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ERS International Congress 2021: 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 (ERS) summarise a selection of four sessions from the Society’s 2021 virtual congress. The topics covered focus on chronic respiratory disease epidemiology, the health effects of tobacco and nicotine, and the respiratory health impact of environmental exposures and climate change. While the burden of chronic respiratory diseases such as COPD is expected to increase in the next decades, research on modifiable risk factors remains key. The tobacco and nicotine research presented here focuses on recent evolutions in cigarette alternatives, including vaping and the use of heated tobacco products, and changes in behaviours related to the coronavirus disease 2019 pandemic. The 2021 World Health Organization air quality guidelines were also a major topic of the congress. Despite their benefits, challenges remain in driving and implementing environmental health policies to take into account the respiratory effects observed at very low air pollution concentrations, as well as the impact of climate change on environmental exposures.

Introduction

In this article, early career members of the Epidemiology and Environment Assembly of the European Respiratory Society (ERS) summarise a selection of the results presented during the Society’s 2021 virtual congress. Four sessions (one “hot topic” session and three “oral presentation” sessions) selected by early career members and focusing on areas of specific interest for the Assembly, *i.e.* epidemiology of chronic respiratory diseases, impact of environmental exposures and climate change, and the health effects of tobacco and nicotine, are presented. Major topics presented and discussed during the congress include the influence of the coronavirus disease 2019 (COVID-19) pandemic on air pollution levels and smoking behaviours, and related health impact, and the new World Health Organization (WHO) air quality guidelines (AQGs) released in September 2021. Novel results in the field of chronic obstructive pulmonary disease (COPD) epidemiology were also presented during the congress.

Environmental and climate change effects on lung health across the life course

Despite the existence of comprehensive evidence linking air pollution to short- and long-term respiratory health effects, industrial factories and vehicle engines continue to pump out emissions that contribute to increasingly polluted air. During this “hot topic” session, four speakers provided an overview of the latest



research regarding this complex public health problem, especially in the context of climate change and considering important socioeconomic disparities. Opportunities and needs for action were discussed, including a discussion on the new WHO AQGs [1], which were released soon after the European Respiratory Society presentation, and a review of new evidence on the respiratory effects associated with low levels of air pollution exposure.

The first speaker, Elaine Fuertes, presented an overview of the conflicting evidence regarding the effects of a green environment and respiratory health [2–6]. The presentation highlighted a shared difficulty in these studies: the still-under-debate question of how to account for air pollution in this research topic. Air pollutants are likely confounding the relationship between greenness and respiratory health (*i.e.* air pollution levels tend to be lower in highly vegetated areas and they are adversely associated with respiratory health outcomes). However, in some instances, air pollutants could act as mediators (*i.e.* vegetation could capture air pollutants) or even as effect modifiers (for example, by increasing the pollen release of plants) [7]. This last activity is expected to be amplified by the increased air pollution levels associated with climate change. Increased levels of air pollution may synergistically affect the amount and allergenicity of the released pollen, through chemical modifications on the plants. It is expected that they may increase the duration of the pollen season as well, which will lead to patients experiencing allergic symptoms for prolonged periods [7].

Another factor adding complexity to this public health emergency is the unequal distribution of health risks associated with air pollution exposure across socioeconomic groups [8]. Ulrike Gehring, the second speaker, explained that the main reasons behind this social disparity are the increased exposure to air pollutants and the unfavourable social determinants (*e.g.* lifestyle) of health leading to increased susceptibility to the effects of air pollution among those in a socioeconomically disadvantaged position [8]. She also summarised the health burden of air pollution across the life course, providing detailed accounts of the evidence linking air pollution exposure to acute and chronic respiratory health effects, such as asthma onset [9, 10] and decreased lung function [11, 12], both in children and adults at pollution levels below those recommended by the WHO.

Indeed, novel evidence linking air pollution to morbidity and mortality supported the need for an update of the WHO AQGs, as presented in the session by Michal Krzyzanowski. The new AQGs [1], released on 22 September 2021, reviewed and integrated the available evidence on the health effects of particulate matter (PM) [13, 14], ozone (O₃) [14–16], nitrogen dioxide (NO₂) [14–16], sulfur dioxide (SO₂) [16, 17] and carbon monoxide [18] following the WHO handbook for guideline development [19], which warrants transparency and robustness. As introduced earlier, according to one of the resulting meta-analyses assessing the body of evidence on long-term exposure to NO₂, an increased risk of death was associated with NO₂ concentrations as low as 10 µg·m⁻³, supporting the reduction of the 2005 WHO-endorsed limit values by over 70% [15] (table 1).

The implementation of the new WHO endorsed limit values [1] will translate into relevant health benefits globally and, in particular, for vulnerable groups such as children. However, as detailed by

TABLE 1 World Health Organization (WHO) air quality guidelines (AQGs) of 2005 and 2021 comparison chart

Pollutant		2005 WHO AQG	2021 WHO AQG
PM _{2.5}	Annual average concentration	10 µg·m ⁻³	5 µg·m ⁻³
	24 h average concentration	25 µg·m ⁻³	15 µg·m ⁻³
PM ₁₀	Annual average concentration	20 µg·m ⁻³	15 µg·m ⁻³
	24 h average concentration	50 µg·m ⁻³	45 µg·m ⁻³
O ₃	Peak season (long-term exposure)		60 µg·m ⁻³
	8 h average concentration	100 µg·m ⁻³	100 µg·m ⁻³
NO ₂	Annual average concentration	40 µg·m ⁻³	10 µg·m ⁻³
	24 h average concentration		25 µg·m ⁻³
SO ₂	24 h average concentration	20 µg·m ⁻³	40 µg·m ⁻³
CO	24 h average concentration		4 µg·m ⁻³

CO: carbon monoxide; NO₂: nitrogen dioxide; O₃: ozone; PM_{2.5}: particulate matter with a diameter of 2.5 microns or less; PM₁₀: particulate matter with a diameter of 10 microns or less; SO₂: sulfur dioxide. Reproduced and modified from the following with the permission of the World Health Organization: <https://www.who.int/news-room/feature-stories/detail/what-are-the-who-air-quality-guidelines>.

Barbara Hoffmann, recent studies have shown respiratory effects down to the lowest observable levels [10], without evidence of an existing safe threshold for any pollutant. It is important to bear in mind that most Europeans live in areas that are already complying with the current EU ambient air quality directive [20] standards in terms of limit values but are still exposed to annual average air pollution levels that, according to the new evidence, are extremely harmful to human health. Given this, and applying the well-known population strategy for prevention proposed by Rose [21], the speaker stressed the need to shift the average exposure of the European population if we seek to obtain large population benefits in terms of burden of disease and mortality. Dr Hoffmann highlighted the upcoming 2022 revision of the EU ambient air quality directive as a unique opportunity to drive meaningful change. The 2022 ambient air quality directive could be improved not only by aligning the air quality standards with the 2021 WHO recommendations for limit values [1], but also by including, for the first time, binding reductions of the average population exposure.

In summary, this “hot topic” session highlighted the complexity of air pollution as a public health problem that is closely intertwined with climate change and directly affected by socioeconomic disparity. The new WHO AQGs [1] acknowledge the intricacy of achieving the newly recommended air quality levels; however, new evidence on adverse respiratory effects observed at air pollution concentrations considerably lower than previously understood make it clear that legislative actions and policies towards achieving this endeavour are of utmost importance.

Environment and respiratory health

In this oral presentation session, studies that reported the potential respiratory health effect of environmental exposures at various periods in the life course were presented.

Several speakers focused on the impact of air pollution, along with other environmental exposures (*e.g.* greenness, pollens), on health outcomes ranging from health-related quality of life to COPD. A study presented by Valérie Siroux investigated cross-sectional associations of long-term air pollution exposure (NO_2 , $\text{PM}_{2.5}$ and PM_{10}) and greenness with health-related quality of life based on a European Community respiratory health survey, including 10228 subjects [22], and the mediating effect of asthma–rhinitis status in this association. The study measured the health-related quality of life using short form 36 (SF-36) comprising the Physical and Mental Component Summary. Exposure to NO_2 , $\text{PM}_{2.5}$ and PM_{10} was measured using the land-use regression model, whereas greenness was measured using the normalised difference vegetation index in a 300 m buffer. About half (48%) of the participants were men and had an average age of greater than 40 years. Based on the Mental Component Summary, long-term exposure to air pollution was found to worsen quality of life, but greenness was found to improve quality of life, and these associations were unlikely to be mediated by asthma–rhinitis status. However, no association was evident between air pollution or greenness and the Physical Component Summary.

A study presented by Dimitra Sifaki-Pistolla investigated the association between air pollution exposure and airflow obstruction (AO) in the Dutch population-based Lifelines cohort [23]. The study included 25506 subjects without AO at baseline. Exposure to black carbon, NO_2 , PM_{10} and $\text{PM}_{2.5}$ at home was estimated at baseline using land-use regression models. Two-pollutant multiple logistic regression adjusted for sex, age, body mass index, pack-years smoking, socioeconomic status and baseline forced expiratory volume in 1 s (FEV_1)/forced vital capacity (FVC) was used to assess the association. Stratified analysis based on sex and smoking status were also conducted. About one in ten ($n=2464$) subjects had developed AO after 4.5 years of follow-up. Higher levels of NO_2 and $\text{PM}_{2.5}$ were significantly associated with AO. In stratified analysis by sex and smoking status, the study also showed a significant positive association between black carbon and $\text{PM}_{2.5}$ and AO in males and current smokers.

Hanne Krage Carlsen presented a study that assessed the effect of exposure to air pollution and pollen on the risk of airway symptoms and obstruction in a panel of subjects with asthma and allergy from Sweden [24]. The study excluded subjects who were currently smoking and with chronic inflammatory or cardiovascular diseases. The study included 38 subjects with a mean age of 49 ± 13 years and 50% were women. This analysis used a mixed-effect model assuming a random effect at individual and city levels and adjusted for humidity and temperature. Pollen levels were positively associated with rhinitis, dry cough, allergy, and asthma medication usage. Pollen levels were found to be negatively associated with peak expiratory flow (both morning and evening). No association was reported between pollen levels and dyspnoea or asthma symptoms nor between air pollution and airway symptoms. However, the study reported the presence of an interaction between air pollutants ($\text{PM}_{2.5}$ and O_3) and pollen, particularly regarding upper airway symptoms and medication usage.

A study that investigated the effects of ambient temperature on COPD exacerbations was presented by Supaksh Gupta [25]. The analysis included 1177 current and former smokers from the SPIROMICS cohort. It was found that ambient temperature was positively associated with COPD exacerbations after controlling the effect of relative humidity.

Einat Fireman Klein presented the results of a case-control study that investigated ultrafine particles in airways during COVID-19 lockdown [26]. This study collected exhaled breath condensate (EBC) samples of 30 healthy subjects during the first lockdown and 25 subjects during April–June 2016. The lockdown and control groups were comparable based on sex, smoking status and distance from air pollution monitoring stations; however, they had different average ages (34 versus 41.9 years, respectively). Air pollution data were collected from the nearest monitoring station a month before EBC samples were collected. The study reported lower exposure to air pollution in the lockdown group than in controls. Higher ultrafine particle concentrations in EBC and lower ultrafine particle concentrations in serum were found in the lockdown group compared to controls.

Konstantinos Dodos presented preliminary results on the differences between elderly COPD patients admitted onto a COVID-19-free respiratory ward before and during the pandemic in Greece [27]. The study included 514 and 464 subjects admitted before and after the COVID-19 pandemic, respectively. Respiratory tract infections were found to be lower during the pandemic than before. This difference was suggested to happen due to changes in everyday life (including preventive strategies) during the COVID-19 pandemic.

Finally, two presentations focused on more specific environmental exposures: phthalates and livestock-emitted exposures. A study by presented by Magda Bosch de Basea assessed the effect of gestational phthalate exposure on lung function in a cohort of children [28]. In this study, exposure to eight phthalate metabolites was measured during the first and third trimesters of pregnancy in 641 mothers from two Infancia y Medio Ambiente cohorts. Lung function was measured at 4, 7, 9 and 11 years of age. Linear regression models at each age period and mixed linear regression models (with a random effect by subject) were adjusted for potential confounders. The study found that the gestational levels of the phthalate metabolites were consistently associated with lower FVC and FEV₁ at all ages, both when assessed individually and jointly as a mixture, although most associations were not statistically significant. The study reported that increased monoisobutyl phthalate levels (among others) were associated with a reduction in lung function at 4 years, but not at a later age.

Warner van Kersen presented the preliminary results of a case-control study that investigated determinants of the oropharyngeal microbiota composition, using oropharyngeal swabs of 99 COPD patients and 184 controls [29]. The study participants were living in a livestock-dense area, were non- or former smokers and had not used antibiotics in the month before sampling. The study was conducted using 323 samples collected at baseline, 6 weeks and 12 weeks in 20 randomly selected subjects. No significant differences in cases and controls were found regarding alpha- and beta-diversity metrics, and abundance of genera. In univariate analyses, differences in oropharyngeal microbiota composition were found by gender, current lung medication use, and season. Residential exposure to livestock-emitted endotoxin and PM₁₀ were not related to oropharyngeal microbiota composition. Multivariate analysis will be conducted to identify the independent effects of the determinants.

In summary, this session highlighted the negative impact of environmental exposures such as air pollution, ambient temperature, and pollen on respiratory health and the quality of life. The studies presented also showed that interventions implemented as part of COVID-19 pandemic control reduced exposure to environmental pollutants and subsequently their respiratory health effects.

New evidence from longitudinal COPD cohorts and other key studies

In this oral presentation session, a broad range of studies were presented covering the future COPD prevalence in Europe, impact of specific air pollutants, pharmacological treatment and clinical characteristics, and mortality rates in COPD.

As emphasised earlier, there is mounting evidence for a role of air pollution in the development and worsening of chronic lung diseases. However, less is known about the specific pollutants, the impact of road traffic noise and the risk of incident COPD. Shuo Liu presented data from a large cohort of Danish nurses (n=28731) which were linked to national health, air pollution and traffic noise databases [30]. They specifically investigated the impact of PM_{2.5}, NO₂ and Lden (day–evening–night sound level) on the risk of COPD. During the 18.6 years mean follow-up time, 977 (4%) nurses developed COPD. Time-varying

Cox-regression models revealed a significant association between all three exposures of interest and incident COPD: PM_{2.5}; 1.13 (1.05–1.20), NO₂; 1.13 (1.05–1.20), and per 10 dB increase in Lden; 1.15 (1.06–1.25). Further, the authors found that the association for both NO₂ and Lden were robust to adjustment for PM_{2.5}, indicating that long-term exposure to traffic-related pollutants in particular were significant predictors of incident COPD in this large cohort study.

BENJAFIELD *et al.* [31] used publicly available data (Global Burden of Disease Data and World Bank Population) to estimate the prevalence of COPD in Europe for 2050 by conducting time in state models. The models generated an estimated count of COPD patients by country, age, sex and year strata from 2020 to 2050. The authors included data from 39 countries for adults above 25 years of age and found that the COPD prevalence in 2020 in Europe was 6.7% and increase to 9.3% by 2050. They also identified the countries with the highest COPD prevalence in both percentage and absolute numbers. The highest prevalences were found in the UK, Belgium, Spain, Denmark and the Netherlands and ranged from 13.1% (UK) to 14.6% (Netherlands), whereas the top five countries with the highest number of persons with COPD were Russia, Italy, Spain, UK and Germany and the numbers ranged from 4.5 million (Russia) to 7.6 million (Germany). The results point towards an increasing burden of COPD in Europe and warrant strategies to prevent incident COPD cases and improve both diagnosis and treatment. However, the results should be interpreted with caution as the study assumes that well-known COPD risk factors such as smoking and air pollution are unchanged the next three decades. Studies indicate that smoking patterns have decreased since the 1960s [32, 33] and there is a large variability in air quality globally [34].

The initiation and withdrawal of inhaled corticosteroids (ICS) in patients with COPD have been examined in several previous studies [35, 36]. The WISDOM trial investigated the risk of COPD exacerbation and decline in FEV₁ in patients who continued tripe therapy *versus* patients who were withdrawn from ICS [35]. The study found no difference in the risk of COPD exacerbations, but a greater decline in FEV₁ was observed in the withdrawal group. Similar results were found in the SUNSET study, in which the decline in lung function upon ICS withdrawal was less apparent in patients with low blood eosinophil counts [36]. In the current treatment recommendations, discontinuation of ICS should be considered in patients with no history of COPD exacerbation in the past 12 months, low blood eosinophil counts and risk of pneumonia due to ICS [37]. A limitation of the WISDOM trial is that the included participants represent a selected population. This issue was addressed by WHITTAKER *et al.* [38], who investigated the rate of FEV₁ decline following ICS withdrawal in a general COPD population in primary care in England. The authors used both primary and secondary care electronic healthcare records to identify COPD patients who received triple therapy for at least 4 months prior to study entry. The patients were then categorised as “ICS-withdrawers” if they subsequently were prescribed with long-acting muscarinic antagonist and long-acting beta2-agonist but no ICS and compared with patients who remained on triple therapy. The patients were followed from 1 January 2004 to either 30 September 2019, death or transfer-out date. Among the patients who met the inclusion criteria (n=116374), only those with a least two FEV₁ measurements at least 6 months apart were included in the main analyses (n=60645). During the study period, 11.5% withdrew from ICS. In a multivariate mixed linear regression, WHITTAKER *et al.* [38] found that patients who withdrew from ICS had a slightly faster decline (ml·year⁻¹) in FEV₁ compared to patients who remained on triple therapy, -36.4 (-39.4–-33.4) *versus* -32.6 (-33.6–-31.5). However, the difference was not clinically relevant. The authors concluded that prescription of ICS for COPD patients should be based on blood eosinophilia, history of exacerbations, and symptoms despite dual therapy.

It is well-known that mortality in COPD patients is higher than in the general population and that an exacerbation is a major cause of death in COPD [39]. LENOIR *et al.* [40] also used data from primary care in the UK to investigate the clinical characteristics, mortality rates and causes of death of non-exacerbating compared to exacerbating COPD patients. They included 67516 patients, of whom 17.3% did not have an exacerbation during a 3-year baseline period. The non-exacerbators were more likely to be male, less likely to have a previous diagnosis of asthma, and had lower lung function. The adjusted hazard ratio for mortality was lower in the non-exacerbating group in both the first year of follow-up (0.62 (0.56–0.70)) and thereafter (0.87 (0.83–0.91)) compared to the exacerbating group. Finally, their results showed that respiratory causes of death were more common in the exacerbating group and that non-exacerbating COPD patients are equally likely to die of respiratory, malignant and cardiovascular diseases.

In summary, the studies presented in the session underline the great burden of COPD in terms of increasing prevalence and higher mortality rates in COPD. The studies also highlight the importance of air pollution as a risk factor for incident COPD and that ICS withdrawal in COPD should be an ongoing clinical consideration.

Tobacco and nicotine research during the pandemic

Tobacco use is a well-known risk factor for many respiratory infections [41–43]. Moreover, exposure to an aerosol generated by electronic cigarettes (e-cigarettes) may lead to several inflammatory lung disorders [44, 45]. The COVID-19 pandemic has inspired researchers to conduct studies assessing the impact of tobacco and nicotine use on the risk of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infection and the severity of COVID-19 [46, 47]. Furthermore, changes in social behaviours evoked by anti-epidemic measures (*e.g.* lockdown) may also influence smoking behaviours [48, 49]. This oral presentation session aimed to present novel findings in tobacco and nicotine research during the pandemic.

E-cigarettes and heated tobacco products are gaining popularity. Several studies on the potential health effects of e-cigarette or heated tobacco product use were presented during the session.

Gustaf Lyytinen presented the results of the randomised cross-over study (n=22) on the potential health effects of the brief use of e-cigarettes with or without nicotine. LYYTINEN *et al.* [50] found that e-cigarette vapour containing nicotine had an immediate impact on thrombus formation and vascular function. However, e-cigarette use without nicotine did not affect microcirculation or thrombogenicity. A similar study protocol was used in another study presented by Gustaf Lyytinen [51], where the authors evaluated the potential health effects of the brief use of heated tobacco products and compared these effects with a non-exposure control group. Contrary to the non-exposure control group, the use of heated tobacco products increased arterial stiffness and thrombus formation in healthy young individuals (n=23). Findings presented by Gustaf Lyytinen revealed that regular e-cigarette or heated tobacco use may impact vascular health [50, 51].

Efthimios Zervas talked about the gaseous emissions of four different tobacco products: two conventional cigarettes and two heated tobacco sticks dedicated to the most popular heated tobacco products. The gaseous emissions of these products were analysed qualitatively. ZERVAS *et al.* [52] found that the number of alkadienes and aromatic compounds detected in tobacco smoke was higher compared to the emission observed during the use of heated tobacco products. However, the emission of alcohols and esters was higher during the use of heated tobacco products compared to smoking conventional cigarettes. There were no markable differences in the emission of alkanes, alkenes, aldehydes, ketones, acids and terpenes between conventional cigarettes and heated tobacco products. Efthimios Zervas concluded that conventional cigarettes and heated tobacco products differed significantly in the chemical composition of their emissions and that may affect toxicological effects related to their use [13].

Overall, these studies significantly contribute to the current state of knowledge on the health consequences of e-cigarette or heated tobacco product use and may be used by policymakers to shape tobacco control policies.

A growing number of studies are indicating various long-term effects of the COVID-19 pandemic [53]. COVID-19 restrictions and social isolation during the pandemic may have significantly influenced smoking behaviours [48, 49]. The different anti-epidemic measures implemented around the world may have led to markable differences in the long-term effects of the COVID-19 pandemic globally. Cara J. Bossley talked about the impact of COVID-19 school closure on child exposure to environmental tobacco smoke in the home [54]. Based on the results of a cross-sectional survey carried out among 50 parents/carers, Bossley observed that two-thirds of parents smoked the same or more during the lockdown, which led to children having increased second-hand and third-hand smoke exposure during the COVID-19 pandemic in the UK. Another study from the UK, presented by Gareth Jones, concerned inpatient smoking cessation during the COVID-19 pandemic [55]. Based on the experience of a university teaching hospital in the UK, Jones observed increased engagement with smoking cessation treatment among smokers admitted to the hospital, wherein the highest increase in nicotine replacement therapy uptake was observed among patients under 50 years of age.

Mingxuan Xie presented findings from a series of experimental studies aimed to determine the effect of cigarette smoke on ACE2 expression (SARS-CoV-2 receptor) in mouse models and non-malignant human lung tissues [56]. Findings showed that smoking is significantly correlated with ACE2 overexpression in bronchial and alveolar epithelial cells both in mouse models and human lung tissues. The results of this study have a practical implication and underline the importance of smoking cessation during the COVID-19 pandemic.

In 2020, a significant proportion of healthcare professionals and public health specialists were involved in the fight against the COVID-19 pandemic. Nevertheless, involvement in anti-epidemic measures should

not lead to the neglect of health policies regarding other public health challenges such as smoking [57]. Three studies focused on tobacco control policy may significantly contribute to anti-tobacco activities around the world. LYKOURAS *et al.* [58] evaluated the presence of smoking in 45 high-visibility films presented on an online streaming platform. They found that leading and supporting characters appeared to smoke in 19 and 32 movies, respectively. However, a movie release date after 2010 was associated with a decreased frequency of smoking for both leading and supporting characters. Linnea Hedman presented findings from a longitudinal population-based study in Sweden (2016–2020) [59]. Of 328 e-cigarette users at baseline, three-quarters also smoked (dual users). In a 4-year follow-up, only 21% of all e-cigarettes users completely quit tobacco or nicotine use. Most of the dual users had quit e-cigarettes but continued to use other forms of nicotine products (mostly cigarettes or snus). Finally, Elif Dagli talked about the use of plain packaging in Turkey. As part of tobacco industry monitoring, four independent observers analysed 105 different sub-branded packages from 22 brands from four different companies [60]. Findings showed a low level of compliance with Turkish plain packaging legislation in terms of labelling and packaging features on the cigarette packs available on the market in Turkey.

In summary, the findings presented in this session showed that novel forms of nicotine-containing products, such as e-cigarettes and heated tobacco products have a negative impact on human health. Moreover, the COVID-19 pandemic has had a significant impact on tobacco use, cessation behaviours as well as exposure to second-hand smoke; therefore, tobacco control interventions should a health policy priority after combating the pandemic.

Conclusion

High-quality research in the field of respiratory and environmental epidemiology was presented during the congress and the present article highlighted the main findings presented in a few “hot topic” and “oral presentation” sessions, selected by early career members from a large number of remarkable sessions. While the burden of chronic respiratory diseases such as COPD is expected to increase in the next decades, research on modifiable risk factors remain key. Novel results emphasised the negative impact of environmental exposures such as air pollution, ambient temperature and pollen on respiratory health and quality of life. Tobacco and nicotine research focused on alternatives to cigarettes, including vaping and the use of heated tobacco products. Changes in behaviours and anti-epidemic measures during the COVID-19 pandemic led to changes in tobacco use, smoking cessation and second-hand smoke exposure, but also in air pollution levels, providing interesting opportunities to study the impact of related respiratory health effects. Despite the benefits of the new WHO AQGs for global health, challenges remain in driving and implementing environmental health policies to take into account the respiratory effects observed at very low air pollution concentrations, as well as the impact of climate change on environmental exposures.

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