- World : **~300 millions, 3rd cause of mortality**

Chronic respiratory diseases

Asthma

Chronic Obstructive Pulmonary Disease (COPD)

- **15-20% of asthma and COPD cases attributable to occupational exposures** (Blanc, AJRCCM, 2019)
- In the past 2 decades: **growing evidence for adverse respiratory effects of occupational exposure to disinfectants and cleaning products (DCP)**

DCP → **Asthma**

PubMed 873 results (Apr 2020†)

†(cleaning worker* OR cleaning product* OR cleaner* OR disinfect*) AND asthma

DCP → **COPD**

PubMed 98 results (Apr 2020†)

†(cleaning worker* OR cleaning product* OR cleaner* OR disinfect*) AND (COPD OR chronic obstructive pulmonary disease)

Outline

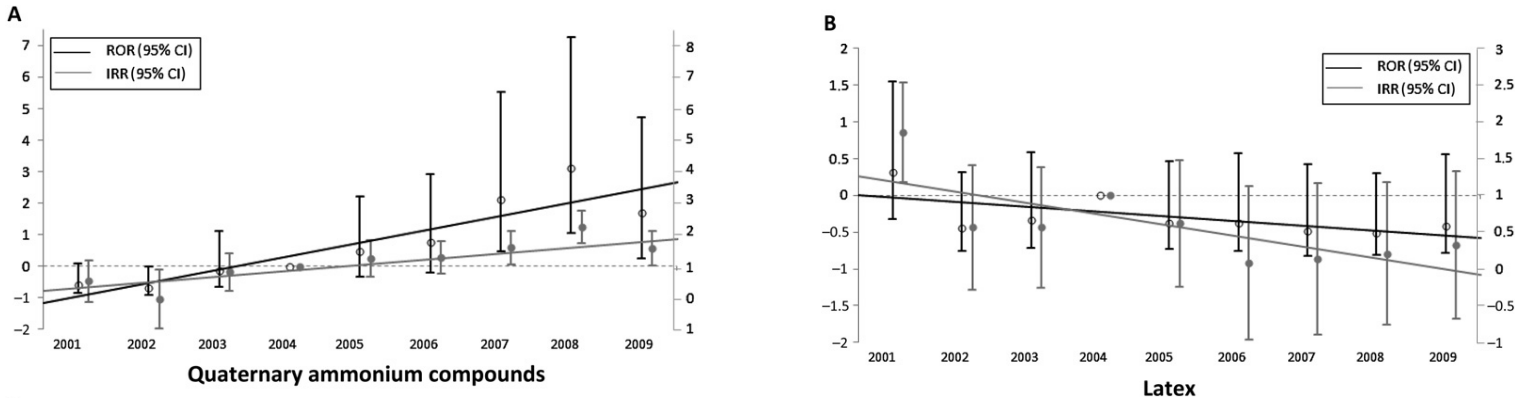
I. Respiratory health effects of disinfectants and cleaning products (DCP)
   - Chronic respiratory diseases
   - DCP and asthma
   - DCP and COPD / lung function

II. Other potential health effects of DCP

III. Conclusion and pending questions

DCP first identified as a risk factor for asthma

- **Surveillance data:** Industries/jobs accounting for a large part of occupational asthma cases:
  - Cleaners
  - **Healthcare**
    - USA: 16% (1st industry)
    - France: 12% (2nd industry)
    - **Hospital workers** - nurses, nursing aides, cleaners
  - DCP increasingly identified as causal agent



French national surveillance network 2000-2010 (Paris, OEM, 2012)

Siracusa, Allergy, 2013; Folletti, COACI, 2017

DCP first identified as a risk factor for asthma

- **Surveillance data:** Industries/jobs accounting for a large part of occupational asthma cases:
  - Cleaners
  - **Healthcare**
    - USA: 16% (1st industry)
    - France: 12% (2nd industry)
    - **Hospital workers** - nurses, nursing aides, cleaners
  - DCP increasingly identified as causal agent

- **Epidemiological studies**
  - Increased asthma risk (asthma development, asthma symptoms) among
    - Healthcare workers : nurses, nursing aides
    - Cleaners

Siracusa, Allergy, 2013; Folletti, COACI, 2017

Agents contained in DCP

Common cleaning / disinfection products

Bleach

Ammonia

Acids (decalcifiers)

Quats (quaternary ammonium compounds)

Alcohol

Perfumes

…

Products used in healthcare settings

Aldehydes (formaldehyde, glutaraldehyde)

Hydrogen peroxide (+ acids)

Chlorhexidine

Chloramine T

Ethylene oxyde

Enzymes (added to detergents)

…

Potential target(s) for prevention: which specific product(s)/agent(s) ?

Specific agents associated with asthma (epidemiological studies)

Reference	Study design, country	Outcome	Agents
Medina-Ramon, 2005	Spain, cleaners, n=195	Current asthma/ chronic bronchitis	Bleach, ammonia
Mirabelli, 2007	Europe, n=2813	New-onset asthma	Bleach, ammonia
Vizcaya, 2011	Spain, cleaners, n=917	Current asthma, asthma symptoms	Hydrochloric acid, ammonia
Arif,2012	USA, healthcare workers, n=3650	Work-related asthma / asthma symptoms	Bleach, ammonia, chloramines, formaldehyde, glutaraldehyde/ ortho-phthalaldehyde, ethylene oxide
Dumas, 2012	France, n=724	Current asthma	Decalcifiers (acids), ammonia
Gonzalez, 2014	France, healthcare workers, n=543	Physician-diagnosed asthma	Quaternary ammonium compounds
Dumas, 2017	USA, female nurses with asthma, n=4102	Asthma control	Bleach, hydrogen peroxide, enzymatic cleaners, formaldehyde, glutaraldehyde
Casey, 2017	USA, hospital workers, n=163	Current asthma	Disinfectant containing hydrogen peroxide, peracetic acid and acetic acid
Su, 2019	USA, healthcare workers, n=2030	Asthma clusters, e.g. “undiagnosed/ untreated asthma”, “asthma attacks/ exacerbations”	Alcohols, bleach, enzymatic cleaners
Brooks, 2020	New Zealand, 425 cleaners, 281 other workers	Current asthma, lung function	Bleach, decalcifiers (acids)

*Results presented only for chemicals significantly associated with asthma outcomes. Products with mixed composition (e.g., “detergents”, “cleaning sprays”, “multipurpose products”) not reported in this table.

Specific agents associated with asthma (epidemiological studies)

- **Bleach (chlorine) and ammonia**: first specific agents identified
- **Bleach** remains the most frequently reported

- High level disinfectants (healthcare settings):
  - Aldehydes (**formaldehyde, glutaraldehyde**) long known as causing agents for occupational asthma
  - High level disinfectants proposed as alternative to aldehydes (**hydrogen peroxide or hydrogen peroxide / peracetic acid mixtures**) also appear associated with asthma outcomes

Outline

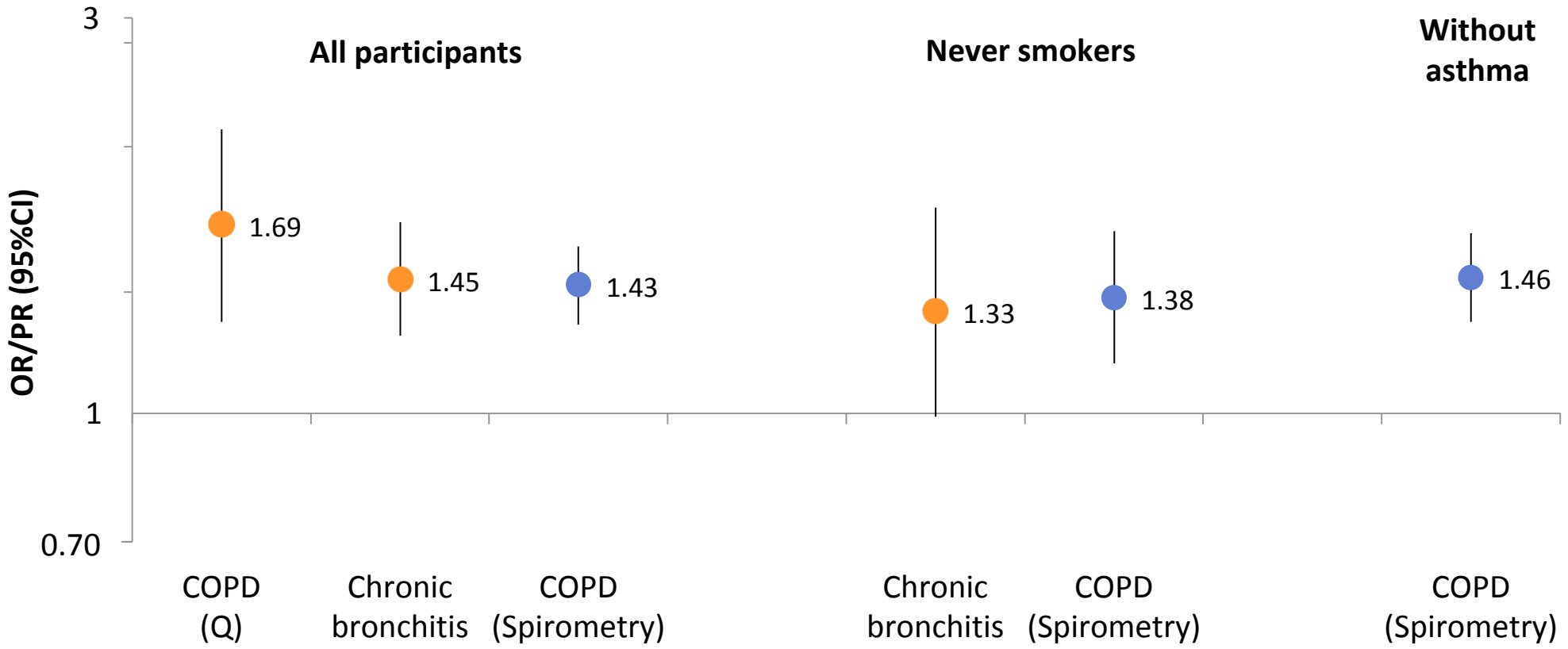
I. Respiratory health effects of disinfectants and cleaning products (DCP)
   - Chronic respiratory diseases
   - DCP and asthma
   - DCP and COPD / lung function

II. Other potential health effects of DCP

III. Conclusion and pending questions

Working as cleaner and COPD: two European studies

RHINE III (Northern Europe): n=13,499 adults (mean age: 51.5) - Svanes, PlosOne, 2015
UK Biobank: n=228,614 adults (mean age: 52) – De Matteis, OEM, 2016



Results adjusted for sex, age, smoking, +education level, parents' education level, body mass index

Working as cleaner and COPD mortality

Van den Borre et al, Int Arch Occup Environ Health 2018

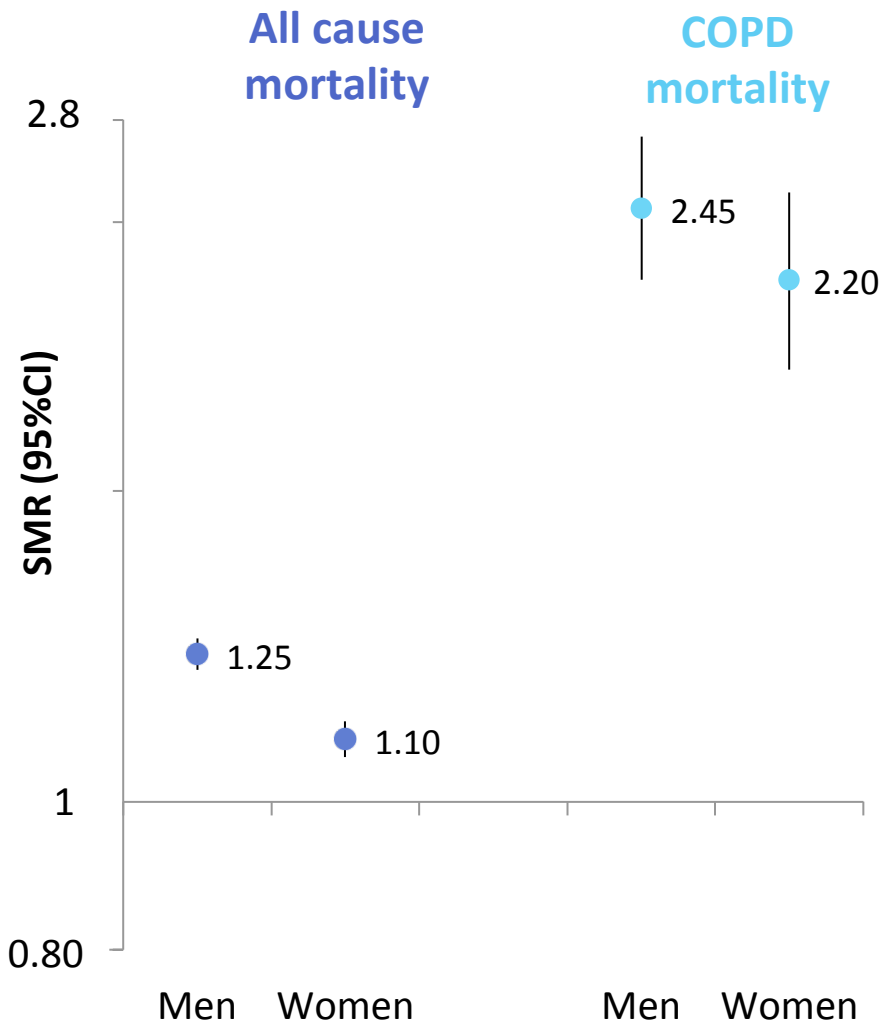
- Linkage of Belgian census, register & death certificate data

Working population in 1991, ~2.5M adults
~260,000 deaths from 1991 to 2011

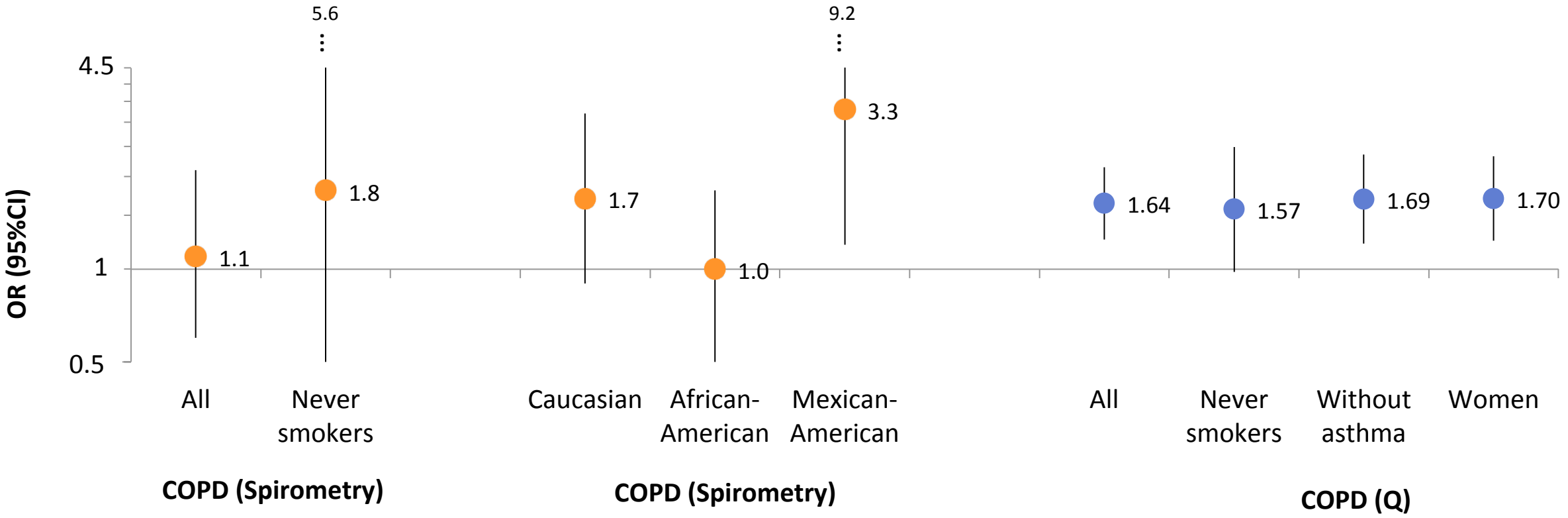
- Cause specific mortality in death certificate:
  ICD 9/10

- Current occupation recorded in 1991 census:
  Comparison cleaners vs. non-manual workers (ref)

- Association with COPD mortality remained similar after adjustment for smoking (indirect) and education
- Working as cleaner also associated with mortality from lung cancer, pneumonia, ischemic heart diseases and cerebrovascular diseases with SMR range [1.10-1.50]



Working in healthcare and COPD: studies in the US



NHANES III - Hnizdo et al., AJE 2002 & AJIM 2004

- US, 1988-94
- n=9,823 adults aged 30-75 years
- Longest held job – healthcare industry

NHIS – Doney et al, JOEM 2014

- US, 2004-11
- Adults aged 40-70 years
- Current job – healthcare support

Results adjusted for sex, age, race/ethnicity, smoking, +education level/SES, body mass index

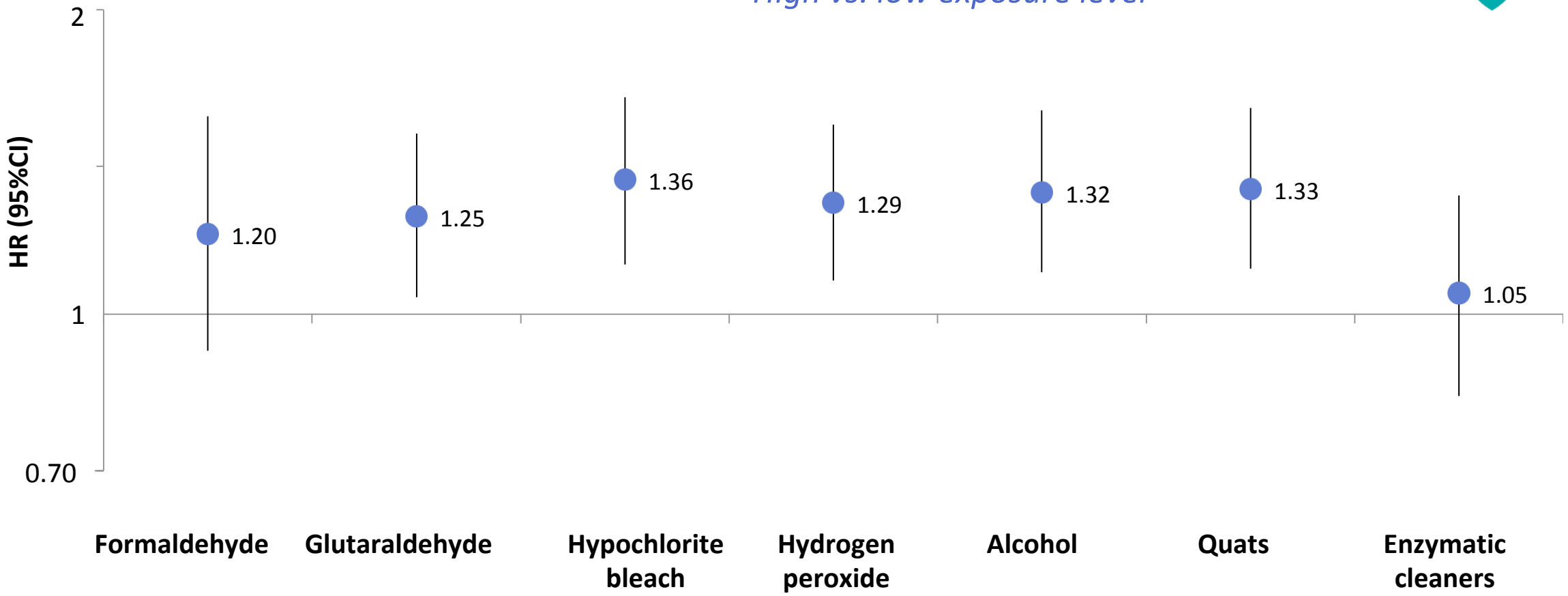
Association of exposure to specific disinfectants/cleaning products with COPD incidence

n=582 incident COPD cases

Exposure to specific agents

High vs. low exposure level

Nurses' Health Study



- Female registered nurses from 15 US states
- Follow-up from 2009 to 2017
- 73,262 nurses (mean age: 54 years)

Results adjusted for age, race, ethnicity, smoking status and pack-years, and body mass index

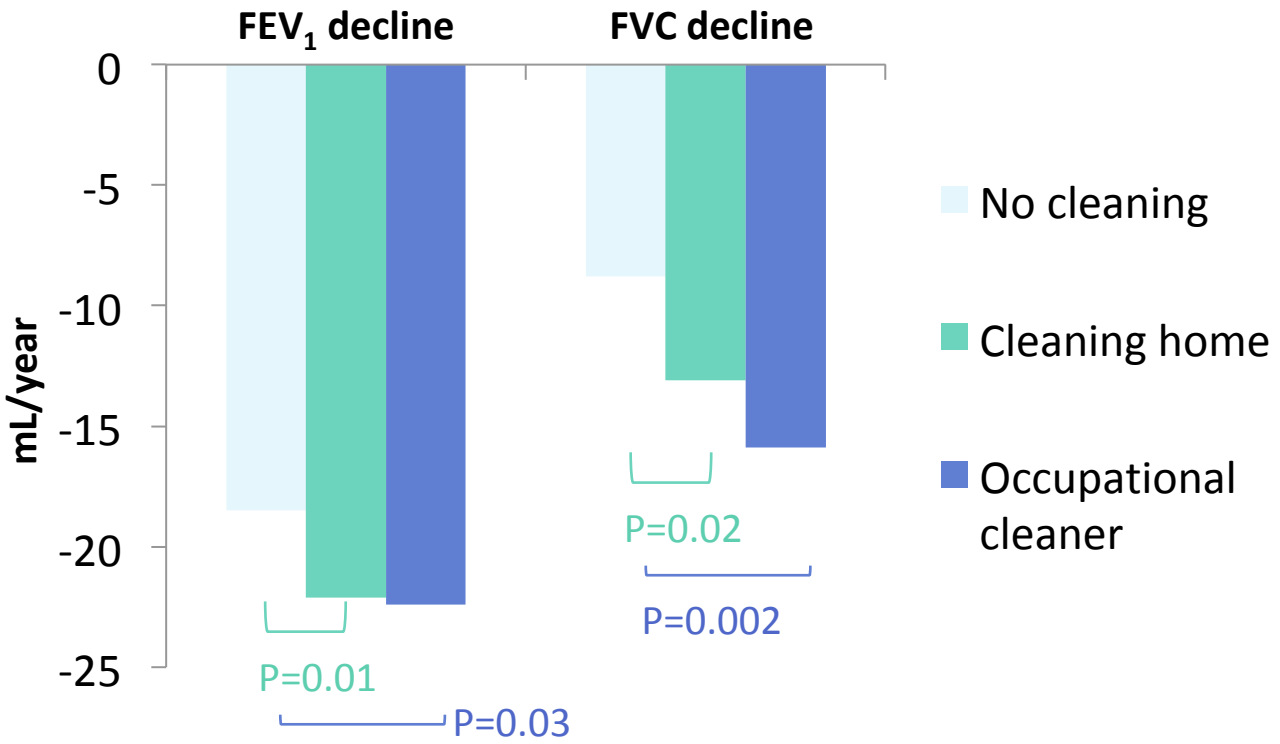
Dumas et al., JAMA Network Open, 2019

Cleaning and lung function decline

ECRHS (Europe) – Svanes, AJRCCM 2018

- n=6,235 adults (mean age: 54 at end of follow-up)
- Lung function decline and airway obstruction:
  - Spirometry at each survey
  - Decline in FEV_1, FVC, FEV_1/FVC
- Cleaning exposures:
  - Cleaning at home (+ use of sprays)
  - Occupational cleaner

Cleaning activities and lung function decline **in women**



Results adjusted for age, height, smoking, education level, body mass index, spirometer model and study center
FEV1: forced expiratory volume in 1 second; FVC: forced vital capacity

Outline

I. Respiratory health effects of disinfectants and cleaning products (DCP)
   - Chronic respiratory diseases
   - DCP and asthma
   - DCP and COPD / lung function

II. Other potential health effects of DCP

III. Conclusion and pending questions

Other potential health hazards of occupational exposure to DCP

- Reproductive outcomes

  Use of sterilizyng agents/disinfectants among female nurses associated with increased risk of :

  - Preterm birth - Lawson, AJOG 2009
  - Spontaneous abortions - Lawson, AJOG 2012
  - Reduced fecundity - Gaskins, SJWEH 2016

- Cardiovascular outcomes

  Long-term frequent use of household spray and scented products in older adult women associated with reduced Heart Rate Variability (suggests cardiovascular health hazards) - Mehta, EHP 2012

- Endocrine disruptors

  Disinfectants may contain endocrine disruptive chemicals used as preservative and antimicrobial agents (e.g., parabens, triclosan, triclocarban) – Dodson, EHP 2012

Outline

I. Respiratory health effects of disinfectants and cleaning products (DCP)
   - Chronic respiratory diseases
   - DCP and asthma
   - DCP and COPD / lung function

II. Other potential health effects of DCP

III. Conclusion and pending questions

Conclusion and pending questions

- **Conclusions:**
  - Strong evidence to support a link between DCP exposure and **asthma**
  - Evidence to support a link between DCP exposure and **COPD** is accumulating
  - Additional studies are needed to examine **other potential health effects**

- **Pending questions:**
  - Clarify the causative agents

    Crucial knowledge for the development of strategies for prevention, in particular in healthcare settings

  - Strategies for asthma and COPD prevention
    - Use of protective equipment, ventilation?
    - Limit use of sprays (likely to increase exposure by inhalation – Loven, Occup Env Hyg 2019)
    - Safer alternatives?
      - "Green products"? (need health safety evaluation) – Garza, AJIM 2015
      - Non-chemical disinfection? (UV light, heat) – Quinn, AJIC 2015

Acknowlegments

- **Inserm CESP, Integrative Respiratory Epidemiology team (Villejuif, France)**
  - Nicole Le Moual
  - Raphaëlle Varraso
  - Rachel Nadif
  - Catherine Quinot
- **MGH, BWH & Harvard Medical School, (Boston, USA)**
  - Carlos Camargo
  - Staff and participants of the NHSII

Nurses' Health Study

Contact: orianne.dumas@inserm.fr

Instituts thématiques Inserm
Institut national de la santé et de la recherche médicale

cesp

Inserm CESP, Integrative Respiratory Epidemiology team, Villejuif (Paris-Sud), France
ERS – Marie Curie Post-doctoral Research Fellowships (RESPIRE 4) **host center**