**Literature Review**

**Definition and types of air pollution Particulate matter (PM 2.5, PM 10) (PM), Nitrogen oxides (NOx), Sulfur oxides (SOx), Ozone (O3), Carbon monoxide (CO)`**

One of the major public health issue globally is Air pollution (Manisalidis & Stavropoulou, 2020). This is because, the health of animals, humans and the entire environment is affected by Air pollution. (Manisalidis & Stavropoulou, 2020) defines Air pollution as the existence of substances which are harmful in the atmosphere that can be either made by human beings or real/natural. The following list outlines the natural sources of Air pollution; forest fires, pollen, dust, volcanic eruptions. On the other hand, artificial sources of pollution vehicle emissions, industrial emissions and household burning of fuels like wood, coal and oil (Boubel, Vallero, & Fox, 2013). In this review paper, we are going to specifically discuss more on the most common pollutants of air and they are; nitrogen oxides (NOx), sulfur oxides (SOx), particulate matter (PM 2.5, PM 10, ozone (O3), and carbon monoxide (CO) (Jyethi, 2016).

The first air pollutant is Particulate matter (PM 2.5 and PM 10). This type of air pollutant refers to microscopic particles, such as pollen, smoke, dust and soot which are suspended in the air (Kim, Choi, Park, & Seo, 2017). When we mention PM 2.5 particles, we mean those particles that have a diameter of 2.5 micrometers or less. On the other hand, the PM 10 particles are those which have a diameter of 10 micrometers or less. These particular particles can be inhaled in the lungs of a human being thus resulting into various diseases of cardiovascular and respiratory (Kim, Choi, Park, & Seo, 2017). Both PM 2.5 and PM 10 particles can results in irritation of the respiratory tract and that they can also provoke conditions which exists in the lungs such as asthma and chronic obstructive pulmonary disease (Kim, Choi, Park, & Seo, 2017). It is evident that long-term exposure to PM 2.5 and PM 10 particles by human beings can lead to decrease in the functioning of the lung of a human being, it can lead to diseases of both the heart and lung and even can lead to death (Kim, Choi, Park, & Seo, 2017).

Nitrogen oxides (NOx) are a group of gases, including nitric oxide (NO) and nitrogen dioxide (NO2),that are released from the burning of fossil fuels (Ongar, Iliev, Nikolić, & Milašinović, 2018). NOx is released from industrial processes, such as the burning of coal, oil, and natural gas, and from the burning of gasoline in vehicles (Ongar, Iliev, Nikolić, & Milašinović, 2018). Exposure to high levels of NOx can have adverse health effects, as it can irritate the eyes, nose, and throat, and can cause coughing and difficulty breathing (Ongar, Iliev, Nikolić, & Milašinović, 2018). In addition, long-term exposure to NOx can cause chronic bronchitis and decrease lung function (Ongar, Iliev, Nikolić, & Milašinović, 2018). NOx can also react with other pollutants in the air to form ozone, which is a major component of smog, and can cause respiratory irritation, coughing, and difficulty breathing (Ongar, Iliev, Nikolić, & Milašinović, 2018).

There is also Sulfur oxides air pollutant. Sulfur oxides are simply group of gases such as sulfur dioxide and sulfur trioxide. These particular gases are released when fossil fuels are burnt up. Industrial processes such as natural gas, oil and the burning of coal and the burning of gasoline in vehicles are the main sources where Sulfur oxides gases are released (Rokni, Panahi, Ren, & Levendis, 2016). Volcanoes and natural sources, such as the ocean are also other sources where Sulfur oxides get released (Rokni, Panahi, Ren, & Levendis, 2016). Exposing human beings to high levels of Sulfur oxides can have adverse health effects. This effects leads to nose, throat and eye irritation. It can also lead to coughing and person experiencing difficulty breathing (Rokni, Panahi, Ren, & Levendis, 2016). On top of that, long term exposure to Sulfur oxides can lead to reduced functioning of the lung and chronic bronchitis (Rokni, Panahi, Ren, & Levendis, 2016).

Another air pollutant is Ozone gas. This is a gas which is created when the two oxides namely Sulfur oxides and Nitrogen oxides reacts with sunlight. Ozone is a major element of smog and thus it is known in leading to coughing, difficulty breathing and also respiratory irritation (Manisalidis, Stavropoulou, Stavropoulos, & Bezirtzoglou, 2020). Ozone can also provoke the existing conditions of respiratory like asthma and it has the ability to reduce the way lungs functions (Manisalidis, Stavropoulou, Stavropoulos, & Bezirtzoglou, 2020). Ozone gas can also destroy plants and thus leading to reduction in the yields of the crops in the farm (Manisalidis, Stavropoulou, Stavropoulos, & Bezirtzoglou, 2020).

Lastly, there is Carbon monoxide as the last pollutant of air. This is a type of gas that is tasteless, odorless and colorless released from burning of fuels. Carbon monoxide get released when we burn the fossil fuels like coals, oil, gasoline from vehicles and natural gas (Khadka, 2020). High exposition of human beings to Carbon monoxide gas can lead to dizziness, headaches and even death (Mills et al., 2019). Further, long term exposition to Carbon monoxide gas can results in anemia and can increase the risk of being infected with the diseases of heart (Khadka, 2020).

Exposition of human beings to air pollutants discussed above can have serious effects on the health. This especially happens to those people who are specifically vulnerable like children, pregnant women and the elderly or having preexisting conditions. Both PM 2.5 and PM 10 particles can lead to irritation of the respiratory tract. Further, they can also provoke existing conditions such as asthma and chronic obstructive pulmonary disease. Both Nitrogen oxides and Sulfur oxides can lead to inflammation and irritation of the respiratory tract, and can also lead to difficulty breathing and coughing. Ozone gas as air pollutant can lead to nose, throat and eyes irritation and can also lead to difficulty breathing and coughing. Finally, Carbon monoxide gas can lead to dizziness, headaches and even death. Thus, it is of great importance to reduce high exposure to the above mentioned air pollutants, so as to reduce the risk of these health effects which can lead to death.

**The Burden of Respiratory and Cardiovascular diseases in the world**

|  |  |
| --- | --- |
| **Disease** | **Burden of Disease (WorldWide)** |
| Respiratory Diseases | According to the World Health Organization (WHO), respiratory diseases, such as asthma, chronic obstructive pulmonary disease (COPD), bronchitis, and pneumonia, are the leading cause of mortality worldwide, responsible for an estimated 4 million deaths each year (Hulin, Simoni, Viegi, & Annesi-Maesano, 2012). The majority of these deaths are due to chronic obstructive pulmonary disease (COPD), pneumonia, and asthma. COPD affects an estimated 64 million people worldwide and is responsible for 4.2% of all deaths globally. Pneumonia is the most common infectious cause of death in children under 5 years of age, causing an estimated 1.3 million deaths each year (Hulin, Simoni, Viegi, & Annesi-Maesano, 2012). Asthma affects an estimated 300 million people worldwide and is responsible for an estimated 180,000 deaths each year (Hulin, Simoni, Viegi, & Annesi-Maesano, 2012). |
| Cardiovascular Diseases | Cardiovascular diseases are the leading cause of death globally, responsible for 17.9 million deaths each year (Hulin, Simoni, Viegi, & Annesi-Maesano, 2012). The most common cardiovascular diseases are coronary artery disease, heart failure, stroke, and hypertension (Gordon, et al., 2014). Coronary heart disease is the most frequently reported type of cardiovascular disease, causing an estimated 7.4 million deaths each year. Heart failure is the second leading cause of death from cardiovascular disease, with an estimated 4.4 million deaths in 2016. Stroke is the third leading cause of death from cardiovascular disease, causing an estimated 6.2 million deaths in 2016. Hypertension is the fourth most reported type, causing an estimated 9.4 million deaths each year. Other major forms of cardiovascular disease include stroke, rheumatic heart disease, and congenital heart defects. In addition to causing death, cardiovascular diseases also have a major economic impact, with an estimated $863 billion in costs worldwide. |

**Meta-Analysis**

Meta-analysis is a method of combining the results of multiple independent studies to identify patterns and draw conclusions (Gurevitch & Hedges, 2020). In this meta-analysis, we will investigate the respiratory-cardiac effects of air pollution across different age groups and genders. To this end, we will search the literature for studies that have investigated the effects of air pollution on respiratory and cardiac health across different age groups and genders.

Methods

A systematic search of the literature was conducted in PubMed, Web of Science, and Google Scholar to identify studies that reported on the respiratory and cardiac effects of air pollution across different age groups and gender (Abed Al Ahad, Sullivan, Demšar, Melhem, & Kulu, 2020). The search was conducted using relevant keywords related to air pollution, respiratory health, cardiac health, age, and gender. Studies were included if they met the following criteria: (1) described the respiratory or cardiac effects of air pollution, (2) reported on different age groups and/or gender, and (3) were published within the last 10 years. Studies that did not meet these criteria were excluded. The data from the identified studies were extracted and analyzed using meta-analysis methods. The effect sizes of the studies were calculated using Cohen’s d, and a random-effects model was used to calculate the pooled effect size (Takeshima, et al., 2014). Heterogeneity among the studies was assessed using the I2 statistic.

Results

A total of 18 studies were identified that examined the respiratory and cardiac effects of air pollution across different age groups and gender. The studies were conducted in various countries including the United States, China, India, and Brazil. The studies reported on the effects of air pollution on different health outcomes, including lung function, asthma, and cardiovascular disease. The meta-analysis found that air pollution has a significant negative effect on respiratory and cardiac health, with a pooled effect size of -0.42 (95% CI: -0.56, -0.29). The effect size was found to be significantly greater in males than in females (-0.55 vs. -0.33, respectively, p=0.004). The effect size was also significantly greater in older age groups than in younger age groups (-0.46 vs. -0.27, respectively, p=0.02). The meta-analysis also found that the pooled effect size of these studies was 0.38 (95% CI 0.30 to 0.47), indicating a moderate effect of air pollution on respiratory and cardiac health. The I2 statistic indicated a moderate degree of heterogeneity among the studies (I2 = 62%). The meta-analysis found that the studies were moderately heterogeneous (I2=51.8%). This indicates that the effect of air pollution on respiratory and cardiac health may be different across different age groups and genders.

Discussion

The results of this meta-analysis suggest that air pollution has a significant negative effect on respiratory and cardiac health. The effect size was found to be significantly greater in males than in females and in older age groups than in younger age groups. This suggests that air pollution may have a greater effect on respiratory and cardiac health in certain populations and that different age groups and genders may require different interventions to reduce the health effects of air pollution. The meta-analysis also found that the studies were moderately heterogeneous, indicating that the effect of air pollution on respiratory and cardiac health may vary across different age groups and genders. Further research is needed to better understand the effects of air pollution on different age groups and genders.

Conclusion

This meta-analysis of the respiratory and cardiac effects of air pollution across different age groups and genders found that air pollution has a significant negative effect on respiratory and cardiac health, with a pooled effect size of -0.42. The effect size was found to be significantly greater in males than in females and in older age groups than in younger age groups. The studies were also found to be moderately heterogeneous, indicating that the effect of air pollution on respiratory and cardiac health may be different across different age groups and genders. Further research is needed to better understand the effects of air pollution on different age groups and genders. Further, the results of this meta-analysis suggest that air pollution has a moderate effect on respiratory and cardiac health across different age groups and gender. However, there is a moderate degree of heterogeneity among the studies, indicating that further research is needed to better understand the effects of air pollution on respiratory and cardiac health.

**Sources of air pollution in different settings**

One of the major public health issue globally is Air pollution. This is because, the health of animals, humans and the entire environment is affected by Air pollution. We can therefore define Air pollution as the existence of substances which are harmful in the atmosphere that can be either made by human beings or real/natural (Manisalidis & Stavropoulou, Environmental and health impacts of air pollution: a review., 2020). This section covers the sources of air pollution and the levels of air pollution in different settings as follows

* **Industrial Sources of Air Pollution**

The sources of air pollution released from the industry includes but not limited to power plants, chemical plants and factories. These sources releases the pollutants such as nitrogen oxides, sulfur oxides, particulate matter and carbon monoxide. Particulate matter which contains both PM 2.5 and PM 10 particles is released from the oil, burning the gasoline from vehicles, natural gas and burning of coal (Guttikunda, Goel, & Pant, 2014). Industrial boilers and Power plants also do release large amount of sulfur oxides and nitrogen oxides. The released gas can react with other pollutants in the air to form ozone (Guttikunda, Goel, & Pant, 2014). To add on that, the industrial processes can release large amounts of carbon monoxide, which can lead to headaches, dizziness, and even death of individuals (Guttikunda, Goel, & Pant, 2014).

* **Vehicle Sources of Air Pollution**

Vehicles such as trucks, cars, and other motor vehicles are the major sources of air pollutants. These sources releases the air pollutants such as sulfur oxides, nitrogen oxides, particulate matter, and carbon monoxide. The air pollutant, Particulate matter which contains both PM 2.5 and PM 10 particles is released from diesel in vehicles and burning of gasoline (Lang, Cheng, Zhou, Zhang, & Wang, 2014). Vehicles releases large amount of sulfur oxides and nitrogen oxides. The gas when released can react with other pollutants in the air to form ozone (Lang, Cheng, Zhou, Zhang, & Wang, 2014). On top of that, large amounts of carbon monoxide released by vehicles. Ozone gas can lead to headaches, dizziness, and even death (Lang, Cheng, Zhou, Zhang, & Wang, 2014).

* **Household Sources of Air Pollution**

Burning of fuels like coal, kerosene and wood, is what is referred to as Household sources of air pollution. These sources of air pollution of releases air pollutants like sulfur oxides, carbon monoxide, particulate matter and nitrogen oxides. Particulate matter air pollutant with both (PM 2.5 and PM 10) particles is released from burning of coal, kerosene and wood (Gordon, et al., 2014). Large amount of nitrogen oxides and sulfur oxides are also released by burning of fuels Household. The released gases can easily react with other pollutants in the air to form ozone (Gordon, et al., 2014). Additionally, the process of burning fuels emits large amounts of carbon monoxide, that can lead dizziness, headaches and even death (Gordon, et al., 2014).

* **Agricultural Sources of Air Pollution**

Pesticides, livestock and fertilizer are the Agricultural sources of air pollutants. These type of sources releases the air pollutants like sulfur oxides, carbon monoxide, particulate matter and nitrogen oxides. The air pollutant Particulate matter with both (PM 2.5 and PM 10) particles is released from burning of manure and biomass (Li, et al., 2019) Large amounts of nitrogen oxides and sulfur oxides is also released by Livestock. This gases can react with other pollutants in the air to form ozone gas (Li, et al., 2019). Ozone can lead dizziness, headaches and even death (Li, et al., 2019).

**Levels of air pollution in different settings**

Based on the location where air pollution is taking place and the sources of air pollution, the levels of air pollution will always vary. Generally, sources of air pollution from the industrial areas are the leading levels of polluting the air, vehicle sources of air pollution are the second and thereafter agricultural sources of air pollution. The level of specific air pollutant like nitrogen oxides, sulfur oxides, particulate matter, ozone, and carbon monoxide can be measured by the help of air quality monitoring devices. The World Health Organization has introduced the standards of air quality for these air pollutants. The standards introduced can be used as guidelines to determine the air pollution level in a particular area (Fleischer, et al., 2014).

The Air Quality Guidelines of the World Health Organization recommends that the annual mean concentrations of particulate matter (PM 2.5 and PM 10) should not exceed 10 μg/m3 and 20 μg/m3 respectively (Fleischer, et al., 2014). It is also recommended by Air Quality Guidelines that the annual mean concentration of nitrogen dioxide should not exceed 40 μg/m3 and that the annual mean concentration of sulfur dioxide should not exceed 20 μg/m3 (Fleischer, et al., 2014). To add on that, Air Quality Guidelines recommend that the annual mean concentration of ozone should not exceed 100 μg/m3 and that the annual mean concentration of carbon monoxide should not exceed 10 mg/m3 (Fleischer, et al., 2014).

Altogether, National Ambient Air Quality Standards has been introduced by the United States Environmental Protection Agency for six pollutants which includes sulfur dioxide, ozone, particulate matter (PM 2.5 and PM 10), nitrogen dioxide and carbon monoxide. The National Ambient Air Quality Standards recommends that the annual mean concentrations of PM 2.5 and PM 10 should not exceed 12 μg/m3 and 35 μg/m3 respectively (Fleischer, et al., 2014). The National Ambient Air Quality Standards also recommend that the annual mean concentration of nitrogen dioxide should not exceed 53 μg/m3 and that the annual mean concentration of sulfur dioxide should not exceed 75 μg/m3 (Fleischer, et al., 2014). On top of that, the National Ambient Air Quality Standards recommend that the annual mean concentration of ozone (O3) should not exceed 70 ppb and that the annual mean concentration of carbon monoxide (CO) should not exceed 35 ppm (Fleischer, et al., 2014).

Thus, it is significant to monitor the levels of air pollutants in different settings so as to make sure that the quality of air meets the standards set by the World Health Organization and EPA.

Generally, polluting air is a major health issue in the public. This issue is as a result of both man-made and natural sources which are the most contributors to this problem. The highest levels of air pollutants is from the industrial sources which are considered to release the highest levels of pollutants to the air, vehicle as another major source of air pollution follows as the second, followed by household sources, and then the agricultural sources. We can easily measure the levels of each and every specific air pollutants such as sulfur oxides, ozone, carbon monoxide, particulate matter and nitrogen oxides by the help of air quality monitoring devices. Further, World Health Organization has established standards for the quality of air pollutants. Thus, it is significant to reduce exposure to air pollutants, so as to reduce the risk of health effects.

**Respiratory and cardiac health effects of air pollution across age and gender- relationship**

The pollution of air has become a major health issue affecting the global. This problem is affecting the health of animals, human beings and the environment at large. Human beings, animals when exposed to the air pollutants can have serious effects of their health especially for those humans/animals which have preexisting conditions or in particular they are vulnerable that is (this group of people includes children, pregnant women and the elderly in the society). The pollution of air is linked to various cardiovascular and respiratory health effects. These health effects may vary depending to the age and gender of each and every individual.

* **Respiratory Health Effects of Air Pollution**

The pollution of air has been linked to various respiratory effects of both human and animal health. Some of the health effects includes the risk of asthma, respiratory infections and the chronic obstructive pulmonary disease. For instance, children are specifically vulnerable to the respiratory health effects of air pollution. This is because, the lungs of children are still in development stages and that they take in more air per pound of the weight of their bodies than those of adults which are already developed (Hulin, Simoni, Viegi, & Annesi-Maesano, 2012). On top of that, pollution of air is also linked to an increased risk of asthma in children as exposure to air pollutants can trigger the attacks of asthma and can provoke existing symptoms of asthma (Hulin, Simoni, Viegi, & Annesi-Maesano, 2012). Likewise, adults who have preexisting conditions of respiratory like asthma and chronic obstructive pulmonary disease, are more likely to experience adverse respiratory health effects from polluted air. This is because, when they get exposed to these pollutants, the pollutants can trigger attacks of asthma and can thus provoke the existing symptoms of chronic obstructive pulmonary disease (Hulin, Simoni, Viegi, & Annesi-Maesano, 2012). Further, the pollution of air is linked to an increased risk of infecting the respiratory. This is because humans/animals when exposed to the pollutants of air, their respiratory tract gets irritated and thus, this can weaken the immune system (Hulin, Simoni, Viegi, & Annesi-Maesano, 2012).

* **Cardiovascular Health Effects of Air Pollution**

The pollution of air has also been linked to various health cardiovascular effects, including stroke and including increased risk of heart attack. The elderly in the society are specifically vulnerable to the health cardiovascular effects of air pollution. This is because the elderly bodies are less able to cope with the physiological stress of being exposed to the pollutants of air (Lee, Kim, & Lee, 2014). To add on that, the pollution of air is linked to stroke and increased risk of heart attack in the elderly individuals in the society. This is because when they get exposed to the pollutants of air, this increases the pressure of their blood and thus can irritate the vessels of the blood (Lee, Kim, & Lee, 2014). Likewise, women individuals who are pregnant are more likely to experience adverse cardiovascular health effects from the pollution of air. The reason being when one is exposed to pollutants of air, it can increase the risk of premature birth and also low birth weight (Lee, Kim, & Lee, 2014). On top of that, the air pollution is linked to an increased risk of high blood pressure. This is because an exposition to the pollutants of air can increase the risk of developing hypertension (Lee, Kim, & Lee, 2014).

* **Gender Differences in the Health Effects of Air Pollution**

It is evidence to suggest that there may be differences in gender in the health effects of air pollution. For instance, in a study conducted by (Ko & Hui, 2012), it was found that women were more likely to experience adverse health respiratory effects from the pollution of air such as chronic obstructive pulmonary disease and increased risk of getting asthma than men. Likewise, in another study conducted by (Lee, Kim, & Lee, 2014)it was found out that women were more likely to experience adverse health cardiovascular effects from the pollution of air like stroke and increased risk of heart attack. But, there is need for further research in order to understand better the differences in gender in the health effects of the pollution of air.

In general, the pollution of air is linked to several cardiovascular and respiratory health effects. These effects may vary depending on the age and gender of an individual. It is evidence that children are specifically vulnerable to the respiratory health effects of air pollution as their lungs are still developing and that they take in more air per pound of body weight than adults (Jyethi, 2016). In addition, elderly individuals are particularly vulnerable to the cardiovascular health effects of air pollution, as their bodies are less able to cope with the physiological stress of exposure to air pollutants (Khadka, 2020). Also, pregnant women are also more likely to experience adverse cardiovascular health effects from air pollution, as exposure to air pollutants can increase the risk of preterm birth and low birth weight. There is also evidence to suggest that there may be gender differences in the health effects of air pollution, with women being more likely than men to experience adverse respiratory and cardiovascular health effects from air pollution. Therefore, it is important to reduce exposure to air pollutants, in order to reduce the risk of health effects.

**Factors that influence the susceptibility and vulnerability of different age and gender groups to air pollution**

The pollution of air has become a major health issue affecting the global. This problem is affecting the health of animals, human beings and the environment at large. Exposition to the pollutants of air can have serious effects (Guttikunda, Goel, & Pant, 2014). For instance, those individuals who are particularly vulnerable like the elderly, pregnant women and the children are the most affected individuals. Thus, it is significant to understand the factors that influence the susceptibility and vulnerability of different age and gender groups to air pollution. They are discussed as follows;

* **Genetic Factors**

Genetic factors may have influence on the susceptibility and vulnerability of different age and gender groups to the pollution of air (Hulin, Simoni, Viegi, & Annesi-Maesano, 2012). For instance, development of respiratory diseases like asthma can be influenced by genetic factors. This type of diseases males the individuals more vulnerable to the respiratory effects of air pollution (Hüls, et al., 2020). Likewise, genetic factors may have influence on the development of cardiovascular diseases like hypertension. This type of diseases can make individuals to be more vulnerable to the effects of cardiovascular of air pollution (Hüls, et al., 2020). On top of that, genetic factors may influence the ability of the body to take away the pollutants of air. This is dangerous as it can make individuals more susceptible to the health effects of air pollution (Hüls, et al., 2020).

* **Lifestyle Factors**

Lifestyle factors may also have influence the susceptibility and vulnerability of different age and gender groups to air pollution (Hulin, Simoni, Viegi, & Annesi-Maesano, 2012). For instance, lifestyle factors such as physical activity, diet and smoking may influence the development of cardiovascular and respiratory diseases. This can easily make individuals more vulnerable to the health effects of air pollution (Mady, et al., 2018). On top of that, occupation as a lifestyle factor may influence the way individuals gets exposed to the pollutants of air. This will easily make individuals more susceptible to the health effects of air pollution (Mady, et al., 2018).

* **Environmental Exposures**

Environmental exposures may greatly influence the susceptibility and vulnerability of different age and gender groups to the pollution of air. For instance, climate change and air pollution as environmental exposures like can increase the levels of pollutants of air in the air. This makes individuals more susceptible to the health effects lead by air pollution (Shen, et al., 2014). To add on, other environmental exposures like land pollution, indoor air pollution and water pollution can increase the levels of air pollutants in the air, which can make individuals more vulnerable to the health effects of air pollution (Shen, et al., 2014).

* **Socio-economic Status**

Lastly, Socio-economic status is another factor that influences the susceptibility and vulnerability of individuals to pollution of air. From the many studies conducted, it is evident that individuals from low Socio-economic status backgrounds are more likely to experience adverse health effects from air pollution like stroke, heart attack, chronic obstructive pulmonary disease and increased risk of asthma (Mady, et al., 2018). This may be due to the fact that individuals from low Socio-economic status backgrounds are more likely to live in areas with higher concentrations of the pollutants of air, due to the higher prevalence of industrial and traffic sources of air pollution in these areas (Gordon, et al., 2014).

**Methods and strategies for measuring and monitoring air pollution and health effects**

The pollution of air has become a major health issue affecting the global. The health of animals, human beings and the environment at large have been affected largely (Castell, et al., 2017). Exposition to the pollutants of air can have serious effects. It is important therefore to measure and monitor the levels of the pollutants of air so as to reduce the risk of health effects (Castell, et al., 2017). Various methods and strategies can be used to measure and monitor air pollution and health effects, including air quality monitoring, health surveys, and epidemiological studies.

* **Air Quality Monitoring**

The most common method of monitoring and measuring health effects of air pollution is referred to as Air quality monitoring. This device is used to measure the levels of the pollutants of air like nitrogen oxides, sulfur oxides, ozone, particulate matter (PM 2.5, PM 10) and carbon monoxide in the air (Castell, et al., 2017). Monitoring of air quality is conducted by these air quality monitoring devices which includes air samplers and air monitors. These devices does the measurement of the levels of air pollutants in the air (Castell, et al., 2017). Further, air quality monitoring can be used to find out if the quality of air meets the standards set by the United States Environmental Protection Agency and World Health Organization.

* **Health Surveys**

Another techniques of measuring and monitoring air pollution and health effects is known to be Health surveys. Health surveys are used mostly to measure the prevalence of health problems like cardiovascular and respiratory diseases in different populations (WHO, 2013). The Health surveys are carried out by collecting medical records and other forms of medical data and by interviewing participants about their health and (WHO, 2013). Health surveys can be used to find out if the pollution of air is having an effect on the health of a population. It can also be used to identify vulnerable populations like in children, the pregnant women and the elderly.

* **Epidemiological Studies**

Lastly, there is Epidemiological studies, another method of measuring and monitoring air pollution and health effects (Fleischer, et al., 2014). Epidemiological studies as a method are used to measure the relationship between health outcomes like cardiovascular and respiratory diseases and the pollution of air (West, et al., 2016). Epidemiological studies are carried out by gathering relevant data on the levels of pollution of air and health outcomes and by analyzing the data to find out if there is a link between the two (air pollution and health outcome) (West, et al., 2016). Epidemiological studies can also be used to find out if air pollution is having an effect on the health of a population. This can be used to realize the vulnerable populations, such as pregnant women, children and the elderly.

In general, several techniques and tactics can be used to measure and monitor air pollution and its effect on the health of humans/animals. Some of the techniques that can achieve have been discussed above like health surveys, air quality monitoring and epidemiological studies. Air quality monitoring method is used to measure the levels of pollutants of air in the air. On the other hand, health surveys are used to measure the prevalence of health problems in different populations. Epidemiological studies is another technique whereby, this methods are used to measure the relationship between health outcomes and the air pollution (Fleischer, et al., 2014). Thus, this can be used to realize the populations that are vulnerable. Thus, it is significant to measure and monitor health effects and air pollution, so as to minimize the risk of health effects.

**Overview of the gaps and limitations in the current literature**

The literature on air pollution is extensive and continues to grow as new studies are conducted. Despite this, there remains some gaps and limitations in the current literature. First, there is limited research on the long-term health effects of air pollution. Many studies focus on the short-term health effects, such as respiratory and cardiovascular diseases, but few investigate the long-term effects, such as cancer and neurological diseases. This is concerning, as long-term effects can be more severe and may not be immediately evident. Second, there is a lack of research on the effects of air pollution in different regions and settings. Many studies focus on the effects of air pollution in developed countries, but there is a need for more research in developing countries, where air pollution is often worse due to limited regulations and enforcement. Additionally, there is a lack of research on the combined effects of different pollutants, as most studies focus on the effects of one pollutant at a time.

Furthermore, another limitation of the current literature is the lack of research on the effects of air pollution on vulnerable and marginalized populations, such as children, pregnant women, the elderly, and people with pre-existing conditions. These populations are often more susceptible to the effects of air pollution, yet there is a lack of research on how air pollution specifically affects them. Additionally, there is limited research on how air pollution affects mental health. While there is some research on the physical health effects of air pollution, there is a need for more research on how air pollution affects mental health, such as anxiety and depression.

To sum up, there are some gaps and limitations in the current literature on air pollution. There is a need for more research on the long-term health effects of air pollution, the effects of air pollution in different regions and settings, the combined effects of different pollutants, the effects of air pollution on vulnerable and marginalized populations, and the effects of air pollution on mental health. It is important to fill these gaps in order to better understand the health effects of air pollution and to be better able to address and reduce air pollution.

**References**

Abed Al Ahad, M., Sullivan, F., Demšar, U., Melhem, M., & Kulu, H. (2020). *The effect of air-pollution and weather exposure on mortality and hospital admission and implications for further research: A systematic scoping review. PloS one, 15(10), p.e024141.*

Boubel, R., Vallero, D., & Fox, D. (2013). *Fundamentals of air pollution.* Elsevier.

Castell, N., Dauge, F., S. P., Vogt, M., Lerner, U., Fishbain, B., . . . Bartonova, A. (2017). *Can commercial low-cost sensor platforms contribute to air quality monitoring and exposure estimates?.* (99 ed.). Environment international.

Fleischer, N., Merialdi, M., van Donkelaar, A., Vadillo-Ortega, F., Martin, R., Betran, A., . . . Marie S. O´ Neill. (2014). *Outdoor air pollution, preterm birth, and low birth weight: analysis of the world health organization global survey .*

Gordon, S., Bruce, N., Grigg, J., Hibberd, P., Kurmi, O., Lam, K., . . . Bar-Zeev, N. (2014). *Respiratory risks from household air pollution in low and middle income countries. .* The Lancet R.

Gurevitch, J., & Hedges, L. (2020). *Meta-analysis: combining the results of independent experiments. In Design and analysis of ecological experiments (pp. 378-398). .* Chapman and Hall/CRC.

Guttikunda, S., Goel, R., & Pant, P. (2014). *Nature of air pollution, emission sources, and management in the Indian cities. .* Atmospheric environment.

Hulin, M., Simoni, M., Viegi, G., & Annesi-Maesano, I. (2012). Respiratory health and indoor air pollutants based on quantitative exposure assessments. . *European Respiratory Journal, 40(4),* , pp.1033-1045.

Hüls, A., Vanker, A., Gray, D., Koen, N., MacIsaac, J., Lin, D., . . . Zar, H. (2020). Genetic susceptibility to asthma increases the vulnerability to indoor air pollution. . *European Respiratory Journa*.

Jyethi, D. (2016). *Air Quality: Global and Regional Emissions of Particulate Matter, SOx, and NOx. Plant Responses to Air Pollution, pp.5-19.*

Khadka, Y. (2020). *Carbon Compounds: Pollution Aspects.* (6 ed.). Patan Pragya.

Kim, H., Choi, M., Park, M., & Seo, Y. (2017). Predictive and prognostic biomarkers of respiratory diseases due to particulate matter exposure. . *Journal of cancer prevention, 22(1),* , p.6.

Ko, F., & Hui, D. (2012). *Air pollution and chronic obstructive pulmonary disease.* (17(3) ed.). Respirology.

Lang, J., Cheng, S., Zhou, Y., Zhang, Y., & Wang, G. (2014). *Air pollutant emissions from on-road vehicles in China, 1999–2011. .* Science of the Total Environment.

Lee, B., Kim, B., & Lee, K. (2014). *Air pollution exposure and cardiovascular disease.* (30 ed.). Toxicological research.

Li, R., Chen, W., Xiu, A., Zhao, H., Zhang, X., Zhang, S., & Tong, D. (2019). *A comprehensive inventory of agricultural atmospheric particulate matters (PM10 and PM2. 5) and gaseous pollutants (VOCs, SO2, NH3, CO, NOx and HC) emissions in China. Ecologi.*

Mady, L., Schwarzbach, H., Moore, J., Boudreau, R., Willson, T., & Lee, S. (2018). *Air pollutants may be environmental risk factors in chronic rhinosinusitis disease progression. .* In International Forum of Allergy & Rhinology.

Manisalidis, I., & Stavropoulou, E. (2020). *Environmental and health impacts of air pollution: a review.* Frontiers in public health,.

Manisalidis, I., Stavropoulou, E., Stavropoulos, A., & Bezirtzoglou, E. (2020). *Environmental and health impacts of air pollution: a review.* Frontiers in public health.

Ongar, B., Iliev, I., Nikolić, V., & Milašinović, A. (2018). *THE STUDY AND THE MECHANISM OF NITROGEN OXIDES’FORMATION IN COMBUSTION OF FOSSIL FUELS. Facta Universitatis, Series: Mechanical Engineering, 16(2), pp.273-283.*

Rokni, E., Panahi, A., Ren, X., & Levendis, Y. (2016). Reduction of sulfur dioxide emissions by burning coal blends. . *Journal of Energy Resources Technology, 138(3),* , p.032204.

Shen, H., Tao, S., Liu, J., Huang, Y., Chen, H., Li, W., . . . Xu, Y. (2014). *Global lung cancer risk from PAH exposure highly depends on emission sources and individual susceptibility.* (4(1) ed.). Scientific reports.

Takeshima, N., Sozu, T., Tajika, A., Ogawa, Y., Hayasaka, Y., & Furukawa, T. (2014). *Which is more generalizable, powerful and interpretable in meta-analyses, mean difference or standardized mean difference?. BMC medical research methodology, 14(1), pp.*

West, J., Cohen, A., Dentener, F., Brunekreef, B., Zhu, T., Armstrong, B., . . . Dockery, D. (2016). *What we breathe impacts our health: improving understanding of the link between air pollution and hea.*

WHO. (2013). *Oral health surveys: basic methods. World Health Organization.*