The Impacts Of Urban Air Pollution On Human Lives

Air pollution is becoming an increasingly prevalent problem across the world, casting tremendous impacts on public health. Air pollution refers to the release of harmful or excessive quantities of substances into the atmosphere, which are: gases (e.g. ammonia), biological molecules and particulates (organic and inorganic). [1] They have already shown alarming consequences: WHO estimates that air pollution is responsible for 4.2 million premature deaths globally, mainly from heart disease, lung cancer, stroke, chronic obstructive pulmonary disease, and acute respiratory infections in children. [2] New scientific research reveals deeper insight into the link between pollutants and certain diseases. The improvement in understanding would enable more possible plans for the future to decrease the risks on public health and our ecosystem.

Poor air quality is a very typical problem in urban areas. Modern technology brought a new lifestyle to people all across the world: travel long distances and even live in megacities. The huge problem, air pollution came together with all the convenience. A major ingredient in the creation of smog in some large cities is vehicle emissions. In the United Kingdom, traffic fumes alone cause 5000 deaths every year as a study conducted by MIT has shown. [3]

Nitrogen oxides (NOx) are a component of car exhaust. NOx refers to NO and NO2, which are produced from the reaction between nitrogen and oxygen during the combustion of hydrocarbon fuels especially at high temperatures (i.e. in engines). Its ability to react with moisture and compounds such as ammonia to form nitric acid vapor and other particles make it particularly harmful to both the human respiratory system and the environment. [4] Photochemical smog is a major type of air pollution caused by nitrogen-containing compounds. It consists of primary pollutants (NOx and VOCs- volatile organic compounds- organic compounds with low boiling points which sublime in air) and secondary pollutants, such as ozone, aldehydes, which are products of primary pollutants undergoing photochemical reactions e.g.ultraviolet light can split nitrogen dioxide into nitric oxide and monatomic oxygen; ozone is then formed from the reaction between monatomic oxygen and oxygen gas. [5]

Both primary and secondary pollutants in photochemical smog are highly reactive oxidising species. Their strong oxidising properties are associated with a variety of negative health impacts. As research suggests, inhaled oxidants initiate a number of pathologic processes, including inflammation of the airways which may contribute to the pathogenesis and exacerbation of various airway diseases (e.g. asthma, COPD, and ARDS) [6]

Moreover, studies have found evidence for the behaviour of reactive oxidative species as a carcinogen. NO2 has the potential to cause oxidative damage to DNA molecules: research found breakages of DNA single-strand in alveolar macrophages after exposing 3-month-old male Sprague-Dawley rats to either 1.2 ppm NO2 or 0.3 ppm O3 alone or a combination of these two oxidants continuously for 3 days. [7] Similarly, “some evidence of carcinogenic activity of ozone” are found by a study for the US Department of Health’s National Toxicology Program. Female mice that inhaled air containing 2000 microgram per metre cube of ozone for two years developed tumours of the lung and bronchial tubes at twice the rate compared with female mice that inhaled no ozone. Female mice which were exposed to 1000 micrograms per

cubic metre have experienced a smaller increase. [8]

Disturbingly, nitrogen oxide is proved to be genotoxic in urban concentrations. The annual limit value for NO2 is defined by the WHO to be 0.02 ppm. In one study where NO2 is set at 0.01 ppm (under the WHO value), researchers examined human nasal epithelium in vitro underexposure of NO2 for different lengths of time, in order to determine genotoxicity of NO2. Experiments have shown no cytotoxic effects (e.g. apoptosis, necrosis or disturbances of cell proliferation) at this NO2 concentration; however, at an exposure duration of 3 h, micronucleus induction which is a sign of genotoxicity was shown. [9] The article suggests that at urban concentrations lower than the limit set by WHO, NO2 could potentially be harmful to public health. Moreover, another source of data shows that the average concentrations in urban areas throughout the world are in the range of around 20–90 ?g/m3. [10] This converted into unit used by WHO and the previous study would be 0.02ppm-0.09ppm, which is a range of worrying concentrations even higher than the limit of WHO. I think the study is well-explained and was carried out in a very precise manner: to eliminate the possibility that the mutation/management in gene is solely due to genetic reasons, nasal epithelial mucosa samples were collected from 10 donors and then cultured at air-liquid interface. Nevertheless, we should also note the authors' note that the present experiments in vitro is not enough to determine a threshold of NO2, I think more research would need to be carried out in common urban areas for more realistic results.

Traffic-related air pollution has been proved to increase the risk of hypertensive disorder and premature birth in pregnant women. According to a very recent report published in December 2019, scientists working on the National Toxicology Program (NTP) suggest that exposure to TRAP is directly linked to the risk of developing hypertension during pregnancy. [11] TRAP are mixtures of gases and particles coming from fossil fuel combustion by motor vehicles. The results have shown that they are a major risk factor as they can be easily inhaled. It brings a particular high risk for cardiovascular disease, including hypertension-- which is the collective term referring to a range of clinical conditions which all involve high blood pressure during pregnancy. Besides, single pollutant was evaluated individual PM2.5 and NO2 exposures can affect vascular inflammation independently, which then may cause an increase in blood pressure [12] I think the study is done precisely with details: the scientists have broken TRAP further down according to their size to evaluate their effects. It is shown that smaller particles, especially fine particulate matter (PM2.5) have the greatest impact on pregnant women. Particulate Matter 2.5 refers to a mixture of solid particles and liquid droplets found in the air. They are fine inhalable particles with diameters smaller than or equal to 2.5 micrometres, about 30 smaller than the diameter of a single string of hair. [13] Their small size enables them to penetrate deeply into sensitive body tissue and damage it. Brandy Beverly, Ph.D, NTP lead scientist for TRAP, said "When these women were exposed to PM2.5 during their entire pregnancy, the likelihood of developing preeclampsia increased by about 50%."

Furthermore, the resulting increased blood pressure can cause premature birth and even birth defects. According to the American College of Obstetricians and Gynecologists, hypertensive disorders are a prominent cause of maternal and fetal illness and death: pregnant women with hypertension are more prone to preterm delivery. [14] This associate with a larger possibility for low birth weight of the infants and other long-term health problems. [15] It is astonishing and alarming to see the chain of impacts the study has revealed, which are not only on the respiratory system of the mothers themselves but also the issues the infants may face in the long-term.

Air pollution can even cause structural alterations to children's brains. In a study conducted in 2008 in Mexico City, children with no known risk factors for neurological disorders were found to have significant shortages in a combination of fluid and crystallized cognition tasks. [16] After investigating the MRI scannings, scientists have concluded that the prefrontal cortex was a target anatomical region and its damage could have contributed to their cognitive dysfunction. Further research reiterates this finding: within all children tested in Mexico City, 56 percent showed prefrontal white matter hyperintense lesions. This is thought to have a close correlation with ultrafine PM present in the air. This study was well-recognised in toxicology for that it's revolutionary at using 'interdisciplinary methodology' to address relationships between pollution, structural brain alterations and cognitive delays in healthy children.

Humans are not the only species affected by airborne toxins, they also affect our animal friends which live around! Multiple studies on dogs living in urban areas found physical signs of harm in dogs that were exposed to air pollution: One study examined dog's brains from Mexico City: increased inflammation and pathology including neurofibrillary tangles are observed in Mexico City dogs' brains. [17] Clumps of proteins are also found, which, shockingly, serve as a primary marker for Alzheimer's disease in humans. Pesticide is another source of pollutants animals are also exposed to. The University of Massachusetts and the Tufts University Cummings School of Veterinary Medicine did a study with 700 dog owners regarding the use of pesticides, according to this study, as high as around 33% of the dogs were diagnosed with a form of cancer called canine malignant lymphoma. The study also revealed that dogs had a 70% higher chance of getting lymphoma if their owner used pesticides in their yard. The effect of pollutants on dogs' brain and its close relationship with cancer echo the results of the other research investigating humans.

The good news is that more advanced technology has been used to find new ways to reduce some of the negative health impacts on people. Vitamin D is shown to help reduce symptoms of asthma amongst urban kids living in polluted areas. [18] The study has revealed the link between vitamin D, obesity and air pollution. "Asthma is an immune-mediated disease," said lead author Sonali Bose, M.D., a professor at Mount Sinai, and adjunct faculty at Johns Hopkins. "From previous scientific studies, we knew that vitamin D was a molecule that may influence asthma by impacting antioxidant or immune-related pathways." The author also notices the connection between asthma and the obesity epidemic amongst the urban minority groups: for example black children, who have more difficulties to get enough sun exposure to synthesis vitamin D due to their darker skin pigmentation; the results show how the complex environment comes together making these urban communities with low-income more vulnerable to asthma. The author suggests that this need to be translated to practical solutions where "a multi-faceted approach" is required for these children to get dietary supplements or eat more foods that are high in vitamin D, for example, fish, mushrooms and milk.

Staying indoors is not always a good action to take: pollutants including NOx, SO2, O3, CO, VOCs, PM, radon, and microorganism also present indoor, [19] many of them (e.g. NOx, SO2, O3, PM) are recognised as both indoor and outdoor pollutants, so are thought to come from outdoor. Some of them originate from human-caused sources, for example, wooden construction materials, oil-based paints and indoor plants, which emit different concentrations of VOCs. It is even worse than when there is insufficient air ventilation, these air pollutants may accumulate in the indoor environment, and will seriously affect the inhabitants' health. [20]

The impacts of urban air pollution on human lives are of a global scale: according to data from

World Bank, in 2018, 55.3% of the world’s total population live in cities [20] whilst only 20% of the urban population surveyed live in areas that comply with WHO air quality guideline levels for PM2.5. [22] Individual reactions to air pollutants depend on the type of pollutant a person is exposed to, the degree of exposure, and the individual's health status and genetics. The good news is: more advanced technology allows us to see the impacts of pollutants in an increasing number of aspects. In response to this alarming evidence, it is essential for countries to take action and strictly obey the limit values. New discoveries are also on their way to give us a more promising future.