European Network on New Sensing Technologies for Air Pollution Control and Environmental Sustainability - *EuNetAir*

COST Action TD1105

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*New Sensing Technologies for Indoor and Outdoor Air Quality Control*

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# INDOOR ENVIRONMENT AND HEALTH IN ELDERLY CARE CENTERS: THE GERIA PROJECT


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# BACKGROUND (I)

- The mean age of the European population is rising and the percentage of adults aged 65 years and older is projected to INCREASE FROM 16% IN 2000 TO 20% IN 2020 (Adan O., 2006).

- It has been estimated that OLDER PERSONS SPEND ABOUT 19-20 HOURS PER DAY INDOOR (WHO, 2003).


- Moreover, ELDERLY CARE HOMES HAVE THE POTENTIAL TO INFLUENCE PEOPLE'S LIVES socially, physically and psychologically (Bradshaw S., 2012).

# BACKGROUND (II)

- Indoor air quality (IAQ) is a key indoor factor that might affect comfort, health and occupants' performance, PARTICULARLY IN SUSCEPTIBLE INDIVIDUALS SUCH AS ELDERLY.
- This population is particularly at risk of detrimental effects from pollutants, EVEN AT LOW CONCENTRATIONS, due to
  - REDUCED IMMUNOLOGICAL DEFENCES AND MULTIPLE UNDERLYING CHRONIC DISEASES.
  - AMOUNT OF TIME SPENT INDOORS (LONG EXPOSURE PERIODS).

- As a result, the STUDY OF IAQ IN THE ELDERLY POPULATION IS BECOMING AN IMPORTANT ISSUE TO BE ADDRESSED BY CLINICAL RESEARCH.

# RESEARCH AIM (I)

- The aim of GERIA project is to CARRY OUT A RISK ASSESSMENT involving:
  - IDENTIFICATION OF MULTIPLE FACTORS potentially affecting HEALTH AND QUALITY OF LIFE;
  - QUANTIFICATION OF HUMAN EXPOSURE to pollutants, and
  - EVALUATION OF THE INDIVIDUAL'S RESPONSE to these stimuli.

GERIA
Geriatric Study in Portugal on Health Effects of Air Quality in Elderly Care Centers
www.geria.webnode.com

# RESEARCH AIM (II)

- The results of this project will:
  - contribute to the UNDERSTANDING HEALTH EFFECTS DUE TO INDOOR ENVIRONMENT VARIABLES, and
  - IMPROVE THE HEALTH OF OUR ELDERLY population.

**We believe that this program will be able to develop innovative strategies which, with relatively simple measures, could provide health benefits to elderly care centers residents.**

# STUDY DESIGN & SAMPLE (I)

**1st Phase** → **2nd Phase**

22 ECC Porto

33 ECC Lisbon

20 ECC Porto and Lisbon

**BUILDING CHARACTERIZATION**

- Type of building construction
- Thermal isolation of the building
- Characteristics of building envelope
- Ventilation system
- Materials used for finishing
- Use of gas burning appliances that could influence the IAQ
- Evidences of dampness and mould at the building envelope
- Ventilation practices of the occupants

**HEALTH AND QUALITY OF LIFE QUESTIONNAIRES**

- WHOQOL-BREF Questionnaire
- BOLD Questionnaire
- Mini Mental State Examination
- Geriatric Depression Scale GDS-15

**INDOOR AIR QUALITY ASSESSMENT**
(AUTUMN/WINTER-SPRING/SUMMER)

- PM10 (INDOOR/OUTDOOR)
- PM2.5 (INDOOR/OUTDOOR)
- Formaldehyde (INDOOR)
- Total Volatile Organic Compounds (INDOOR/OUTDOOR)
- Carbon Dioxide (INDOOR/OUTDOOR)
- Carbon Monoxide (INDOOR/OUTDOOR)
- Temperature (INDOOR/OUTDOOR)
- Relative Humidity (INDOOR/OUTDOOR)
- Bacteria (INDOOR/OUTDOOR)
- Fungi (INDOOR/OUTDOOR)
- Thermal Comfort Indexes (INDOOR)

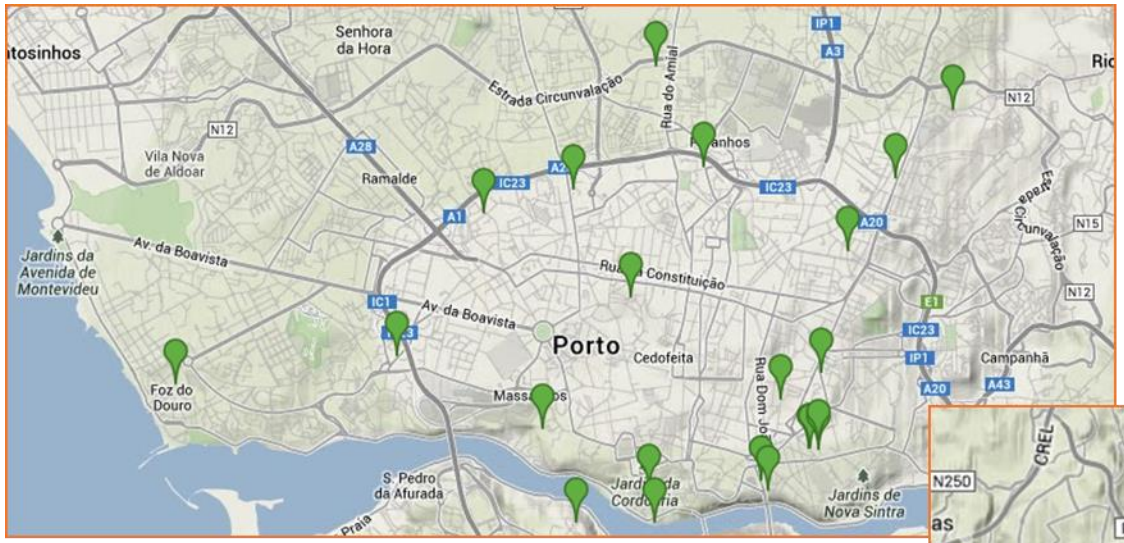
**CLINICAL TESTS**

- Nasopharyngeal swabs for virus characterization
- Exhaled breath condensate
- Spirometry

**VENTILATION ASSESSMENT**

- Tracer Gas Technique PFT
- Ventilation modeling

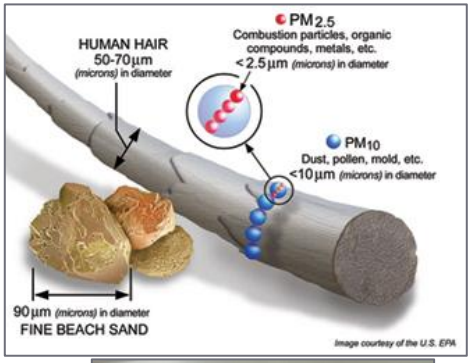
# STUDY DESIGN & SAMPLE (II)

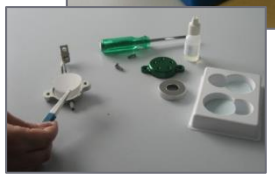


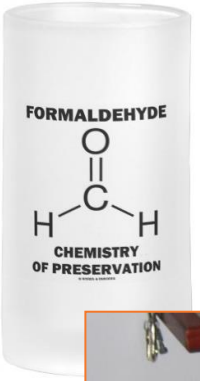

# METHODS & MATERIALS

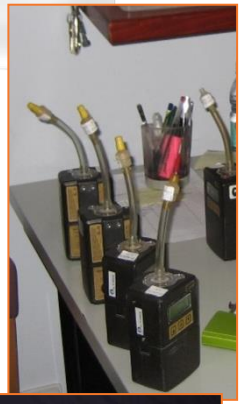
## IAQ ASSESSMENT | ACTIVE SAMPLING

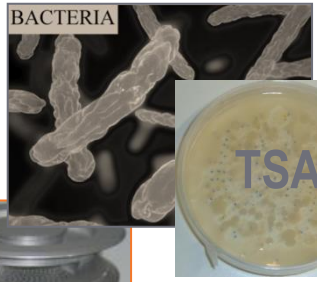
Senior Housing











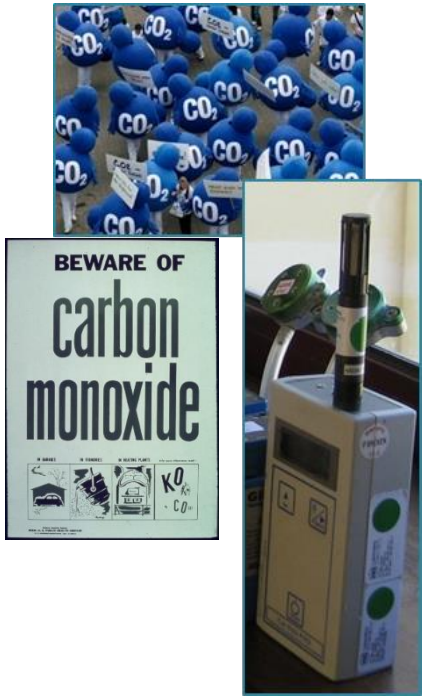

naked eye count

cost
EUROPEAN COOPERATION IN SCIENCE AND TECHNOLOGY

# METHODS & MATERIALS

## IAQ ASSESSMENT | DIRECT READING

Senior Housing




**TC indexes following ISO 7730:2005**
**PMV Predicted Mean Vote**
**PPD Predicted Percent of Dissatisfied People**

**_moderate environments_ (class C – comfort standard)**

**Homogeneous' and steady-state environment**

**tested according ISO 7726:2005 specifications**

**with TSI 8386A-M-GB thermo-anemometer**

**MATLAB® Software**

# METHODS & MATERIALS

## VENTILATION ASSESSMENT | TRACER GAS TECHNIQUE (PFT) & MODELING

Senior Housing

### VENTILATION MODELING


### PASSIVE PERFLUOROCARBON TRACER (PFT)

# DEVELOPED WORK

## 1st Phase

22 ECC Porto

33 ECC Lisbon

**BUILDING CHARACTERIZATION**

- Type of building construction
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- Materials used for finishing
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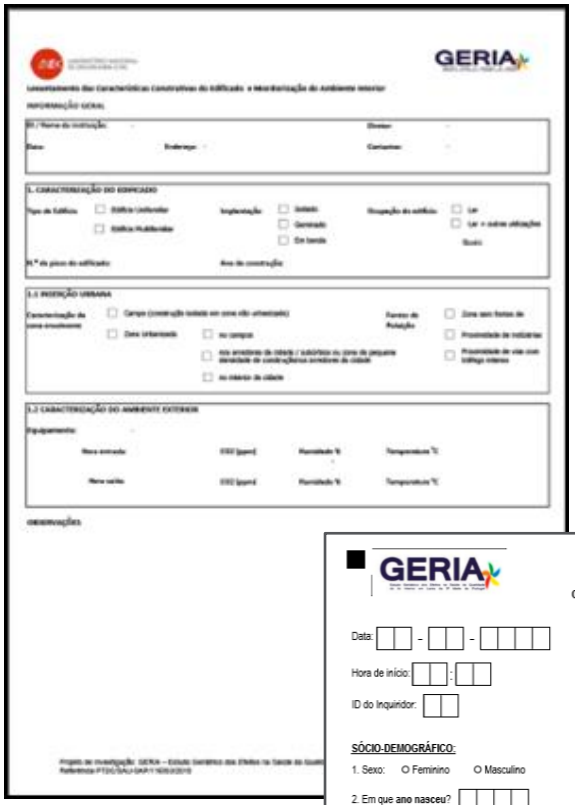
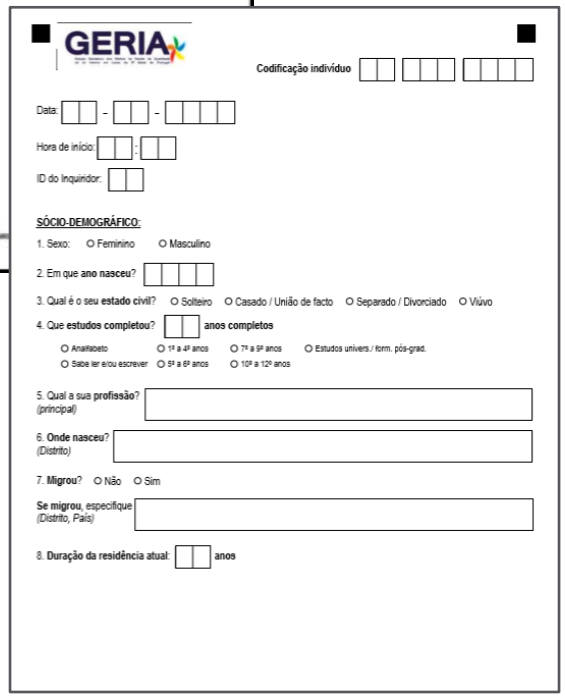
**HEALTH AND QUALITY OF LIFE QUESTIONNAIRES**

- WHOQOL-BREF Questionnaire
- BOLD Questionnaire
- Mini Mental State Examination
- Geriatric Depression Scale GDS-15

n = 933




cost
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# ONGOING WORK

## 2nd Phase

20 ECC Porto and Lisbon

**INDOOR AIR QUALITY ASSESSMENT**
(AUTUMN/WINTER-SPRING/SUMMER)

- PM10 (INDOOR/OUTDOOR)
- PM2.5 (INDOOR/OUTDOOR)
- Formaldehyde (INDOOR)
- Total Volatile Organic Compounds (INDOOR/OUTDOOR)
- Carbon Dioxide (INDOOR/OUTDOOR)
- Carbon Monoxide (INDOOR/OUTDOOR)
- Temperature (INDOOR/OUTDOOR)
- Relative Humidity (INDOOR/OUTDOOR)
- Bacteria (INDOOR/OUTDOOR)
- Fungi (INDOOR/OUTDOOR)
- Thermal Comfort Indexes (INDOOR)

**CLINICAL TESTS**

- Nasopharyngeal swabs for virus characterization **n = 132**
- Exhaled breath condensate **n = 150**
- Spirometry **n = 306**

**VENTILATION ASSESSMENT**

- Tracer Gas Technique PFT
- Ventilation modeling

**PORTO** ✓

**LISBON**


**LISBON** ✓

**PORTO & LISBON**

# PRELIMINARY RESULTS (I) BUILDINGS & IAQ

- Overall $PM_{10}$ MEAN CONCENTRATION WAS ABOVE NATIONAL REFERENCE LEVELS (0.05 mg/m$^3$) in both seasons.

- $PM_{2.5}$ MEAN CONCENTRATION of the 22 ECC WAS ABOVE NATIONAL (0.025 mg/m$^3$) and INTERNATIONAL (0.035 mg/m$^3$) reference levels in both seasons.

- Although all the other indoor air pollutants were within the reference levels PEAK VALUES OF TVOC, $CO_2$, BACTERIA AND FUNGI EXCEEDED THE REFERENCE LEVELS.

# PRELIMINARY RESULTS (II) BUILDINGS & IAQ

- **TVOC, BACTERIA, CO AND $CO_2$ showed SIGNIFICANTLY HIGHER INDOOR LEVELS compared to outdoor, in both seasons.**

- **Indoor $PM_{10}$, TVOC, BACTERIA AND $CO_2$ PRESENT SIGNIFICANT DIFFERENCES BETWEEN SEASONS ($p < 0.01$).**

- **TVOC, BACTERIA AND $CO_2$ SHOW SIGNIFICANT VARIATION BETWEEN ECC ROOMS ($p < 0.01$).**

# PRELIMINARY RESULTS (III) BUILDINGS & IAQ

- **4% OF FUNGI SAMPLES WERE POSITIVE FOR PATHOGENIC Aspergillus species.**

- **The building variables 'INSULATION', 'HEATING VENTILATION' AND 'WINDOWS FRAMES' were significantly associated to chemical and biological parameters.**

- **'BACTERIA', 'FUNGI' are the mostly significantly environmental parameters affected by building characteristics.**

# PRELIMINARY RESULTS (IV) RESPIRATORY HEALTH

- In elderly respondents, BREATHLESSNESS (27.5%) and COUGH (23.1%) were the major respiratory symptoms, and ALLERGIC RHINITIS (21.7%) the main self-reported illness.
- HEART TROUBLES were reported by 36.6% residents.
- Symptoms of WHEEZING (10.5%) in the last 12 months and ASTHMA diagnosis (8.4%) were MORE COMMON IN FEMALES, as opposed to symptoms BREATHLESSNESS (4.9%) and PHLEGM (3.5%), MORE FREQUENT IN MALES.
- SMOKING HABITS, both past and present, were MORE FREQUENT IN MEN (11.9%)

# PRELIMINARY RESULTS (V) RESPIRATORY HEALTH & IAQ

- **The preliminary results show a strong association between wheezing symptoms and PMV and PPD indexes, as well as, some border line association between:**

  - **(i) PHLEGM AND $PM_{10}$;**
  - **(ii) WHEEZING AND TVOC;**
  - **(iii) BREATHLESSNESS AND VOLATILE ORGANIC COMPOUNDS AND THERMAL ENVIRONMENTAL PARAMETERS.**

# FURTHER DEVELOPMENTS

- Study the IMPACT OF IAQ VARIABLES IN THE ELDERLY RESPIRATORY HEALTH & QUALITY OF LIFE;

- Logistic regression analysis is ongoing, thus FOCUSING ON THE IMPACT OF IAQ AND RESPIRATORY HEALTH SYMPTOMS ON ECCS RESIDENTS;

- PRODUCE GUIDELINES ON REMEDIAL MEASURES AND RECOMMENDATIONS TO ECCS in order to improve the wellbeing of our elderly population.

# CONCLUSIONS

- Our study suggested that ATTENTION IS NEEDED TO $PM_{2.5}$ PARTICLE FRACTION as well as to PEAK CHEMICAL AND BIOLOGICAL CONCENTRATIONS AND FUNGI SPECIES THAT MIGHT COMPROMISED IAQ comfort.
- To prevent low indoor temperatures and discomfort, especially on winter season, SIMPLE MEASURES COULD PROVIDE HEALTH BENEFITS TO ECC RESIDENTS AND WORKERS, SUCH AS INSULATING CEILINGS, WALLS, AND WINDOWS, MAINTAINING NATURAL AND PASSIVE VENTILATION, solutions that are common in Portugal due to the advantage of the country's generally mild weather.
- Investigations are still needed to BETTER UNDERSTAND THE LINKS BETWEEN IAQ AND RESPIRATORY HEALTH IMPAIRMENT IN ELDERLY.

# MORE INFORMATIONS…


**www.geria.webnode.com**

# RESEARCH TEAM & FUNDING

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INSTITUTO DE SAÚDE PÚBLICA DA UNIVERSIDADE DO PORTO

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UNIVERSIDADE NOVA DE LISBOA

FCT
FACULDADE DE CIÊNCIAS E TECNOLOGIA
UNIVERSIDADE NOVA DE LISBOA

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IRCCS San Raffaele
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PORTUGAL 2007.2013

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