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# ERS International Congress 2022: highlights from the Epidemiology and Environment Assembly

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## Abstract

In this article, early career members of the Epidemiology and Environment Assembly of the European Respiratory Society summarise a selection of five sessions from the Society's 2022 International Congress, with a focus on areas of specific interest for the Assembly, *i.e.* epidemiology and risk factors of respiratory diseases in both children and adults. Topics covered include the characterisation of obstructive respiratory diseases, their comorbidities and their evolution, with novel insight from large cohorts. The importance of early-life factors in respiratory health was also emphasised, including maternal exposures and habits during pregnancy. As smoking behaviours have changed following the introduction of e-cigarettes and heated tobacco products, research remains very active to determine the health consequences and predictors of these novel uses, especially in teenagers. The impact of environmental and occupational exposures on respiratory health remained a major topic of the congress, with a focus on emerging risk factors such as landscape fire smoke, non-exhaust particles and nanoparticles. Regarding workplace exposures, old and novel causes of occupational asthma and rhinitis were discussed.

## Introduction

In this article, early career members of the Epidemiology and Environment Assembly of the European Respiratory Society (ERS) summarise a selection of results presented during the Society's 2022 International Congress in Barcelona, Spain (4–6 September). Five sessions (four oral presentation sessions and one poster session) were selected by early career members, with a focus on areas of specific interest for the Assembly, *i.e.* epidemiology and risk factors of respiratory diseases in both children and adults. The 2022 Congress featured research on the negative impact of emerging environmental pollutants, such as landscape fire smoke or non-exhaust particles, and on a wide range of workplace exposures, as well as potentially beneficial public health interventions. Major topics also included genetic, lifestyle and behavioural determinants of respiratory diseases such as diet, smoking and vaping. Finally, novel results on the characterisation and evolution of lung diseases, including their trajectories and outcomes, were presented.

## Latest news from paediatric population-based and clinical cohort studies

Cohort studies are valuable tools for providing new insights into respiratory health of children including identifying potential risk factors or assessing prevalence or morbidity. This oral presentation session



provided new epidemiological data in childhood respiratory health, covering chronic and infectious diseases, their early-life potential risk factors, and their impacts on children's lives such as cognitive abilities or hearing, from population-based and clinical cohorts.

Two presentations focused on *in utero* exposures and the respiratory health of children. In the Italian NINFEA (*Nascita e Infanzia: gli Effetti dell'Ambiente*; Birth and Childhood: Effects of the Environment) birth cohort [1], RUSCONI *et al.* [2] investigated the impact of pesticide exposures, agricultural and gardening activities, and proximity to crops during the first and third trimesters of pregnancy on wheezing in infants. Agricultural and gardening activities were not associated with wheezing. However, nonoccupational use of pesticides was associated with wheezing in infants aged 6–18 months. A J-shaped association was also found with proximity to fruit trees [3]. The other presentation focused on maternal dietary quality in relation to allergic and respiratory multimorbidity. In the French national cohort of children (ELFE) birth-cohort [4], DELVERT *et al.* [5] constructed unsupervised allergic and respiratory profiles up to 8 years with latent class analysis, and the following five profiles were identified: “asymptomatics”, “wheezing without asthma”, “asthma only”, “allergies without asthma” and “multiallergic”. Quality of maternal diet during pregnancy assessed through a global score was not associated with allergic and respiratory multimorbidity in children. However, high consumption of legumes was associated with a lower probability of belonging to the “wheezing without asthma” profile, and consumption of fish higher than the guidelines was associated with a higher probability of belonging to the “allergies without asthma” profile.

As preterm birth is known to be a risk factor for lung dysfunction [6], KOTECHA *et al.* [7] investigated the factors associated with lung function at 7–12 years old in the Respiratory Health Outcomes in Neonates study, a case–control study with preterm-born and term-born neonates. Gestational age ( $\beta = -0.15 \pm 0.051$ ) and intrauterine growth restriction (OR 1.78, 95% CI 1.06–3.00), but not bronchopulmonary dysplasia, were associated with a lower lung function in multivariate logistic regression [8].

Two presentations provided new epidemiological data on asthma and impedance from children population-based cohorts. ABELLAN *et al.* [9] presented the 2021 prevalence of asthma and trends in the incidence of asthma over a decade (2010–2021), using data from the Catalan Information System for the Development of Research in Primary Care database [10]. In 1.7 million children aged 0–17 years, the asthma prevalence was 6.96% in June 2021. The incidence rate decreased from 831.1 per 100 000 person-years in 2010 to 664.9 in 2019. A decrease was also observed during the first year of the coronavirus disease 2019 (COVID-19) pandemic (–37% between 2019 and 2020), followed by a small catch-up in 2021 (9% increased between 2020 and 2021). Asthma incidence was higher in boys  $\leq 15$  years, in younger children and those living in the most deprived areas. The coming years will help to assess the contribution of the pandemic to the observed decrease in the prevalence. Next, VALACH *et al.* [11] presented reference values for respiratory impedance in healthy asymptomatic children and adolescents of the general population, established using data from the Austrian LEAD (Lung, Heart, Social, Body) cohort [12]. The authors created percentile curves and included reference values for whole-breath and within-breath resistance and reactance for a height from 101 to 183 cm. Males and females showed progressive decline in resistance values over the height spectrum. No sex difference in either whole- or within-breath parameters were observed after correction for height.

GRENVILLE *et al.* [13] investigated the association between lung function and cognitive ability in children, using data from the Avon Longitudinal Study of Parents and Children, a British birth cohort [14]. Cognitive function was approximated by the full-scale intelligence quotient (FSIQ) from the Wechsler scales at 8 and 15 years and the change in FSIQ percentile rank from 8–15 years old was also investigated. After adjustment for confounders, an increase in forced vital capacity (FVC) was significantly associated with an increase in FSIQ at 8 or 15 years, but these results were not significant in longitudinal analyses. No association was found with forced expiratory volume in 1 s ( $FEV_1$ ).

The last two presentations were on clinical cohort data. The first focused on primary ciliary dyskinesia (PCD), a rare, genetic disease that affects cilia [15]. GOUTAKI *et al.* [16] aimed to characterise otologic disease among PCD patients. The data were from an international cohort of patients with PCD aged 0 to 63 years, which included ear, nose and throat (ENT) examination and patient-reported ear symptoms [17]. The most common symptom reported by patients was hearing problems. On ENT examination, the most frequent problem in children was glue ear. Hearing problems were common according to audiometry but patients did not always perceive hearing loss. The findings highlight the need for audiometry even if the patient does not complain. Finally, BYAMUNGU *et al.* [18] investigated the predictive factors associated with the need for critical care and mortality among patients with COVID-19. The population consisted of 82

children with COVID-19 confirmed by RT-PCR admitted to a quaternary hospital in KwaZulu-Natal, South Africa, a region particularly affected by HIV. The factors associated with critical need were age <1 year, having more than one comorbidity, especially chronic lung diseases, presenting seizure at admission, and having increased creatinine or increased blood urea nitrogen. Predictors of in-hospital mortality were HIV-positive child, HIV-positive mother, increased creatinine, increased blood urea nitrogen and any invasive ventilation. Compared with children referred to a quaternary hospital, children admitted primarily had a lower risk of death. Thus, children <1 year of age and those with comorbidities, including HIV, could be specific targets for triage decisions and allocation of intensive care resources.

In summary, presentations in this session highlighted the importance of studying early-life respiratory health, as paediatric respiratory diseases not only are influenced by a large number of perinatal factors, but may also impact child development or interact with other diseases such as allergies or infections.

#### The environment and human health: from cohort to cell culture studies

This oral presentation session encompassed work investigating the impacts of inhaled particles and pollutant gasses, and their mitigation, on respiratory health, using an array of techniques from cell culture and *in vivo* studies to epidemiological models.

First, several observational studies were presented. ROESER *et al.* [19] presented a retrospective cohort study of 181 patients investigating the link between air pollution (particulate matter with diameter  $\leq 10 \mu\text{m}$  ( $\text{PM}_{10}$ ) or  $\leq 2.5 \mu\text{m}$  ( $\text{PM}_{2.5}$ ), nitrogen dioxide and ozone) and systemic sclerosis (SSc)-associated interstitial lung disease (ILD) severity. Air pollution was evaluated at the patient's residential address 5 years pre-diagnosis and the Goh staging algorithm [20] was used to determine SSc-ILD severity, based on high-resolution computed tomography and pulmonary function tests. No link between air pollution and SSc-ILD progression was observed at 12 and 24 months post-diagnosis. However, exposure to  $\text{O}_3$  was associated with SSc-ILD severity at diagnosis (OR 1.08, 95% CI 1.02–1.14). The authors suggest the mechanism underlying this is likely to be oxidative stress, which has been linked to SSc progression [21]. NICOLAOU *et al.* [22] presented a cross-sectional analysis of the exposure–response relationship between exposure to household air pollution from indoor combustion and blood pressure in 418 women (aged 40–79 years) across four resource-poor areas (Rwanda, Guatemala, Peru and India). They found systolic blood pressure was positively associated with  $\text{PM}_{2.5}$  exposure in women over 64 years, with the systolic blood pressure of women aged 65 years being 10.8 mmHg (95% CI 1.0–20.6 mmHg) higher at the 90th percentile of  $\text{PM}_{2.5}$  exposure ( $232 \mu\text{g}\cdot\text{m}^{-3}$ ) compared to women with exposures of  $10 \mu\text{g}\cdot\text{m}^{-3}$  (which represents the lowest interim target set by the World Health Organization) [23]. This suggests that improved indoor air quality could aid in reducing systolic blood pressure in older women. SCALES *et al.* [24] presented data from the Children's Health in London and Luton study, which aims to investigate the impact of the introduction of the London Ultra Low Emission Zone (ULEZ) on the physical activity of children in Central London (intervention area) and Luton (control), UK. Baseline data suggest that the proportion of active travel on the journey to or from school in the control (Luton) study population is similar to the UK average, while that in London is greater than the UK national average. They are following the cohort longitudinally to determine if the introduction of the ULEZ will be associated with a further shift toward active travel methods. JOSA-CULLERÉ *et al.* [25] presented work that aimed to assess the association between air pollution and weather on physical activity in 407 COPD patients. Physical activity records were collected along with spatiotemporal air pollution meteorological data. Higher average and maximum temperatures were associated with increased exercise, whereas higher levels of air pollution were also associated with decreased exercise; interestingly, the latter effect was only observed with a lag of 3–4 days.

Animal and cell models examining the impact of air pollutants were also presented. GOMEZ *et al.* [26] presented a study of the impact of geography-specific sources of landscape fire smoke on cardiorespiratory health.  $\text{PM}_{10}$  was generated to be representative of landscape fire smoke from specific regions using a customised combustion chamber. 8-week-old female Balb/c mice were then exposed to high ( $100 \mu\text{g}\cdot\text{m}^{-3}$ ) or moderate ( $25 \mu\text{g}\cdot\text{m}^{-3}$ ) concentrations daily for 3 (short-term) or 14 days (long-term). Landscape fire smoke exposure increased airway hyperresponsiveness and induced suppression of pro-inflammatory mediators (tumour necrosis factor- $\alpha$ , interleukin (IL)-6 and IL-8). Short-term exposure suppressed antioxidant concentrations, whereas long-term exposure had the opposite effect. In another study, PARKIN *et al.* [27] looked at the chemical characteristics of different non-exhaust  $\text{PM}_{2.5}$  and the influence of chemical composition on toxicity in alveolar epithelial cells *in vitro*. Of the different particles characterised using inductively coupled plasma mass spectrometry,  $\text{PM}_{2.5}$  with poor transition metal content grouped separately (diesel exhaust particle, low-metallic and road wear particles) from high iron-containing semimetallic particles and the high copper and zirconium particles (non-asbestos organic and ceramic) by

principal component analysis. The non-asbestos organic and ceramic particles exhibited the highest toxicity among the particles, with the greatest number differentially expressed genes, notably primarily from the heat shock protein family, oxidative stress response genes and genes related to metal ion homeostasis. Given that these non-exhaust particles are at least as toxic as diesel exhaust particles in this model, and their emission is expected to increase, such studies with more understanding of causative mechanisms may provide valuable input for better regulation.

Three presentations focused on exposure to nanoparticles, studied through cell and animal models and among printing centre workers. Voss *et al.* [28] presented work aimed toward the identification of cell-specific perturbations by nanoparticle exposure. While it is evident that nanoparticle exposure is associated with adverse outcomes such as inflammation, fibrosis or cancer, safety assessment is limited by the diverse types of nanoparticles and is mostly performed in a mouse model in the absence of suitable alternative methods. While this can be addressed using an adverse outcome pathway, a major challenge in the construction of particle-dependent adverse outcome pathway is that in most cases, the effector cell is largely unknown. The author reported findings from single-cell transcriptomics (Drop-Seq) analysis showing cell perturbation specific to the physicochemical characteristics of the material. Performed on mice lungs instilled with three different forms of carbon-based nanoparticles, all forms indicated neutrophil influx and nanoparticle-specific perturbation of bronchial epithelial cells. Additional cell communication analysis confirmed the differences in cell communication both for initiation and maintenance of inflammation based on the physicochemical properties. To investigate alveolar macrophage dynamics and immune responses during nanoparticle inhalation, Liu *et al.* [29] conducted an *in vivo* study using mice exposed to quantum-dot nanoparticles. The nanoparticles had different surface modifications (carboxyl-, amine-polyethylene glycol (PEG)- or PEG-). Intravital microscopy was used to image the alveolar region of the murine lung after ventilator-assisted inhalation of nanoparticles. Within seconds, nanoparticles were visible within the alveolar region. After 60 min, a significant increase in neutrophil numbers was observed. Alongside this, alveolar macrophages also increasingly internalised the carboxyl-nanoparticles, but little uptake was seen for the amine-PEG-nanoparticles. Motivated by the lack of information on the influence of nanoparticles released from toner-based equipment on environmental and airway microbiome, Ivan *et al.* [30] designed a prospective study in five commercial printing centres in Singapore. Characterisation of bacterial (16S ribosomal RNA) and fungal (18S internal transcribed spacer) diversity in sputum samples from unexposed office workers (20 samples from 10 individuals) and exposed printing floor workers (50 samples from 12 individuals) revealed enrichment of *Chryseobacterium*, *Porphyromonas* and *Candida*, and a reduction of *Alloprevotella* and *Lactobacillus* in the exposed printing floor workers.

Overall, these presentations highlighted the importance of a range of lesser-studied sources of pollutants including particles generated from wildfires, printer toners and brake pads. Other presentations demonstrated associations between well-established pollutants and various morbidities, including systemic sclerosis and hypertension. Taken together, these studies emphasise the detrimental impact of environmental pollutants to human health and underline the need for continued research in this area.

#### Lung function and risk factors associated with obstructive lung diseases

In this oral presentation session, studies covered a broad range of risk factors associated with relevant clinical outcomes of COPD and asthma.

The session started with BACKMAN *et al.* [31] presenting lung function trajectories of 993 individuals living with airway obstruction ( $FEV_1/FVC < 0.70$ ) in the OLIN (Obstructive Lung Disease in Northern Sweden) studies and estimating determinants of trajectory membership. Using latent class mixed models, three distinct trajectories were identified, characterised by a high  $FEV_1$  with expected decline, a medium  $FEV_1$  with rapid decline and a low  $FEV_1$  with expected decline. Sex, age, pack-years and baseline  $FEV_1$  were determinants of trajectory membership; and baseline  $FEV_1$  and obesity at follow-up were determinants of trajectory decline. Results of this study show how lung function evolves differently among individuals with airway obstruction and that important modifiable risk factors (*i.e.* smoking and weight) are associated with lung function trajectories.

Two genomic studies were presented, contributing to the growing field of genetics in respiratory medicine. First, SHRINE *et al.* [32] presented a multi-ancestry genome-wide association study of lung function based on data arising from 49 different cohorts ( $n=580\,869$ ) including individuals with European, African, American, and East and South Asian ancestries. By exploring multiple ancestries, SHRINE *et al.* [33] identified >1000 independent signals for lung function and proposed a novel multi-ancestry genetic risk score that is more predictive of lung function in diverse populations compared to previous European ancestry genetic risk scores. Second, TALAEI PASHIRI *et al.* [34] presented an investigation of 55 lung

development genes that aimed to explore shared development pathways explaining the association between lower lung function in adulthood and cardiovascular health, in the UK Biobank. Among the 55 genes, 19 were shared between respiratory and cardiovascular traits, and seven were considered novel. Furthermore, 64% of the studied colocalisation pairs supported the hypothesis that lower lung function is associated with higher cardiovascular risk.

Three studies using real-world data were presented in this session. Two of them were reported by WHITTAKER and co-workers [35, 36], who used data from primary care records, hospital episode statistics and death certificates to study factors associated with COPD. In her first presentation, Hannah Whittaker described the frequency and severity of lower respiratory tract infections (LRTIs) before COPD diagnosis in 215 234 COPD patients in UK and estimated their association with relevant COPD outcomes. A higher frequency of moderate and severe LRTI was associated with increased risk of exacerbations, all-cause mortality and COPD mortality. Moreover, patients suffering from multiple or severe LRTIs were older and had worse lung function and dyspnoea, suggesting that COPD may have been present before formal diagnosis. In her second presentation, Whittaker analysed data from 339 749 individuals, aiming to identify factors associated with specific causes of death in patients with COPD. In this study, frequency and severity of exacerbations, lower lung function (FEV<sub>1</sub> % predicted), and Global Initiative for Chronic Obstructive Lung Disease B and D categories were associated with increased all-cause mortality, but effect sizes of associations differed for COPD and cardiovascular disease-related mortality. Her findings suggest that COPD patients are heterogeneous and different characteristics may be associated with their mortality.

The third real-world data study was presented by CUSHION [37], who used data arising from electronic medical records of secondary care facilities to compare the frequency of exacerbations and eosinophils levels among patients with COPD or asthma in two time periods: before the COVID-19 pandemic (2019–2020) and during the pandemic (2021–2022). The proportion and rate of exacerbations were higher before the pandemic in both patient populations but the eosinophil counts remained similar in both time periods.

Then, in a study of COPD biomarkers, ÇOLAK *et al.* [38] suggested that plasma IgE concentrations may be a potential prognostic biomarker and treatment target in COPD, as higher IgE concentrations at baseline were associated with an increased risk of severe exacerbations and all-cause mortality in COPD patients [39].

With the provocative title of “Race-adjusted lung function increases inequities in diagnosis and prognosis and should be abandoned”, EKSTRÖM and MANNINO [40] questioned the use of race-specific equations in lung function assessment. Using data from the US National Health and Nutrition Examination Survey 2007–2012 study, EKSTRÖM and MANNINO [41] calculated individual reference values of FEV<sub>1</sub> and FVC using the Global Lung Function Initiative 2012 equations for white, black and other race. Taking these values into consideration, Magnus Ekström estimated the prevalence of lung function impairment, moderate/severe impairment, breathlessness and mortality, and found that using race-specific equations did not improve the prediction of outcomes across individuals identified as white, black or other race. Since white reference values were more sensitive and specific to identify impairment across all races, Ekström suggested abandoning race-specific equations in order to improve health equity.

Finally, HÅKANSSON *et al.* [42] closed the session with a presentation on the financial burden of young adult asthma in Denmark. The results suggest that both direct costs of treatment and hospitalisation (EUR 1555 per patient), and indirect costs including loss of personal income (EUR 1060 per patient) and welfare expenditure (EUR 1480 per patient) need to be considered as part of the high financial burden of adult asthma (EUR 4095 per patient). In terms of disease severity, higher costs were associated with severe asthma compared to mild-to-moderate asthma.

In summary, using a wide variety of populations and methodologies, presenters delved into the study of risk factors and sought to elucidate their relationships with obstructive lung diseases. For instance, the study of lung function trajectories highlighted the importance of well-known modifiable risk factors on lung function decline, and the study of race-specific equations questioned the differentiation by race while assessing lung function. While genomic studies presented novel results in terms of lung development genes and genetic risk scores, studies using real-world data provided relevant insights on disease characteristics and prognosis. Overall, this session highlights the importance of exploring different methodologies to identify novel risk factors in the study of lung conditions.

### Occupational asthma and upper airway diseases

In this poster session on occupational asthma and upper airway diseases, various aspects of occupational respiratory diseases were covered, from diagnostic to specific causes and consequences.

Two studies aimed at better characterising and diagnosing work-related asthma. In a study of inflammatory endotypes in patients with work-related asthma, MASON *et al.* [43] observed that occupational asthma (OA) and work-exacerbated asthma (WEA) subjects did not exhibit a different serum inflammatory profile before and 7 h after specific inhalational challenge (SIC). Exhaled nitric oxide fraction ( $F_{ENO}$ ) increased 24 h after SIC in OA subjects but not in WEA subjects. However, type 2 (T2) airway inflammation in OA was not associated with changes in T2 serum cytokines after SIC. A study presented by SOLER SEGOVIA *et al.* [44] examined the utility of using methacholine test, exhaled nitric oxide, exhaled breath condensate and sputum pH to diagnose work-related asthma in patients exposed to low molecular weight agents. They observed that performing spirometry, methacholine test and/or sputum induction in periods at work and off work in patients with suspected work-related asthma may improve WEA and OA diagnosis.

Many posters presented studies on specific causes of respiratory diseases. HEIBATI *et al.* [45] presented a study on healthcare workers and concluded that exposure to cleaning agents increased the occurrence of respiratory symptoms among them. PACHECO DA SILVA *et al.* [46] examined the use of cleaning agents in the French Constances cohort and found that weekly use of commercial disinfecting wipes at home was associated with current asthma, similarly to weekly use of irritants and sprays, but fewer risks were observed with the use of “green” and home-made products [47]. SIT *et al.* [48], in the French NutriNet-Santé cohort, found that occupational exposures to both sensitisers and irritants were associated with current adult-onset asthma and uncontrolled asthma. They concluded that irritant exposures should be carefully considered in asthma management [49]. MOORE *et al.* [50] studied patients exposed to welding fumes and found that the mechanism for the development of asthma in these workers was hypersensitivity, and that a purely irritant mechanism was unlikely. In a study conducted by LINDSTRÖM *et al.* [51] in greenhouse workers, it was observed that cultivated plants, biological pest control organisms and storage mites may cause OA and occupational rhinitis, while occupational contact urticaria was induced only by cultivation plants. Cucumber and *Amblyseius swirskii* appeared as novel causes of OA. Preventive measures in workplaces and regular health surveillance are needed to prevent allergic occupational diseases among greenhouse workers. In a study conducted on 56 students first exposed to laboratory animals after 10 months of follow-up, DOS SANTOS OLIVEIRA VIANNA *et al.* [52] found that prevalence of nose symptoms increased in students exposed to laboratory animals. This prevalence was already high at the beginning of the follow-up 64% and increased to 84% after 10 months. A case series of respiratory allergy to tobacco leaves in the workspace was presented by Ons Grissa, suggesting that primary prevention measures are essential in the tobacco industry [53]. In another study, GRISSA *et al.* [54] found that the allergic risks associated with emissions from thermal degradation of plastics justify the reinforcement of preventive measures and medical surveillance of exposed workers.

Finally, several presentations focused on the consequences of work-related asthma and rhinitis. In a study conducted by MOUSSA *et al.* [55], poor sleep quality was associated with poorly controlled asthma in patients with OA, suggesting the need for a screening programme for sleep disorders in these patients. A study by GRISSA *et al.* [56] showed that occupational rhinitis impacts the quality of life and productivity. The impact of gender on work productivity loss and activity impairment in asthmatic patients was studied by BRAHAM *et al.* [57], who found that asthma had a more pronounced effect on work productivity amongst women. Finally, KHAN *et al.* [58] conducted a study on WEA, OA and non-work-related asthma in the web-based NutriNet-Santé cohort. They found that both WEA and OA have poorer asthma control than non-work-related asthma, and that OA was more severe than non-work-related asthma.

In conclusion, this session covered many facets of work-related asthma and rhinitis, and emphasised the importance of a systematic search for occupational origin in patients with respiratory disease, as well as adequate preventive measures at the workplace to improve the workers’ respiratory health.

### **Tobacco, nicotine and cannabis**

Tobacco use is a leading cause of preventable deaths [59]. The introduction of e-cigarettes and heated tobacco products (HTPs) to the market has significantly changed smoking behaviours [60, 61]. The health risks of these products, particularly for respiratory health, are not sufficiently understood. This oral presentation session aimed to present novel findings in tobacco, nicotine and cannabis research.

Marijuana is the most widely used illicit drug. Aryn Bhamani talked about the prevalence and demographics of marijuana users in a Lung Cancer Screening cohort in London, UK (n=13 035; aged 55–77 years) [62]. Among the participants, 16.4% had ever used marijuana and 6.3% had history of regular marijuana use (at least once a week for  $\geq 1$  year), wherein they were more likely to be males, current

cigarette smokers and have higher education degrees. Further research on marijuana use and respiratory health is needed.

Several studies examined the health effects of HTPs, in humans, using cell models, or characterising exposure by focusing on emissions. Paulina Majek presented the results of the human-based study (n=120) on acute health effects of HTP use [63]. Seven parameters were assessed before and after the use of one heated tobacco stick (n=40), smoking one cigarette (n=40) or in a control group (n=40). A significant increase in blood pressure and heart rate was observed after cigarette or HTP use. A significant decline in  $F_{\text{ENO}}$  was observed after cigarette or HTP use. Moreover, an increase in exhaled carbon monoxide levels was observed, wherein a higher increase was observed among smokers than HTP users. There were no changes in blood pressure, heart rate,  $F_{\text{ENO}}$  or CO level in the control group. There were no significant changes in saturation, airway temperature or spirometry parameters in all three groups. Then, Hideki Inoue presented the results of the *in vitro* study on the effects of heated tobacco smoke on IL-8 production in human monocytic cell lines (THP-1) [64]. THP-1 cell lines were exposed to cigarette smoke extract or heated tobacco extract for 24 h at the concentration of 5%, 10%, 20% and 50%, respectively. Both cigarette smoke extract and heated tobacco extract exposure increased IL-8 gene expression, IL-8 protein expression and IL-8 cytokine protein expression in THP-1 cells, wherein the effect was more prominent in cigarette smoke extract than heated tobacco extract exposure. Findings from this study indicate on potential cytotoxicity of heated tobacco smoke. Finally, Efthimios Zervas talked about the particulate matter emissions from HTPs. Four HTP brands and 15 flavours were tested, with puff duration of 2 s, every 30 s, and a puff volume of 35 mL. Emissions of  $\text{PM}_{10}$ ,  $\text{PM}_{2.5}$ ,  $\text{PM}_4$ ,  $\text{PM}_{10}$ ,  $\text{PM}_{\text{total}}$  and black carbon emission were assessed. ZERVAS *et al.* [65] found that HTPs emit very small particles and  $\text{PM}_{10}$  corresponded to 98% of  $\text{PM}_{\text{total}}$ . Moreover, emissions of black carbon were reported. However, during the first puffs, humectants were evaporated, and PM/black carbon emissions appeared in the second to fourth puff. There was a significant impact of flavour and type of HTP device (and heating temperature) on PM and black carbon emissions. Findings from this study confirm that HTPs should not be promoted as “heat-not-burn” products.

Parental smoking is associated with teenage initiation and sustained smoking [66]. Given the broad use of e-cigarettes by teenagers, Salome Sunday talked about the results of a cohort study aiming to assess whether this association involves e-cigarette smoking too [67]. Indeed, teenagers (17–18 years old) were more likely to have ever smoked, be current smokers or use e-cigarettes if exposed to parental smoking at the age of 9 and 13 years, thus raising a need for interventions targeting smoking caregivers. Shedding further light on predictors of teenage e-cigarette smoking [68], Joan Hanafin focused on gender differences and presented results of a cohort study of >3000 teenagers in two waves (2015 and 2019) [69]. It is worth noting that a marked increase was documented in both e-cigarettes ever use and current use by 70% and 80% respectively, with the rate of increase being higher for girls than boys (adjusted OR 2.67 *versus* 2.04), though boys still showed a higher prevalence and a stronger association with peer smoking. Loose parental monitoring was reported to be another risk factor, with a stronger association for boys, thus underlining gender differences in e-cigarette use and paving the way for targeted interventions.

Warnings on cigarette packages referring to the detrimental impact smoking has on health, including texting and images, have been widely used as a limiting strategy [70]. A cross-sectional study, presented by Ioannis Karagiannidis, aimed to determine whether on-cigarette dissuasive messages or text on the beneficial impact of quitting and smoking cessation tips could be an acceptable add-on measure [71]. Both adult smokers and nonsmokers rated modified cigarettes to be significantly more effective than conventional ones. The most effective messages included “minutes of life lost”, “quality of life” and “economy”.

Keir Philip presented the results of a cohort study assessing the impact of smoking on psychosocial health in older adults [72]. Nearly 9000 people >50 years of age in England, UK, were included, with smokers showing higher levels of loneliness, and less social interaction with family, friends and the broader community at the study baseline. Furthermore, at 4-, 8- and 12-year follow-up, smokers were more likely to be more socially disengaged, having fewer social contacts and being lonelier than their nonsmoking counterparts.

The late-breaking abstract of this session was presented by Ruth Tal-Singer [73] and involved sentiments on the tobacco industry owning respiratory therapies [74]. A survey was conducted by the COPD Foundation and partners including >1000 patients with respiratory diseases from all over the world. 70% of patients reported being “bothered or really bothered” about this situation and 78% of patients expressed negative feelings in free text, thus showing that patients care deeply about who profits from their therapies.



## Conclusion

The 2022 ERS Congress, organised for the first time with both on-site and online attendance, was a renewed opportunity for excellent scientific exchanges around respiratory health. In the present article, early career members of the Epidemiology and Environment Assembly summarised the main findings presented in a few sessions from the congress, chosen from a wide range of topics and high-quality presentations.

Several of the studies presented aimed towards a better characterisation of respiratory diseases, their comorbidities (e.g. cardiovascular risk) and their evolution, using data from large cohorts, and questioning common practices such as the use of race-specific equations in lung function assessment. Contributing to the field of genetics in respiratory medicine, an improved genetic risk score to predict lung function in populations of diverse ancestry was proposed. The importance of early-life factors in respiratory health was also emphasised, with studies focused on maternal exposures (e.g. pesticides) and habits (e.g. diet) during pregnancy or pregnancy outcomes (e.g. preterm birth). As smoking behaviours have changed following the introduction of e-cigarettes and HTPs, research remains very active to determine not only health consequences but also predictors of these novel uses, especially in teenagers, in order to identify adequate prevention strategies. The impact of environmental and occupational exposures on respiratory health remained a major topic of the congress, with a focus on emerging risk factors such as landscape fire smoke, non-exhaust particles or nanoparticles. Regarding workplace exposures, large epidemiological studies confirmed the deleterious impact of exposure to cleaning products and irritants on respiratory health, and novel causes of occupational asthma and rhinitis were identified, for example in greenhouse workers. Beneficial public health interventions were also suggested during the congress such as the introduction of low emissions zones in the urban environment, the use of green cleaning products, or novel forms of dissuasion messages to prevent smoking, although all these need further investigations.

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