



3<sup>rd</sup> Scientific Symposium  
Emerging Climatic &  
Environmental Health Risks  
in the Mediterranean

Harvard Cyprus Endowment Program  
Thursday, 23 January 2025  
Shakolas Educational Centre of Clinical Medicine  
Medical School, University of Cyprus  
Nicosia, Cyprus

## Welcome message

Dear Collaborators, Dear Friends,

It is with great pleasure that we welcome you to the 3<sup>rd</sup> scientific symposium entitled Emerging Climatic & Environmental Health Risks in the Mediterranean organized by the Medical School of University of Cyprus in collaboration with the University of Nicosia Medical School and the Harvard T.H. Chan School of Public Health. We would like to thank all of you for your participation. We look forward to an outstanding scientific program, consisting of seven presentations and introduce the invited speaker Dr Eric Garshick (Professor of Medicine, Veterans Affairs Boston Healthcare System; Harvard Medical School, USA) who will review the assessment pulmonary health outcomes in environmental health research. The presentations included in the scientific program report on novel findings in the field of environmental health from the Eastern Mediterranean region and relied on data kindly provided by governmental agencies from Cyprus, Greece, and Kuwait. For Cyprus, these agencies included the Department of Labour Inspection of the Ministry of Labour and Social Insurance, the State General Laboratory and the Health Monitoring Unit of the Ministry of Health, the Cyprus Department of Meteorology of the Ministry of Agriculture, Rural Development and Environment, the Statistical Service of Cyprus and the Cyprus National Addictions Authority. For Greece, these included the Hellenic Statistical Authority, the Greek Ministry of Environment and Energy and the National Observatory of Athens and for Kuwait, Kuwait Institute for Scientific Research (KISR) and Kuwait's Ministry of Health

We do hope that you enjoy the Scientific Symposium.

**Prof. Panayiotis Yiallourous** (University of Cyprus - UCY) – Medical School

**Dr. Souzana Achilleos** (University of Nicosia - UNIC) – Medical School

**Prof. Petros Koutrakis** (Harvard T.H. Chan School of Public Health - HSPH) - Program Director  
of Cyprus Harvard Endowment Program

### Invited Talk

**Title:**

Assessment of pulmonary health outcomes in environmental health research.

**Presenter:**

Dr. Eric Garshick

Professor of Medicine, Veterans Affairs Boston Healthcare System;  
Harvard Medical School, USA

### Short Bio:

Dr Eric Garshick is Associate Chief of Pulmonary Medicine at Veterans Affairs (VA) Boston, Professor of Medicine at Harvard Medical School, and Medical Director of the VA Boston Pulmonary Function Laboratory. He is also a clinician with Board certification in Internal Medicine, Pulmonary Diseases, and Critical Care Medicine. He has conducted epidemiologic studies regarding the health effects of particulate matter over the past 35 years, focusing on pulmonary, systemic effects, and lung cancer, including effects on pulmonary function. He served on a working group at the International Agency for Research on Cancer in Lyon, France and on the US EPA Clean Air Advisory Committee that contributed to the regulation of diesel exhaust emissions. He is currently a study chair of VA Cooperative Study #595 reconstructing air pollution exposures in Iraq and Afghanistan and linking this to pulmonary health effects in U.S. Veterans. Dr. Garshick has published over 200 peer-reviewed research papers, book chapters, and reviews.

## Agenda

### 15:00 - Arrival and registration

### 15:30 - Welcome addresses

**Prof. Panayiotis Yiallourous** - University of Cyprus, Medical School

**Dr. Souzana Achilleos** - University of Nicosia, Medical School

**Dr. Barrak Alahmad** - Harvard T.H. Chan School of Public Health

**Prof. Petros Koutrakis** - Harvard T.H. Chan School of Public Health - Program Director  
of the Cyprus Harvard Endowment Program

### 16:00 - Invited Talk: Assessment of pulmonary health outcomes in environmental health research

**Chair: Assis. Prof. Pinelopi Anagnostopoulou (UCY)**

**Prof. Eric Garshick** - Veterans Affairs Boston Healthcare System; Harvard Medical School, Boston, MA, USA

### 16:20 - Session 1: Personal exposure to environmental factors

**Chairs: Dr. Barrak Alahmad (HSPH), Dr. Petros Mouzourides (UCY)**

- 1. Investigation of factors influencing the association between individually experienced temperature assessed using wearable sensors and outdoor ambient temperature**  
**Zhengyuan Wang** (SM, HSPH)  
*Supervisors: Mr. Antonis Michanikou (UCY) - Dr. Barrak Alahmad (HSPH)*
- 2. Development of a predictive model for PM<sub>2.5</sub> over the greater Athens metropolitan area, Greece at 1kmX1km grid using satellite measurements and machine learning methods**  
**Seyong Chang** (SM, HSPH)  
*Supervisors: Prof. Evi Samoli (National and Kapodistrian University of Athens) - Dr. Evangelia Diapouli (National Centre for Scientific Research "Demokritos") - Prof. Petros Koutrakis (HSPH)*
- 3. The association of socio-economic and built environment characteristics with smoking behavior in a cohort of Greek Cypriot adults**  
**Benjamin Weitz** (SM, HSPH)  
*Supervisors: Dr. Panayiotis Kouis (UCY), Dr Petros Mouzourides (UCY)- Dr. Angelos Kassianos (CUT) - Dr. Carolina Zilli Vieira (HSPH)*

### 17:05 - 17:30 Coffee Break

## 17:30 - Session 2: Health effects of environmental factors

**Chairs:** *Dr. Carolina L Zilli Vieira (HSPH), Dr Annalisa Quattrocchi (UNIC)*

- 4. Ambient temperatures and mental health hospital admissions in Cyprus**  
Amanda Larasati (SM, HSPH)  
*Supervisors: Dr. Annalisa Quattrocchi (UNIC) - Dr. Barrak Alahmad (HSPH)*
- 5. Ambient temperatures and respiratory hospital admissions in Kuwait**  
Saanya Sharmar (SM, HSPH)  
*Supervisors: Dr. Souzana Achilleos (UNIC) - Dr. Barrak Alahmad (HSPH)*
- 6. Health effects of short-term exposure to ultrafine particles on cause-specific mortality in Athens, Greece in 2010-2019**  
Rezaul Rippon (SM, HSPH)  
*Supervisors: Prof. Evi Samoli (National and Kapodistrian University of Athens) - Dr. Evangelia Diapouli (National Centre for Scientific Research "Demokritos") - Dr. Carolina Zilli Vieira (HSPH)*
- 7. Allergic sensitization and respiratory health in children with asthma in the Eastern Mediterranean**  
Yinying Qian (SM, HSPH)  
*Supervisors: Dr. Constantinos Pitsios (UCY) - Prof. Eric Garshick (HSPH)*

## 18:30 Closing remarks

**Prof. Panayiotis Yiallourous** (University of Cyprus)

## Associations Between Weather Station Heat Indices and Personal Sensor Temperatures in a Cyprus Cohort

Student: **Zhengyuan Wang** (Harvard T.H. Chan School of Public Health)

Supervisors: **Barrak Alahmad** (Harvard T.H. Chan School of Public Health), **Antonis Michanikou** (University of Cyprus)

**Background:** Accurate assessment of individual heat exposure is critical for understanding heat-related health risks. Epidemiology studies often rely on weather station data as a proxy for heat exposure, which may not accurately capture personal microenvironment conditions.

**Methods:** Within the context of a prospective case-control observational study in the context of the BeAT Heat project (Biometeorological Aspect of Thermal environment and Health), we recruited 35 participants from six regions in Cyprus and collected personal sensor temperature data at 5-minute intervals during the warm months (June to September) and cool months (October to December) of 2020 and 2021. Weather station data from the Department of Meteorology (Cyprus Ministry of Agriculture, Rural Development and Environment) were also collected, with each participant matched to the nearest station. Heat stress indices, including Wet Bulb Globe Temperature, Discomfort Index, and Heat Index, were calculated from weather station data using established algorithms and compared to personal sensor temperatures. We used Pearson correlation coefficients to evaluate the agreement between the two data sources and fitted linear mixed-effects models with natural cubic splines to account for the nested data structure and identify potential thresholds in non-linear relationships during the warm months.

**Results:** Personal sensor temperatures exhibited lower variability (Mean = 29.2°C, SD = 2.35°C) compared to weather station temperatures (Mean = 27.3°C, SD = 4.08°C) during the warm months. The correlation between personal sensor temperatures and weather station heat indices was weak during this period ( $R = 0.36 - 0.42$ ), in contrast to the stronger correlation observed across all seasons ( $R = 0.62 - 0.68$ ). Non-linear relationships and a plateau effect were observed in the warm months when the station temperature ranged from 30°C to 35°C. At a station temperature of 20°C, the model predicts a personal sensor temperature of 28.0°C (95% CI: 27.8 - 28.3°C). When the station temperature reaches 35°C, the predicted personal sensor temperature is 29.4°C (95% CI: 29.1 - 29.6°C).

**Conclusions:** Weather station data may not adequately capture personal heat exposure and can lead to misclassification. Personal sensors provide a more accurate representation of microenvironmental conditions, which is crucial for understanding heat-related health risks, particularly among vulnerable populations. Future studies should integrate comprehensive indoor and outdoor heat exposure data and explore advanced modeling approaches to enhance the accuracy of heat exposure assessments, enabling the development of targeted adaptation strategies for high-risk groups.

## Development of a predictive model for PM<sub>2.5</sub> over the greater Athens metropolitan area, Greece at 1kmX1km grid using satellite measurements and machine learning methods

Student: **Seyong Chang** (Harvard T.H. Chan School of Public Health)

Supervisors: **Petros Koutrakis** (Harvard T.H. Chan School of Public Health), **Evangelia Samoli** (National and Kapodistrian University of Athens), **Evangelia Diapouli** (National Centre for Scientific Research “Demokritos”)

**Background:** Ambient PM<sub>2.5</sub> exposure is strongly associated with numerous adverse health effects, including all-cause mortality and cardiovascular outcomes. However, the lack of dense monitoring networks globally does not allow for a better understanding of the spatiotemporal distribution of near-surface PM<sub>2.5</sub> pollution to assess its impact on the environment and estimate risks to the general population and vulnerable groups.

**Objective:** While previous studies have utilized land use regression models, this study aims to demonstrate the application of ensemble machine learning methods to estimate PM<sub>2.5</sub> in Athens, Greece between 2007 and 2019 at a high spatiotemporal resolution.

**Methods:** Daily data from 15 weather monitors, combined with satellite data from MERRA-2, MODIS-Terra/Aqua, and the Copernicus Land Monitoring Service, was collected for 2007–2019, encompassing 53 aerosol, meteorological, and land use variables. A stacked ensemble machine learning model, using a distributed random forest and gradient boosting machine as base models and a generalized linear model as the meta-model, was employed to generate daily PM<sub>2.5</sub> predictions at a 1 km × 1 km resolution.

**Results:** The model performance showed great predictive ability, with a Coefficient of Variation-R-Squared (CV-R<sup>2</sup>) of 0.89 and a Coefficient of Variation-Root Mean Squared Error (CV-RMSE) of 3.51 µg/m<sup>3</sup>. The annual average PM<sub>2.5</sub> predictions was 22.3 µg/m<sup>3</sup>, which is higher than current US and WHO advisory guidelines, with considerable spatiotemporal differences in PM<sub>2.5</sub> across Athens. The highest annual PM<sub>2.5</sub> concentrations were in 2007 (33.18 µg/m<sup>3</sup>) and on average, PM<sub>2.5</sub> concentrations were highest during the months of November to February (24.55 µg/m<sup>3</sup>), which is consistent with seasonal variations in PM<sub>2.5</sub>.

**Conclusions:** This is the first study to estimate PM<sub>2.5</sub> exposures in Athens at a high spatiotemporal resolution using a diverse array of measurement and land use data, enabling the investigation of health effects and contributing to the development of regional environmental policies. The flexible model demonstrated here could be applied in other regions with limited monitoring networks.

## The association of socio-economic and built environment characteristics with smoking behavior in a cohort of Greek Cypriot adults

Student: **Benjamin Weitz** (Harvard T.H. Chan School of Public Health)

Supervisors: **Panayiotis Kouis** (University of Cyprus), **Angelos Kassianos** (Cyprus University of Technology), **Petros Mouzourides** (University of Cyprus), **Carolina Zilli Vieira** (Harvard T.H. Chan School of Public Health)

**Background:** Previous studies from Cyprus and elsewhere have demonstrated consistent associations between individual level characteristics and smoking behaviors in adults. Nevertheless, the association of urban built environment characteristics with smoking behavior as well as how individual level characteristics interact with built environment characteristics to modify smoking behavior remain unclear and have never been investigated in Cyprus and the region.

**Objectives:** This study aimed to explore associations between individual socio-economic characteristics and urban built environment characteristics with smoking behavior in Greek Cypriot adults.

**Methods:** Data on individual level characteristics and smoking outcomes (active smoking and whether participants had ever tried quitting) were obtained from the 2023 cross-sectional survey from the Cyprus National Addictions Authority. Information for built environment characteristics (building height, green urban area, sports and leisure facilities, and trees at the street level) were obtained from the Copernicus Land Monitoring Service, aggregated at the postal code level.

**Results:** From a total of 2643 adults (>18 years old), 49.2% were males (mean age = 35.74). Of them, 44.6% were active smokers, and individual factors were associated with smoking outcomes consistent with the literature. Building height was associated with increased odds of active smoking, especially among city center participants [1.21 (1.01, 1.46);  $p=0.036$ ], and the presence of sports and leisure facilities was associated with decreased odds of active smoking [0.77 (0.63, 0.96);  $p=0.020$ ]. The presence of green urban areas was associated with increased odds of having ever tried to quit [1.48 (1.07, 2.05);  $p=0.020$ ], and attenuated the effects of building height.

**Conclusions:** Building height was associated with smoking behaviors and the opposite effects were observed for sports and leisure facilities and green urban area in adults. These results indicate the contrasting effects of urban built environment characteristics on health behavior.

## Ambient Temperatures and Mental Health Hospital Admissions in Cyprus in 2000-2019

Student: **Amanda Larasati** (Harvard T.H. Chan School of Public Health)

Supervisors: **Annalisa Quattrocchi** (University of Nicosia), **Souzana Achilleos** (University of Nicosia), **Barrak Alahmad** (Harvard T.H. Chan School of Public Health)

**Background:** The global burden of mental health diseases is on the rise. Emerging evidence suggests that temperature may play a role in exacerbating mental health outcomes. However, little is known about the impact of ambient temperatures on mental health in one of the world's fast-warming regions: the Eastern Mediterranean region. The objective of the study is to determine the association between ambient temperatures and mental health hospital admissions in Cyprus between 2000-2019.

**Methodology:** We conducted a case-crossover study using mental and behavioral disorders hospital admissions data, according to ICD-10 code (F00-F99), retrieved from the Division of Demographic, Social and Tourism Statistics of the Statistical Service of Cyprus, Ministry of Finance; and daily temperature and relative humidity data, obtained from the Cyprus Department of Meteorology of the Ministry of Agriculture, Rural Development and Environment for each district in Cyprus. Data were analyzed using Quasi-Poisson generalized nonlinear model, including 3- 5- and 7-day moving average lags. Analysis was also stratified by mental disease category, sex and age groups.

**Results:** Between 2000-2019, 9119 mental health hospital admissions were reported, of which 3881 (42.6%) were schizophrenia disorders (F20-F29). For every 5°C increase on a 7-day moving average, all mental health hospital admissions increased by 18% (RR: 1.18; 95%CI: 1.08-1.29), similarly admissions for schizophrenia disorders increased by 23% (RR:1.23; 95%CI: 1.08-1.40). Stratified analysis showed that the risk was significant only among males (RR<sub>all\_mental\_health</sub>: 1.25; 95%CI: 1.08-1.45) and RR<sub>schizophrenia</sub>: 1.28; 95%CI: 1.07-1.52) and among people aged 17–50 years (RR<sub>all\_mental\_health</sub>: 1.27; 95%CI: 1.11-1.44) and (RR<sub>schizophrenia</sub>: 1.32; 95%CI: 1.13-1.55).

**Conclusions:** Our results indicate an association between rise in ambient temperature and increased risk of mental disorders hospital admissions in Cyprus. These findings can be used to inform policy makers and institutions to include mental health as a core outcome in relevant heat-related policies.

## Associations Between Extreme Temperatures and Respiratory Illness-related Hospital Admissions in Kuwait from 2010 to 2020

Student: **Saanya Sharma** (Harvard T.H. Chan School of Public Health)

Supervisors: **Souzana Achilleos** (University of Nicosia), **Barrak Alahmad** (Harvard T.H. Chan School of Public Health)

**Background:** Exposure to extreme cold and hot temperatures may worsen pre-existing health conditions, including respiratory illnesses. While robust literature exists on the impact of cold weather on respiratory illness, evidence for hot temperatures is inconsistent. This issue is especially pressing in warm regions like the Middle East, where the frequency of extreme heat events is increasing due to climate change. Therefore, the aim of this study is to examine the relationship between extreme cold and hot temperatures and hospitalizations due to respiratory causes in Kuwait.

**Methods:** We collected daily hospitalization data from the National Center for Health Information Kuwait Ministry of Health (2010–2020), and temperature and relative humidity data from the Meteorological Department of the Directorate General of Civil Aviation. PM<sub>2.5</sub> levels were estimated using a hybrid prediction model. We examined the effect of temperature (and its lagged effects up to 28 days) on respiratory illness-related hospitalizations using time series design and distributed lag non-linear models, adjusting for day of the week and relative humidity. A sensitivity analysis adjusting for PM<sub>2.5</sub> was performed, showing similar results to the main analysis.

**Results:** Between 2010–2020, 241,067 respiratory illness-related hospitalizations were reported in Kuwait, with temperatures ranging from 5.7°C to 44.0°C (SD 9.8°C). The minimum morbidity temperature, the optimal temperature associated with the lowest number of respiratory illness-related hospitalizations, was 36.0°C. The relative risk for respiratory illness-related hospitalizations was 1.26 (95% CI: 1.00–1.59) at the lowest temperature (5.7°C) and 1.23 (95% CI: 1.04–1.47) at the highest temperature (44.0°C).

**Conclusions:** Both low and high temperatures were linked to an increased risk of respiratory illness-related hospitalizations in Kuwait. The impact of low temperatures is evident, while the effect of high temperatures becomes apparent beyond a threshold of 36°C. Additional research is required to better understand the relationship between extreme heat and respiratory illness.

## Impact of Short-Term Exposure to Air Pollution Particles on Cause-Specific Mortality in Athens, Greece, 2010-2019

Student: **Rezaul Karim Ripon** (Harvard T.H. Chan School of Public Health)

Supervisors: **Carolina L Zilli Vieira** (Harvard T.H. Chan School of Public Health), **Evangelia Diapouli** (National Centre for Scientific Research “Demokritos”), **Evangelia Samoli** (National and Kapodistrian University of Athens)

**Background:** We aimed to investigate the relationship between air pollution particle sizes and adverse health outcomes, focusing on natural, cardiovascular, and respiratory mortality in Athens, Greece, from 2010 to 2019.

**Methods:** Data was collected on particle number concentrations categorized by size: nucleation mode (10-25 nm), Aitken mode (25-100 nm), accumulation mode (100-550 nm) for ultra fine particles (UPF), alongside PM<sub>2.5</sub> (µg/m<sup>2</sup>) and PM<sub>10</sub> (µg/m<sup>2</sup>) mass concentrations, during 2010-2019, from the Demokritos urban background station. We applied quasi-Poisson regression models adjusting for overdispersion and covariates.

**Results:** The one-pollutant model revealed significant associations between PM<sub>2.5</sub> and mortality, e.g., for same-day exposure and natural mortality, an increased risk of 0.95% (95% CI: 0.38% to 1.53%, p=0.001), while for respiratory mortality a 1.75% (95% CI: 0.21% to 3.32%, p=0.026) increase and for nucleation mode was a non-significant 0.05% (-0.57% to 0.67%) change for natural mortality. PM<sub>10</sub> was also significantly associated with mortality. The lag analysis indicated significant effects of PM<sub>2.5</sub> on natural mortality on the exposure 24h before the event with an increased risk of 1.33% (95% CI: 0.76% to 1.89%, p=0.0004) and PM<sub>10</sub> on cardiovascular mortality with 0.69% (95% CI: 0.12% to 1.27%, p=0.01). However, there was no significant association between UFP exposure and mortality risk.

**Conclusions:** Our findings, using updated time series, concur with the previously identified significant health risks associated with PM<sub>2.5</sub> and PM<sub>10</sub> exposures, particularly in respiratory and cardiovascular mortality in Athens. PM<sub>2.5</sub> exposures consistently emerged as a critical predictor of mortality, suggesting that public health strategies should prioritize reducing finer particle concentrations to mitigate health impacts.

## Allergic sensitization and respiratory health in children with asthma in the Eastern Mediterranean

Student: **Yinying Qian** (Harvard T.H. Chan School of Public Health)

Supervisors: **Constantinos Pitsios** (University of Cyprus) - **Eric Garshick** (VA Boston Healthcare System/Harvard Medical School)

**Background:** The spring and fall seasons in the Eastern Mediterranean are characterized by climatic conditions that increase potential exposure to aeroallergens as a result of higher pollen counts (particularly in spring) and frequent desert dust storms. Although aeroallergen exposure may worsen asthma in atopic children, the association of atopy with respiratory health in a region with overlapping seasonal dust and pollen periods, such as Cyprus and Crete, Greece, has not been examined.

**Methods:** We conducted a secondary analysis of respiratory health data collected during the MEDEA randomized clinical trial in primary school children with asthma in Cyprus and Crete, which included the use of air purifiers and recommendations to limit outdoor activities. The study took place in spring 2019 and 2021 in Cyprus, and spring 2019 and fall 2021 in Crete. Children were assessed 3 to 4 times over 4 months, including allergen sensitization evaluated at the end of the follow-up using skin prick tests with a panel of 14 aeroallergens common in Cyprus and Crete. Mixed effect models were used to assess associations between atopy and respiratory health measures, adjusting for study arm, country, year, weeks on study, age, and gender.

**Results:** The analytical sample included 133 children (79 atopic and 54 non-atopic; mean (SD) age=9.5 (1.6) years; 64% boys). Over the study period, atopic children exhibited 113.2% (95% CI: 66.7%, 172.5%) higher fractional exhaled nitric oxide (FeNO) levels and were more likely to use asthma medication in the preceding 4 weeks (OR=2.30, 95% CI: 1.06, 4.98), compared to non-atopic children with asthma. There was a significant weekly decline in %-predicted FEV<sub>1</sub> (-0.28, 95% CI: -0.43, -0.13) and FEV<sub>1</sub>/FVC% (-0.15, 95% CI: -0.24, -0.07) among atopic children. Sensitivity analyses that only included children assessed during spring (pollen season) yielded similar findings. The most common sensitizing allergens were seasonal, including olive (55.4%) and tree mix (45.2%). Children with only seasonal sensitization had the highest odds ratio (OR=4.62, 95% CI: 1.53, 13.97) for asthma medication use during the study compared to non-atopic children.

**Conclusions:** Lower pulmonary function, increased medication use, and higher FeNO levels suggest that atopic children with asthma may be prone to worse asthma morbidity compared to non-atopic children during the overlapping seasonal dust and pollen periods in Cyprus and Crete.

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- Department of Labour Inspection, Cyprus Ministry of Labour and Social Insurance
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- Health Monitoring Unit, Cyprus Ministry of Health
- Cyprus Department of Meteorology, Cyprus Ministry of Agriculture, Rural Development and Environment
- Statistical Service of Cyprus, Cyprus Ministry of Finance
- Cyprus National Addictions Authority
- Hellenic Statistical Authority
- Directorate of Climate Change & Air Quality, Hellenic Ministry of Environment and Energy
- National Observatory of Athens
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- Kuwait's Ministry of Health