Indoor air quality and health effects in European modern office buildings: main results from the OFFICAIR study

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### European collaborative project, funded from the European Union FP7 under Theme ENV.2010

<table>
<thead>
<tr>
<th>Name of organisation</th>
<th>Acronym</th>
<th>Country of origin</th>
</tr>
</thead>
<tbody>
<tr>
<td>PANEPISTIMIO DYTIKIS MAKEDONIAS (UNIVERSITY OF WESTERN MACEDONIA)</td>
<td>UOWN</td>
<td>Greece</td>
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<tr>
<td>JRC - JOINT RESEARCH CENTRE- EUROPEAN COMMISSION</td>
<td>JRC</td>
<td>Belgium</td>
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<td>VLAAMSE INSTELLING VOOR TECHNOLOGISCH ONDERZOEK N.V.</td>
<td>VITO</td>
<td>Belgium</td>
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<tr>
<td>DET NATIONALE FORSKNINGS CENTER FOR ARBEJDSMILJO</td>
<td>NCRWE</td>
<td>Denmark</td>
</tr>
<tr>
<td>UNIVERSITY OF YORK</td>
<td>UOY</td>
<td>United Kingdom</td>
</tr>
<tr>
<td>UNIVERSITA DEGLI STUDI DI MILANO</td>
<td>UML</td>
<td>Italy</td>
</tr>
<tr>
<td>INSTITUTO DE ENGENHARIA MECANICA</td>
<td>IDMEC</td>
<td>Portugal</td>
</tr>
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<td>KING’S COLLEGE LONDON</td>
<td>KCL</td>
<td>United Kingdom</td>
</tr>
<tr>
<td>NEDERLANDSE ORGANISATIE VOOR TOEGEPAST NATUURWETENSCHAPPELIJK ONDERZOEK</td>
<td>TNO</td>
<td>Netherlands</td>
</tr>
<tr>
<td>CENTRE SCIENTIFIQUE ET TECHNIQUE DU BATIMENT</td>
<td>CSTB</td>
<td>France</td>
</tr>
<tr>
<td>CONSIGLIO NAZIONALE DELLE RICERCHE</td>
<td>CNR-IIA</td>
<td>Italy</td>
</tr>
<tr>
<td>ACCIONA INFRAESTRUCTURAS S.A.</td>
<td>ACCIONA</td>
<td>Spain</td>
</tr>
<tr>
<td>EÖTVÖS LORÁND TUDOMÁNYEGYETEM</td>
<td>ELTE</td>
<td>Hungary</td>
</tr>
<tr>
<td>UNIVERSITY OF IOANNINA</td>
<td>UOI</td>
<td>Greece</td>
</tr>
<tr>
<td>UNIVERSITA DEGLI STUDI DELL INSUBRIA</td>
<td>UNINS</td>
<td>Italy</td>
</tr>
</tbody>
</table>
ON THE REDUCTION OF HEALTH EFFECTS FROM COMBINED EXPOSURE TO INDOOR AIR POLLUTANTS IN MODERN OFFICES

OFFICIAIR Final PSG Meeting – Thessaloniki, 30 January 2014

Università degli Studi di Milano

WP1: Management

WP2: Database

WP3: Emission testing, Reactions

WP5: Toxicological studies

WP4: Monitoring campaigns

WP6: IAQ – Exposure Modelling

WP7: Health effects evaluation

WP8: Risk management & Policies

WP9: Dissemination

WP2: Database

WP3: Emission testing, Reactions

WP5: Toxicological studies

WP4: Monitoring campaigns

WP6: IAQ – Exposure Modelling

WP7: Health effects evaluation

WP8: Risk management & Policies

WP9: Dissemination
ON THE REDUCTION OF HEALTH EFFECTS FROM COMBINED EXPOSURE TO INDOOR AIR POLLUTANTS IN MODERN OFFICES

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THE
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IN
MODERN
OFFICES

Officair

WP4/WP7: Health effects evaluation in modern office buildings and health risk assessment

– To evaluate the present situation about complaints and symptoms known to be related to IAQ in modern offices across Europe.

– To evaluate the health effects of selected and prioritised IA pollutants, including reaction products, e.g. oxidation product, under different conditions in modern office buildings across Europe, taking into account the role of stress;

– To perform health risk assessment of targeted indoor air pollutants, based on results from this WP (WP7), field campaigns study (WP4), toxicological studies (WP5) and indoor exposure modelling (WP6);

– To evaluate the benefits on health of intervention strategies on IAQ.
ON THE REDUCTION OF HEALTH EFFECTS FROM COMBINED EXPOSURE TO INDOOR AIR POLLUTANTS IN MODERN OFFICES

Officair

✓ 8 European countries
✓ 167 buildings
✓ 26.500 office workers
✓ 2011/2014

Modern Office Buildings (voluntary basis)

Selection criteria:
• to be new or recently retrofitted (<10 years)
• operating in their current form for a minimum 1 year prior to the start of the study (preferable 2 years)
• no major renovation / change before the autumn of 2012
Officair Project - WP4/WP7 key strategy

On the reduction of health effects from combined exposure to indoor air pollutants in modern offices (EU FP7 Env 2010).

General survey: 167 buildings – ~7500 workers – Questionnaire + building checklist

DETAILED study: 37 buildings – ~1400 workers – measurements + detailed checklist

2 SEASONS

INTERVENTION study: 9 buildings – ~250 workers – Innovative measurement and strategy

BEFORE & AFTER AN INTER.

7441 workers investigated in eight European countries, representing all the European climatic regions.

HEALTH RISK ASSESSMENT

HEALTH RISK MANAGEMENT
1. GENERAL SURVEY

20 BUILDINGS PER COUNTRY (Oct 2011 – March 2012)

- **WP4: CHECKLIST SURVEY**
  To inventory the design characteristics of the building and HVAC system, and the activities occurring (e.g. including maintenance and occupational), in order to identify the main causes and sources of pollution and the problems identified by the questionnaire (perceived symptoms related to IAQ).

- **WP7: ONLINE QUESTIONNAIRE SURVEY ON HEALTH EFFECTS**
  To investigate the association between health effects, IAQ perception and building characteristics, taking into account the potential role of stress in the observed associations.

20 selected office buildings per country visited on scheduled days for inspection with the checklist and in the same week online questionnaire compilation
QUESTIONNAIRE (online web-based compilation) based on standardised and validated questionnaires further developed in order to investigate:

- **IAQ correlated self-reported Complaints and Symptoms**
  *HOPE Questionnaire* (e.g. air quality perception, eyes and airways irritation, wheezing - Last four weeks - Last week – Now)

- **Psycho-social (work) environment and Psychological characteristics**
  *Effort-Reward Imbalance (ERI), PANAS, Emocards* (to investigate the combined effects of psychosocial stress and IAQ on health)

- **Further data (to control for confounders):**
  - Personal data (e.g. age, sex, BMI, job-position, level of study)
  - Private data (e.g. household, sleeping habits, emotional state)
  - General medical history information (e.g. allergy, respiratory disease)
  - Lifestyle information (e.g. smoke-habit, ETS exposure at home)
65 During the PAST FOUR WEEKS, on how many days did you experience each of the following symptoms when you were at work at your workstation (including today)?

Only answer this question for the items you selected in question 5 (Have you ever experienced any of the following symptoms while working in this building (or workstation) (including today)?)

<table>
<thead>
<tr>
<th></th>
<th>Not in the last 4 weeks</th>
<th>1-3 days in the last 4 weeks</th>
<th>1-3 days per week in the last 4 weeks</th>
<th>Every or almost every workday</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry eyes</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Watering or itchy eyes</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Blocked or stuffy nose</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Runny nose</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Dry/irritated throat</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Chest tightness or breathing difficulty</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Flu-like symptoms</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Dry skin</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Rash or irritated skin</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Headache</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Lethargy, unusual tiredness</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Burning or irritated eyes</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Wheezing</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Cough</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Sneezing</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Tachycardia</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Irregular heart beats</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Bradycardia</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Phlegm / mucus</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Any other symptoms</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>

66 Was it better on days away from the office (e.g. holidays, weekend)?

Only answer this question for the items you selected in question 5 (Have you ever experienced any of the following symptoms while working in this building (or workstation) (including today)?)

<table>
<thead>
<tr>
<th></th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry eyes</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Watering or itchy eyes</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Blocked or stuffy nose</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Runny nose</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>
### Physical environment (1st part)

#### 73 How would you describe the typical indoor conditions in your OFFICE ENVIRONMENT during the past month?

#### 74 Temperature

<table>
<thead>
<tr>
<th>Uncomfortable</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>Comfortable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Too cold</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Too hot</td>
</tr>
<tr>
<td>Varies too much during the day</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Not enough variation</td>
</tr>
</tbody>
</table>

#### 75 Air movement

<table>
<thead>
<tr>
<th>Draughty</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>Still</th>
</tr>
</thead>
</table>

#### 76 Air quality

<table>
<thead>
<tr>
<th>Humid</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>Dry</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stuffy</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Fresh</td>
</tr>
<tr>
<td>Smelly</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Odorless</td>
</tr>
<tr>
<td>Unsatisfactory</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Satisfactory</td>
</tr>
</tbody>
</table>
Self-reported health and comfort in ‘modern’ office buildings: first results from the European OFFICAIR study

Abstract In the European research project OFFICAIR, a procedure was developed to determine associations between characteristics of European offices and health and comfort of office workers, through a checklist and a self-administered questionnaire including environmental, physiological, psychological, and social aspects. This procedure was applied in 167 office buildings in Europe. Environment, Indoor Comfort, Europe, OFFICAIR Project.

P. M. Bluyssen1, 2, C. Roda1, 2, C. Mandin3, S. Fossati4, P. Carrer5, Y. de Kluizenaar6, V. G. Mihucz7, E. de Oliveira Fernandes8, J. Bartzis9

Building and Environment 102 (2016) 54–63

Contents lists available at ScienceDirect

Building and Environment

journal homepage: www.elsevier.com/locate/buldev

Office characteristics and dry eye complaints in European workers—The OFFICAIR study

Yvonne de Kluizenaar a, 1, Célina Roda b, *, 1, Nienke Elske Dijkstra a, Serena Fossati c, Corinne Mandin d, Victor G. Mihucz e, Otto Hänninen f, Eduardo de Oliveira Fernandes g, Gabriela V. Silva g, Paolo Carrer c, John Bartzis h, Philomena M. Bluyssen b
Table 1
General characteristics of the study population in OFFICAIR (N = 7441).

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>n (% )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Participants per country</td>
<td></td>
</tr>
<tr>
<td>The Netherlands</td>
<td>1014 (13.6)</td>
</tr>
<tr>
<td>Italy</td>
<td>809 (10.9)</td>
</tr>
<tr>
<td>Portugal</td>
<td>508 (6.8)</td>
</tr>
<tr>
<td>Spain</td>
<td>698 (9.4)</td>
</tr>
<tr>
<td>Greece</td>
<td>1020 (13.7)</td>
</tr>
<tr>
<td>Finland</td>
<td>793 (10.7)</td>
</tr>
<tr>
<td>Hungary</td>
<td>1409 (18.9)</td>
</tr>
<tr>
<td>France</td>
<td>1190 (16.0)</td>
</tr>
<tr>
<td>Sex</td>
<td></td>
</tr>
<tr>
<td>Men</td>
<td>3561 (47.9)</td>
</tr>
<tr>
<td>Women</td>
<td>3880 (52.1)</td>
</tr>
<tr>
<td>Age (years), mean (SD)</td>
<td>40.3 (10.1)</td>
</tr>
<tr>
<td>Level of education</td>
<td></td>
</tr>
<tr>
<td>Master, PhD or specialization</td>
<td>2322 (31.4)</td>
</tr>
<tr>
<td>University, college or equivalent</td>
<td>3205 (43.3)</td>
</tr>
<tr>
<td>Professional</td>
<td>625 (8.5)</td>
</tr>
<tr>
<td>Secondary school</td>
<td>1117 (15.9)</td>
</tr>
<tr>
<td>Primary school or lower</td>
<td>68 (0.9)</td>
</tr>
<tr>
<td>Smoking status</td>
<td></td>
</tr>
<tr>
<td>Current</td>
<td>1463 (20.0)</td>
</tr>
<tr>
<td>Former</td>
<td>1815 (24.7)</td>
</tr>
<tr>
<td>Never</td>
<td>4057 (55.3)</td>
</tr>
<tr>
<td>Alcohol consumption</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>4733 (64.1)</td>
</tr>
<tr>
<td>No</td>
<td>2646 (35.9)</td>
</tr>
<tr>
<td>Hours working with a VDU, on average per week, mean (SD)</td>
<td>22.9 (16.7)</td>
</tr>
</tbody>
</table>
Worker’s perception of environmental conditions during the past month

Percentages of office workers who rated the environmental parameters below the value ‘4’ on a scale from 1 to 7.

N. Buildings 156; N. workers 7441

Bluyssen et al., Indoor Air 2015
Negative Environmental perceptions and Building characteristics

- number of occupants/open-plan office
- presence of carpet
- cleaning activities

- lack operable windows
- low perceived indoor environment control

- overall comfort negatively correlated with ERI (Effort-Reward Imbalance)
- overall comfort positively correlated with self-estimated productivity

Bluyssen et al., Indoor Air 2015
Prevalence of building-related health symptoms during the past month

About 68% of the workers believed that symptoms were due to his/her office environment.

Bluyssen et al., Indoor Air 2015
Symptoms and Building characteristics

- mold growth
- presence of a cooling system
- office furniture less than 1 year old
- printer/copy machines located in offices
- cleaning activities
- acoustical solutions

Bluyssen et al., Indoor Air 2015
Among all office workers investigated, complaints of dry eyes ‘during the four past weeks’ were reported by 34% of them.

Majority of workers (91.2%) experiencing these symptoms, reported improvement on days away from the office.
Conclusions

The high prevalence (34%) of self-reported dry eye complaints in offices may be explained by:

- **work-related factors** (Visual Display Unit use)

- **office building characteristics** which may affect exposure to environmental conditions:
  - nearby outdoor pollution sources,
  - certain types of wall coverings,
  - locations of printers/copy machines in offices
  - portable humidifiers
  - absence of operable windows
  - cleaning activities
INTERVENTION STUDY

- 8 BUILDINGS: - BEFORE INTERVENTION (January/March 2013)
  - AFTER INTERVENTION (March/May 2013)

- INTERVENTION STRATEGIES RELATED TO IAQ
  substitution of floor cleaning products with low terpenes contents (Intervention Area)
  and no substitution in Non Intervention Area

- WP4: ENVIRONMENTAL MONITORING
  Detailed IAQ investigation

- WP7: HEALTH EFFECTS
  Protocol to investigate:
  the sensory irritation, the inflammatory and oxidative effects (both local, i.e. in the airways, and systemic),
  and the endothelial and autonomic dysfunction due to exposure to targeted indoor air pollutants (including reaction products).
Intervention study: results for aldehyde concentrations

A significant change in aldehyde concentrations after *versus* before in the intervention room

<table>
<thead>
<tr>
<th>Aldehyde</th>
<th>Variability between phases (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Formaldehyde</td>
<td>*-50%</td>
</tr>
<tr>
<td>Acetaldehyde</td>
<td>**-38%</td>
</tr>
<tr>
<td>Acrolein</td>
<td>***-14%</td>
</tr>
<tr>
<td>Propionaldehyde</td>
<td>8%</td>
</tr>
<tr>
<td>Crotonaldehyde</td>
<td>15%</td>
</tr>
<tr>
<td>Methacrolein</td>
<td>**-32%</td>
</tr>
<tr>
<td>Benzaldehyde</td>
<td>***-22%</td>
</tr>
</tbody>
</table>

*: p-value between 0.010 and 0.050; **: p-value between 0.001 and 0.010; ***: p-value below 0.001

Courtesy of Corinne Mandin et al. *Indoor Air Conference 2016*
Table 6: Average and maximum measured indoor air concentrations (µg/m³) (2-h mean) reported in the ‘Intervention study’ and comparison with acute limits of exposure – intervention room: before and after the intervention strategy.

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Limit of exposure (µg/m³)</th>
<th>Conc. (µg/m³) / Limit of exposure (%)</th>
<th>Conc. (µg/m³) / Limit of exposure (%)</th>
<th>Conc. (µg/m³) / Limit of exposure (%)</th>
<th>Conc. (µg/m³) / Limit of exposure (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>formaldehyde</td>
<td>100</td>
<td>14 / 14</td>
<td>7 / 7</td>
<td>37 / 37</td>
<td>8 / 8</td>
</tr>
<tr>
<td>acrolein</td>
<td>21</td>
<td>2 / 9</td>
<td>1 / 5</td>
<td>4 / 19</td>
<td>1 / 5</td>
</tr>
<tr>
<td>d-limonene</td>
<td>90000</td>
<td>15 / &lt;1</td>
<td>8 / &lt;1</td>
<td>166 / &lt;1</td>
<td>92 / &lt;1</td>
</tr>
<tr>
<td>α-pinene</td>
<td>45000</td>
<td>1 / &lt;1</td>
<td>3 / &lt;1</td>
<td>5 / &lt;1</td>
<td>1 / &lt;1</td>
</tr>
<tr>
<td>6-MHO</td>
<td>1550</td>
<td>2.5 / &lt;1</td>
<td>3 / &lt;1</td>
<td>12 / &lt;1</td>
<td>14 / &lt;1</td>
</tr>
<tr>
<td>4-OPA</td>
<td>246</td>
<td>&lt;1 / &lt;1</td>
<td>&lt;1 / &lt;1</td>
<td>3 / 1</td>
<td>&lt;1 / &lt;1</td>
</tr>
</tbody>
</table>

1. max concentration reported for building code PT17
2. max concentration reported for building code PT17
3. max concentration reported for building code PT13
4. max concentration reported for building code NL02
5. max concentration reported for building code PT13
6. max concentration reported for building code IT03
7. should not be exceeded at any 30-min interval during the day (WHO 2010 guideline value)

Note: for HRA, intervention room measurements before intervention strategy not available from FR for d-limonene, α-pinene, 6-MHO, 4-OPA.
Intervention Area - IAQ related symptoms

(last week)

Carrer P et al. *Indoor Air Conference 2016*
Psychosocial work environment and building related symptoms
The OFFICAIR study

Céline RODA
Philomena M. Bluyssen, Corinne Mandin, Serena Fossati, Paolo Carrer, Yvonne de Kluizenaar,
Victor G. Mihucz, Eduardo de Oliveira Fernandes, and John Bartzis
Effort-Reward Imbalance model - ERI

A combination of high Effort spent and low Rewards received could lead to adverse health effects (Siegrist 1996, 2004)

Extrinsic components:
- demands / obligations
- motivation (‘overcommitment’)
- labour income
career mobility / job security
esteem, respect

Intrinsic component:
- motivation (‘overcommitment’)

Courtesy of Celine Roda et al. Healthy Buildings Conference 2015
Psychosocial work environment in Officair

**Effort / Reward ratio > 1**

- Overall
- Greece
- Hungary
- Spain
- France
- Italy
- Portugal
- The Netherlands
- Finland

Courtesy of Celine Roda et al. *Healthy Buildings Conference 2015*
Association between work-related stress and building related symptoms

**Eye irritation**

- High efforts / High rewards (vs. LE/HR)
- Low efforts / Low rewards (vs. LE/HR)
- High efforts / Low rewards (vs. LE/HR)
- High overcommitment (vs. low)

**Upper respiratory symptoms**

- High efforts / High rewards (vs. LE/HR)
- Low efforts / Low rewards (vs. LE/HR)
- High efforts / Low rewards (vs. LE/HR)
- High overcommitment (vs. low)

**General symptoms**

- High efforts / High rewards (vs. LE/HR)
- Low efforts / Low rewards (vs. LE/HR)
- High efforts / Low rewards (vs. LE/HR)
- High overcommitment (vs. low)

**Skin symptoms**

- High efforts / High rewards (vs. LE/HR)
- Low efforts / Low rewards (vs. LE/HR)
- High efforts / Low rewards (vs. LE/HR)
- High overcommitment (vs. low)

Adjusted for sex, age, educational level, job, tobacco smoke status, current alcohol consumption and negative affectivity

Courtesy of Celine Roda et al. *Healthy Buildings Conference 2015*
Frequent negative environmental perceptions >30% in particular for air quality unsatisfactory, air too dry (air stuffy, air smelly), noise from inside building

Frequent complaining of symptoms (>20%) in particular eye symptoms (34%) and headache
Indoor Air Quality and Health in Modern Office Buildings - 2

Negative Environmental perceptions and Symptoms mainly associated with:

- VDU work
- Number of occupants, open-plan office
- Chemical sources (office furniture less than 1 year old, printer/copy machines located in offices, cleaning activities)
- Biological sources (mold growth, presence of a cooling system)
- Microclimate parameters (*ongoing evaluation*)
- Low perceived indoor environment control
- Work-related stress (ERI)
Multi-disciplinary approach needed in order to provide a healthy work environment:

- Potential role of work activities and indoor sources/parameters on IAQ perceptions/symptoms
- Role of low indoor environment control on environmental perceptions/symptoms
- Complex effects of psychosocial factors on BRSs: independent and/or combined effects impact on workers’ perceptions of health and/or increased susceptibility to environmental exposures?
Thanks for your attention

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ICOH 2018 CONFERENCE, Dublin