

**RESPONDENT'S AWARENESS ON VARIOUS HEALTH IMPACTS OF EXPOSURE TO
AIR POLLUTION IN OSLO, NORWAY**

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ABSTRACT

While there are significant findings on air pollution in Oslo and its subsequent health impacts, not study has been conducted on the residents' awareness of this problem. The purpose of this study is to establish the Oslo residents' awareness of impacts of exposure to air pollution on the health of Oslo. Air pollution remains a major world problem with significant health and environmental issues. In Oslo, Norway, the health of Norwegian population remains at risk because outdoor air pollution, which is significantly related to aggravated illnesses. The objectives of this paper are (1) to determine the main sources of air pollution in Oslo (2) to determine main health impacts of air pollution in Oslo (3) to determine the Oslo resident's awareness of health impacts of air pollution, and (4) to determine possible mitigation measures against air pollution in Oslo. This study adopted a positivism research philosophy, where the researcher considered adopting deductive research strategy. The survey targeted 500,000 residents living in Oslo, using a sample size of 400 respondents. Close-ended questionnaires were disseminated to research participants, with only 300 successfully done. The study shows that 69.3% of Oslo residents are aware of air pollution problem. Air pollution resulted from transportation (68.3% of respondents) and biomass burning (31.7% of respondents). Furthermore, the residents maintained that air pollution mainly caused allergies (48%) and respiratory health issues (20.3%). They suggested the use of public policy, reduction of fossil fuel combustion, and individual action as the main strategies for mitigation the problem in the city. The study shows that Oslo residents are aware of the problem, sources, health impacts, and mitigation measures of air pollution in their city. Numerous agencies have participated in spreading information about air pollution. In urban areas, many people own cars, which influenced the perception that transportation was the main cause of air pollution in the city. Apparently, allergens are the main cause of respiratory diseases. To improve air quality in the city, their need to be public awareness, policy enforcement, collaboration, and use of communication technology. In conclusion, further study is needed to understand the effectiveness of modern reporting methods and the impact of key variables such as education and SES

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1.0 INTRODUCTION

1.1 Background of the study

Air pollution, like other forms of pollution (water, noise, land, and light) remains a major world problem with significant health and environmental issues. Various studies across countries have associated it with high mortality rates (Kelly & Fussell, 2015), physical and psychological health problems (Rajper, Ullah, & Li, 2018), and climate change (Wen et al., 2009). Air pollution comprises of different affluences, depending with the source. They include, but are not limited to particulate matter, nitrogen (IV) oxide, carbon (II) oxide, metals, polycyclic aromatic hydrocarbons, sulfur (IV) oxide, and volatile organic compounds (Anderson et al., 2004). Even so, air pollution levels and impacts vary with jurisdiction. For instance, in Western countries, such as America, Europe, and Australia, studies have revealed lower levels of pollution and subsequent health impact (Anderson et al., 2004). Meanwhile, in Eastern and developed countries in various parts of the world, air pollution and its subsequent impact remains extravagantly high (Rajper, Ullah, & Li, 2018; Zhao et al., 2015).

1.2 Air Pollution in Oslo, Norway

Norway's capital Oslo, is the largest city in the country. By 2018, the metropolitan hosted more than 500,000 residents, but the entire Oslo fjord region had a population of approximately 1.7 million (Mapes, 2018). It has a well-established transportation system, which is apparently, a major source of air pollution in Norway. In 2014, the European Free Trade Association's Surveillance Authority (ESA) pointed that Norway has been infringing on the EU air quality directives (Stranden, 2014). According to Stranden (2014), the country was in the verge of litigations at the institution's court as its particulate matter and nitrogen dioxide emissions, especially in its larger cities, exceeded the limits established by the organ since 2009. Accordingly, Norway filed to delay the goal achievement until 2015. It is however, imperative to state that levels of particulate 2.5 (Appendix 1), particulate matter 10 (Appendix 2), and nitrogen (IV) oxide (Appendix 3) in Oslo have been on the downward trend since 2003.

1.3 Problem Statement

Though there is significant research on air pollution, there is no empirical study that has been conducted on Oslo residents' awareness of air pollution and its sources and health impacts. More so, no study has been conducted to assess the residents' suggestions on mitigation measures against air pollution. The Institute of Transport Economics and the Norwegian Institute of Air

Research calculated that nitrogen (IV) oxide emissions in Oslo would continue until 2025 (Stranden, 2014). Apparently, Oslo has failed to reach the deadline because the process of transforming its systems is likely to take a long time. While the metropolitan region continues to emit toxic pollutants in the atmosphere, the health of Norwegian population remains at risk. This is because outdoor air pollution is significantly related to aggravated illnesses (World Health Organization, 2006). Furthermore, according to the Norwegian Institute of Public Health (2016), fine fraction PM_{2.5} can be linked to approximately 185 deaths. Meanwhile, 115 deaths in Norway can be traced from fine fraction PM₁₀ (NIPH, 2016). NIPH (2016), adds that the total burden of disease, including premature death and severe health issues in Oslo attributed to particulate matter (PM_{2.5}) is estimated at more than 2,600. Clinical and population studies have also established that brief exposure to nitrogen (IV) oxide and ground-level ozone have contributed to health issues in Norway (Forouzanfar et al., 2016; NIPH, 2013). This demonstrates that prolonged exposure to air pollution until 2025 is likely to have significant health impact on Oslo population. Even so, it is imperative to understand whether Oslo residents are aware about these findings, and subsequently suggest appropriate mitigation measures against air pollution.

1.4 Purpose of Study

The purpose of this study is to establish the Oslo residents' awareness of impacts of exposure to air pollution on the health of Oslo.

1.5 Research Objectives

- To determine the Oslo resident's awareness of health impacts of air pollution
- To determine the main sources of air pollution in Oslo
- To determine main health impacts of air pollution in Oslo
- To determine possible mitigation measures against air pollution in Oslo

1.6 Research Questions

- Are Oslo resident's aware of health impacts of air pollution?
- What are the main sources of air pollution in Oslo?
- What are the main health impacts of air pollution in Oslo?
- What are the possible mitigation measures against air pollution in Oslo?

1.7 Significance of the Study

The findings of this study informs individual, as well as corporate, and government institutions to comprehend the sources of air pollution and the impact air pollution has on health,

and encourage them to adopt efficacious mitigation measures to promote a healthy Oslo (and Norwegian) population. Individual Oslo residents would benefit from this study would change their behavior in light of air pollution. Meanwhile, corporations and governments would not only change their behavior but also implement policies to curtail air pollution in Norway.

1.8 Limitations and Delimitation of the Study

The study was constrained by time and money. Even so, the researcher used available resources to achieve the project objectives. In addition, some respondents could fail to respond to the questionnaires, but the researcher ensured the research participants understood that the research is solely for academic purposes. Meanwhile, the study will center on three main objectives. It will target both male and female respondents above the age of 18 years old. The focus of the study will be in Oslo.

2.0 LITERATURE REVIEW

2.1 Introduction

This chapter presents what previous studies have established on the subject matter. It contains information on the relevant empirical and theoretical literature reviewed that demonstrates the relationship between the variables.

2.2 The main sources of air pollution

2.2.1 Transportation

Significant studies have shown that transportation is the main cause of air pollution in urban areas. In France (Paris), road transport was determined as the main source of particulate matter (36 percent), carbon (II) oxide (77 percent), and nitrogen (IV) oxide (52 percent) (Ferreira et al., 2013). Meanwhile, the NIPH (2013), report established that road traffic comprised of high levels of particulate matter and nitrogen (IV) oxide, especially in densely populated towns in Norway. Stranden (2014), noted that privately owned cars comprising of 70 percent of Oslo's traffic spew toxic gasses from their diesel and petrol engines, contributing to high air pollution in the city. Even so, more than 70 percent of nitrogen (IV) oxide emissions are derived from heavy cargo trucks as well as delivery vans compared to the lighter privately owned vehicles (Stranden, 2014). According to NIPH (2013), the maximum hourly value of nitrogen (IV) oxide in Oslo exceeded 200 micrograms, and was likely to increase by seven folds per annum.

2.2.2 Biomass Burning

Over the years, Europe has experienced increased largescale burning of biomass through wildfires, which is a vital contributor of air pollution in the northern hemisphere (Ferreira et al., 2013). For instance, the NIPH (2013), report established that wood burning contributed to high emission of particulate matter in Oslo. In 2011, the Nordic Council of Ministers initiated a research to elaborate on the effect of burning of biomass in Eastern Europe in terms of the disposition of nitrogen to the northern ecosystem (Karlsson et al., 2013). According to Karlsson et al. (2013), wildfires resulted from poor agricultural practices such as burning of arson. Similar results were also established by the Joint Research Center (2007), where 60 percent of fires were linked to burning of crop remnants. Meanwhile, in terms of unintentional fires, not only poor agricultural practices but also management issues have been linked to biomass burning. For instance, in 2016, two transmission towers caught fire in the forested north of Romsås (The Local, 2016). The Local (2016), reported that as a result of the dry forest floor and boisterous winds, the two fires occupied

approximately 300 square meters, and going further into the woods. Unfortunately, the Oslo Fire Brigade spokesperson expressed that they took a lot of time to get their hoses into the wooded area and begin to extinguish the fire, demonstrating a significant lapse in forest fire management (The Local, 2016).

2.3 The main health impacts of air pollution

Indeed, air pollution remains a major health concern for millions of people globally. The World Health Organization (2006) supports this observation by estimating that at least 2.4 million deaths result from air pollution. Apparently, this form of pollution has significant health impacts, most of which contribute to those deaths.

2.3.1 Respiratory health issues

Pollutants go through the airways, which may lead to lung diseases. Task Group on Lung Dynamics (1966) demonstrated that particulate matter is deposited into the extrathoracic (PM > 10 μm in diameter), tracheobronchial (PM of 5-10 μm in diameter), or the alveolar (PM <2.5 μm in diameter) regions. While the fraction for PM of 3-5 μm in diameter is deposited more in women than men, with Kim & Hu (2006) noting that the greatest impact on respiratory health results from the particles deposited in the tracheobronchial and alveolar. Meanwhile, toxicological studies have shown that indoor activities, such as cooking, cleaning, and movement of people contribute in the generation of particles that affect the health of the household members. According to Ozkakynak et al (1996), cooking contributes to at least 4.1 ± 1.6 mg/min of particulate matter (PM₁₀), besides 40 percent of the fine fraction. Upon entry into the body, particulate matter affects various body organs. For instance, exposure to ozone reduces the functions of vital organs such as the lungs; this may lead to airway infections, such as asthma, COPD, and inflammations (Forouzanfar, 2016). Forouzanfar (2016) maintains that the most vulnerable groups include children who have underdeveloped respiratory tracts. Furthermore, exposure to nitrogen (IV) oxide not only reduces lung function but also exacerbates asthma and bronchitis (Forouzanfar, 2016).

2.3.2 Allergies

Allergic diseases such as allergic rhinitis and asthma have been reported as common in children and young adults that results from exposure to air pollution. For the most part, asthma as an allergic infection is related with enhanced synthesis of immunoglobulin E against various allergens (Nielsen et al., 2002). According to Muranaka et al (1986), exhaust from diesel contains pollutants as well as polycyclic aromatic carbons; these elements increase allergenicity including

asthma symptoms by working in synergy with allergens. In the experimental study, the author demonstrated that diesel exhaust particles operate as adjuvant for the production of immunoglobulin E as a response to specific allergens (Muranaka et al., 1986). In addition, when an individual inhales diesel exhaust particles, a typical asthma phenotype is formed, which involves pulmonary inflammations alongside airway hyper-responsiveness (Inoue K & Takano, 2011). Singer et al (2005) furthermore demonstrates that high concentration of carbon (IV) oxide increases the production of pollen (such as ragweed pollen) as well as the allergenicity of pollen. Similarly, traffic pollutants, such as nitrogen (IV) oxide and ozone have triggered high concentration of airborne pollen allergens, which have affected Dutch school going children (Parker et al., 2009) and US children residing in urban areas (Jansen et al., 2003). A cohort birth study conducted by Morgenstern et al. (2008), revealed that children exposed to ambient particulate matter had a high chance of developing atopic diseases.

2.3.3 Intestinal health

Some studies have found a relationship between air pollution and intestinal diseases. For instance, Garcia-Perez et al (2010) and Mills et al. (1991) demonstrated that digestive tract cancer was associated with exposure to air pollutants. Another recent study in Canada demonstrated that exposure to ozone, nitrogen (IV) oxide, and particulate matter contributed to increased tumor necrosis factor and increased pro-inflammatory cytokines, which could activate appendicitis (Kaplan et al., 2009). Meanwhile, in Italy, Orazzo et al (2009), investigated the association between air pollution and the number of visits in emergency rooms for people with wheezing, diarrhea, and vomiting episodes in six health care facilities. The results showed that exposure to carbon (II) oxide during winter was unassertively associated with enteric disease, even though the other pollutants failed to reach significance (Orazzo et al., 2009) as there was no relationship between intestinal disorders and air pollution (Lipsett et al., 1997). Apparently, these studies demonstrate that air pollution mainly affected young children and the young adults compared to older adults. For instance, exposure to carbon (II) oxide resulted in more emergency room visits for enteric infections among children (Orazzo et al., 2009), Crohn disease among <23 years olds, and ulcerative colitis among <25 years olds (Kaplan et al., 2010) than in adults (Lipsett et al., 1997).

2.3.4 Psychological health

Air pollution is also associated with negative psychological health. According to Guéguen and Jacob (2014), positive psychological and mental health alongside appropriate behavior result from suitable, clean, and comfortable environment and weather conditions. On the other hand, Calderon-Garciduenas et al. (2015), assert that unhealthy environments adversely affect behavior and mental health, leading to abnormalities. Mabahwi et al. (2014), pointed that polluted air aggravates depression and stress, and more so, alters behavior. In their study, Sahari et al. (2012), established that poor atmospheric conditions in human surrounding had a significant impact on stress. Brealey (2002), further noted that stress was not only contagious but also responded to physical and emotional pressure. Łopuszańska and Makara-Studzińska (2017) comprehensively studied depression and found it was highly associated with air pollution. Other researchers have also explored different stressor that could trigger human behavioral changes. For instance, Brealey (2002), found that among other thing, the job nature and local weather affected the behavior of people. More specifically, Torres and Casey (2017), established that mental health was affected by climate change as a result of air pollution.

2.4 Awareness of health impacts of air pollution on health

The European Commission (2013), points that a substantial number of urban residents inhale air that fails to meet the European standard as well as the WHO's Air Quality Guidelines. According to Bell et al. (2004), studies have demonstrated the great impact of particulate matter on health. Studies assessing public awareness and understanding of the matter, however, have produced mixed results. Some acknowledge that the people are significantly concerned with poor air quality (Department for Environment, Food and Rural Affairs, 2002), aware of air quality warnings (Wen et al. 2009), and more so, taken action to modify their indoor activities as a result of such warnings (McDermott et al. 2006). Neidell and Kinney (2010) examined the impact of air quality as a result of ground ozone on public attendance to outdoor facilities. The authors submitted that ambient air quality results from national and regional monitors may influence people to limit their exposure to poor air quality areas. In another study, Bell et al. (2004), pointed that people deliberately avoided spending time outside when they realized the considerable mortality impact of ozone. Studies by Bickerstaff and Walker (2001) and Semenza et al. (2008), further concluded that public awareness about the link between air pollution and diseases was limited, and that information on air quality was lacking amongst the public. Most recently, in 2013, the European

Commission (2013), embarked on understanding the public view on the matter of air quality and pollution. Surprisingly, 60 percent of the Europeans who participated in the flash Eurobarometer maintained that they felt less informed about air quality concerns in their respective countries (EC, 2013). Even so, they – 87 percent, 92 percent, and 87 percent – felt that air quality was a serious issue for respiratory disorders, CDV diseases, and asthma/allergy, respectively (EC, 2013).

Research has also shown that people are barely interested in the subject matter, especially among the ‘healthy people’ (who do not have any illnesses related to air pollution) (McDermott et al. 2006), and as a result of increasing medication for those illnesses (Wen et al. 2009). According to Kelly et al. (2012), many countries have established air quality networks and infrastructure to report air quality and most importantly, model predictions. In Wen et al. (2009), study, 31 percent of people with asthma changed their outdoor activities as a result of media alerts on poor air quality, while only 16 percent of people without asthma modified their outdoor activities. What is more, Shooter and Brimblecombe (2009) discovered that public perception significantly influenced their understanding of the need for healthy air, for attitudes and behavior are swayed by individual’s immediate locality and understanding, rather than the accurate statistics derived from monitoring agencies, which are communicated via advisory services. Other studies, such as Rotko et al (2002), have found little or no relationship between perceived air qualities and measured outdoor air quality. At least, Semenza et al. (2008) found that at some (10-15 percent) level of behavioral change occurred as a result of an air pollution episode, but that was mainly as a result of individual perception of poor air quality and its subsequent health impact rather than the advisory services. Some epidemiological scholars, such as Yen et al (2006) and Piro et al. (2008), have further pointed that self-reported health status was related to individual perceived air pollution rather than monitored air pollution.

2.5 The possible mitigation measures

Increasingly, studies have identified that strategies to curtail air pollution have substantial benefits for health. For instance, the Environmental Protection Agency suggested that implementing measures to curtail diesel exhaust could reduce mortalities by 12,000, prevent 15,000 cardiac arrests, and avert 8,900 hospital admissions annually in the US (EPA, 2013).

2.5.1 Biomass burning reduction

The burning of arson continues to be rampant because using agricultural waste remains a major problem in the world. In addition, there are limited viable business models to harvest,

transport, and store crop remnants (Brealey, 2002). At the international level, various approaches have been used to utilize agricultural waste as alternatives to burning those wastes, but in a country like Russia, weak economic state of agriculture as an enterprise makes it less important for people to apply these practices (Anderson et al., 2004). As a result, Andersen et al. (2004) notes, Russia can barely utilize more than 50 percent of the agricultural waste it produces per annum. Subsequently, the only economically appropriate means of utilizing arson and other agricultural waste is via burning. To mitigate the problem, governments in the European Union provide subsidies per hectare of agricultural land to promote positive agricultural waste utilization (EU, 2013). In addition, vast structures for sharing agricultural knowledge and enhancing the capacity to support other waste management strategies can significantly reduce arson burning practices (Brealey, 2002). For instance, Brealey (2002), pointed that crop residue can be embedded into the soil through ploughing under, and low or zero soil tilling; burning of arson in boilers to harness the subsequent heat energy; processing of arson to produce biocoal; and so on. Even so, these methods require significant additional investment by agricultural enterprises that adds to the already expensive soil treatment, fertilizer, and fuel (Andersen et al., 2004). Thus, it is imperative for the government to establish and promote financial consultation services for farmers, as well as manufacturing of boilers to assist with the implementation of arson waste management alternatives.

2.5.2 Reducing Fossil Fuel Combustion

As a result of the increased knowledge about the impact of air pollution on health, the Norwegian Environmental Agency alongside the NIPH have established a set of stringent measures to ensure air quality. Forouzanfar et al. (2016), however, points that it remains impossible to assess the appropriate criteria for all particulate matter, but these can be revised regularly to ascertain air quality. To curtail the production of particulate matter and nitrogen that enhance outdoor air pollution, measures on road traffic, as well as industrial emissions, must be increased. This can further be enhanced by stricter international agreements to curtail the emission of nitrous oxides and volatile organic compounds with health-based targets (Norwegian Environmental Agency, 2014). Intensified measures to promote the replacement of old heaters, limit car exhausts, and replace fossil fuel vehicles can be promising (NIPH, 2013). It will also be imperative to follow-up on the Parma Declaration on Environment and Health and the Gothenburg Protocol to guarantee good air quality and curtail exposure to hazardous pollutants. Other measures

for reducing include the adoption of efficient use of fossil fuel in industrial processes and generation of electricity. EC (2013) further proposed transforming the transport system. For instance, in the UK, taxis older than 15 years are not allowed in the London streets, and this applies to private hire vehicles, which are older than 10 years (EC, 2013). Bicycle superhighways have also been built in Netherlands and Germany, for instance, to further curtail diesel exhaust from vehicles (EC, 2013). In Norway, the public has taken the initiative to purchase electric vehicles as a means of reducing air pollution. According to Stranden (2014), between 2012 and 2013, the number of electronic vehicles increased from 8,000 EVs to 18,000 EVs. Currently, however, less than one percent of vehicles in Norway are electric compared to 44 percent of diesel powered vehicles (Stranden, 2014). Subsequently, Stranden (2014), concluded that at that rate, achieving air quality in the country will take a long time.

2.5.3 Public Policy and individual action

Reducing air pollution requires public participation to encourage people to switch to more energy efficient solutions. For instance, the government of Mexico introduced measures such as a law to curtail the emission of carbon (IV) oxide by 30 percent by 2020 and by 50 percent in 2050 (Vance, 2012). In addition, authorities in Monterrey developed a seven megawatt power plant to convert more than 200 million cubic meters of landfill gas into electricity to power the city's light rail transit system and for night lighting (Vance, 2012). Additional initiatives include urban planning. For instance in London, taxis older than 15 years are not allowed in the streets, and this applies to private hire vehicles, which are older than 10 years (EU, 2013). In addition, the UK introduced the use of hybrid buses in London. Meanwhile, in Norway, the government is using incentives and environmentally differentiated taxes imposed on commercial and heavy cargo transport (Stranden, 2014).

Urban forests and green roofing are additional strategies for curtailing air pollution in urban areas (Escobedo et al., 2011). According to Smith et al. (2011), vegetation eliminate pollutants by intercepting particulate matter through the leaves, and breaking down polycyclic aromatic carbons and other organic compounds. What is more, transpiration cooling contributes in temperature reduction through photochemical reactions that transform ozone and other air pollutants (Smith et al., 2011). Nowak et al. (2006), approximate that annually, trees eliminate more than 710,000 metric tons of carbon (II) oxide, nitrogen (IV) oxide, ozone, particulate matter, and sulfur (IV) oxide in the US, despite many urban areas having limited space for tree planting and vegetation.

For instance, in the mid-Manhattan, 94 percent of the land is concrete (Rosenzweig et al., 2006). Even so, rooftops provide better opportunities for growing vegetation as 2,000 square meters of rooftop grass can eliminate approximately 4,000 kilograms of particulate matter (Johnston et al., 2004).

At the individual and corporate level, people can seek to enhance their health by avoiding busy roadways to reduce their exposure to pollutants and improve ventilation at home (Johnston et al., 2004). Additional public policy and communication could encourage the masses to adopt biofuels and renewable energy sources use to further reduce emissions. Such initiatives have demonstrated significant impact on human health. According to Zhao et al. (2015), respiratory health diseases substantially reduced in China as a result of using renewable energy sources during the Beijing Olympics. Pope et al. (2009), study of 51 American cities established that reduction of particulate matter in those cities between the years 1980 and 2000 contributed to increased life expectancy. An earlier study conducted in Switzerland on air pollution and lung diseases among adults in eight communities demonstrated that between the years 1991 and 2002, a reduction of particulate matter contributed to improved lung function (Downs et al., 2007). Similarly, Schindler et al. (2009), noted fewer reports on coughs (regular and chronic), breathlessness, and wheezing as a result of particulate matter reduction. Another study in Switzerland followed up on children in nine communities between the years 1992 and 2001. The study demonstrated a reduction of bronchitis, chronic cough, and nocturnal dry cough, common cold, and conjunctivitis symptoms in children as a result of declining particulate matter concentration (Bayer-Oglesby et al. 2005). These results strongly support the positive impact of reducing air pollution on health. With recent technological advances, personal pollution monitoring can significantly improve. According to Austen (2015), affordable, portable, and easy to use apps and devices (smartphones and laptops) can be used to disseminate information on air quality, allowing people to act promptly. This data can be derived from official monitoring network, which generate their data from satellite. The data is often dynamic as it measures time activity patterns in light of exposure (Nwokor et al., 2012). Different entities, such as the government, media, and companies can also take part in promoting community awareness on the impacts of air pollution (Anderson et al., 2004).

3.0 THEORETICAL FRAMEWORK

3.1 Cognitive Dissonance and Perceptions

The theory of cognitive dissonance was developed by Festinger (1957) based on a review of various studies that asserted that humans barely tolerate prolonged inconsistencies between their behaviors and beliefs. With such inconsistencies, strain (or otherwise, dissonance, is created. This in turn affects an individual's perception that make him or her to either perceive or misperceive different facets of a problem in a situation (Festinger, 1957). People tend to be intolerant for cognitive inconsistency, which leads them to misrepresent their perception of reality as a way of maintaining their cognitive organization (Andrews et al., 2004). By adopting this line of reasoning, Andrews et al. (2004), assert that people, by choice, would feel experience some dissonance when they pollute the environment, and feel the need to justify their actions when subjected on a morality test. Because modifying his behavior (for instance, purchasing a new car or investing in new methods of burning arson, both of which are expensive) would present some form of hardship, their alternative would be consider the situation less serious. This limits them to take appropriate actions towards mitigating air pollution (Andrews et al., 2004). Based on this theoretical model, the present study can demonstrate that Oslo residents choose to pollute their environment regardless of the health impact it has on them. They tend to perceive the issue of pollution differently based on their socioeconomic position, and other intervening variables, such as age, sex, and education level.

4.0 METHODOLOGY

4.1 Introduction

This chapter presents what previous studies have established. It contains information on the relevant empirical and theoretical literature reviewed demonstrates the relationship between the variables.

4.2 Research Design

According to Smith (2010), a research design entails a plan structure and strategy used for investigation to respond to research questions. That is, the plan is a comprehensive scheme or program of research. Research design comprises of an organization of the steps the researcher undertakes from writing the hypothesis and how to operationalize their inferences during data analysis. Owing to the fact that this study adopts a positivism research philosophy, the researcher considers adopting deductive research strategy.

When undertaking deductive research reasoning, the researcher will develop a research hypothesis. The hypotheses will be either approved or discarded. For this study, the researcher will use a deductive research approach to evaluate the validity of the impacts of, awareness of, and mitigation of air pollution, which are the focus in this study. More so, this approach will be used to test the research hypotheses.

Following a critical review of research approaches, the researcher concluded not to use an inductive reasoning approach. The researcher discarded this approach mainly because inductive reasoning focuses on theory development. However, there are significant theories already in place. As such, the focus of this study is to test the existing theories, alongside the hypotheses formulated. Based on the research objectives, the researcher believes that exploring events, creating new themes, and establishing an alternative conceptual framework deviates from responding to the research questions.

To arrive at logical conclusions, there is need for an efficacious research strategy for this study. As such, the most appropriate approach will be a survey, where the research respondents answer well-structured questionnaires. The researcher will consolidate the information on the participants' practices and views. Consequently, the researcher intends to adopt an explanatory research strategy to address the research objectives. Smith (2010), describes an explanatory research as an approach for establishing the degree and value of a cause-effect relationship.

According to Smith (2010), researchers take up this form of research as a method for evaluating the impact of processes and norms on an event.

Apparently, this research strategy is different from descriptive and exploratory research strategies. A descriptive research strategy will not be considered because it compels the researcher to engage in classifying, clarifying, or creating phenomenon, without controlling the study variables (Ross, 2012). Furthermore, an exploratory research, the researcher will be required to predominantly explore the research objectives and questions without arriving at conclusive evidence. Descriptive and exploratory research strategies are partially defined and highly ambiguous, respectively, in terms of their level of uncertainty exemplifying decision situations.

What is more, the selected research approach (deductive research reasoning) compels the researcher to consider an explanatory research strategy. This facilitates the confirmation or rejection of formulated hypothesis (H_1 , H_2 , and H_3). In the event that the main focus of this study was the research questions, ideally, the researcher would have adopted either a descriptive or an exploratory research strategies. Furthermore, the researcher is planning for a highly structured strategy, which an explanatory research is capable of providing (Miles & Gilbert, 2005). Even so, the adopted research strategy has both advantages and disadvantages. These, the researcher anticipate.

According to Fischer (2006), explanatory research used to find the cause behind a process. Furthermore, an explanatory research strategy allows researchers to estimate the impact of altering norms and processes on events. For this study, this merit will be vital as it will allow the researcher to not only explore the research objectives but also authenticate the formulated hypotheses. Additionally, the researcher deliberated on an explanatory research strategy because of its high degree of internal validity. Fischer (2006) explains that the research strategy facilitates systematic selection of study respondents. This is reflected in the strategy's internal validity. For one thing, it is imperative that this study must be valid. To achieve that, all procedures must be clearly assessed in terms of what they are required to measure. Smith (2010), argues that when a study fails to have internal validity, the subsequent findings will be invalid.

The main disadvantage of explanatory research is dealing with coincidences that emerge during research. In that scenario, through an explanatory research strategy, the researcher is likely to have problems arriving at suitable deductions. This happens because social, economic, political and environmental factors might tamper with the anticipated results. In the event that the researcher

fails to effectively identify correlations between variable, establishing the actual outcome of the variables will be impossible.

4.3 Target Population

For this study, the researcher targets 500,000 residents living in Oslo (Appendix 1). Based on the study scope, this study will focus on respondents who are 18 years old and above and have lived in Oslo for at least 4 years. The researcher will target this group of respondents for consent reasons. More so, considering the incubation period of respiratory diseases is within days to weeks, 4 years will be an invaluable period to assess both parents and their children. In addition, the researcher also intends to include health care providers, and policymakers in the study. This will ensure that the study is rich in terms of the data collected during survey.

4.4 Sample Size and Sampling Procedure

This section deals with the sample size and the sampling procedure adopted for this study.

4.4.1 Sample size

To establish the sample size, the researcher will use Yamane's formula.

$$n = \frac{N}{1 + N(me)^2}$$

Since the population of Oslo is approximately 500000, the at least 65 percent of the population are between the age of 15 and 64 years old. That means, approximately 325000 people are adults qualify to take part in this study. In Yamane's formula, the sample size required is represented by n while N is the target population with the trait required, which in this case is approximately 300000. Meanwhile, me is the margin of error. The margin of error is 5 percent. As such, based on these approximation and using Yamane's formula:

$$n = \frac{300000}{1 + 300000(0.05)^2} = 400$$

Thus, the sample size for this study is 400 respondents. Even so, considering inclusion and exclusion criteria, the sample will be approximately.

4.4.2 Sampling procedure

In this study, the researcher will use random sampling procedure. This is one of the most straightforward and purest probability sampling strategies popularly used to select respondents in from a large population. According to Kothari (2005), with simple random sampling, it is highly

likely that each member of the target population has an equal chance to be selected. Respondents will include students and employees of my school, and leaders from The Institute of Transport Economics, the Norwegian Institute of Air Research, and the Norwegian Institute of Public Health.

4.5 Data Collection Instruments

For this study, primary data will be collected using questionnaires (Appendix 5). The research respondents will respond to questionnaires administered via online, via survey monkey that was designed in the simplest way in order to ensure user friendly aspect. Conducting online survey is easy as it provides the research participants an ample time to respond to the questionnaires. However, some respondents might either ignore or altogether fail to answer and/or send the questionnaire back to the researcher. What is more, some respondents might skip some questions, deeming the questionnaires invalid.

4.6 Pilot testing of the instruments

Pilot testing involves finding out whether the survey and key informant interview guide will work when the researcher goes to the field by trying it out first on a few people (Gakuu, 2018). As such, for this study, the researcher administered 10 questionnaires to classmates the same way and under similar conditions as they plan to do for actual data collection. The researcher paid attention to instances when respondents hesitated to answer or ask for clarification, as this was an indication that questions or answers were too vague, difficult to understand or had more than one meaning. Accordingly, the researcher noted where these occurred. After the respondents finished the survey, the researcher explained that proceeded to ask how the respondents understood each question and response choice. The research went over the survey again, and for each question, had the respondent state what they thought was being asked. Based on the researcher's observations, the researcher inquired about instances when the person hesitated or needed clarification. This ensured that everyone in the sample not only understood the questions, but also understood them in the same way.

4.7 Reliability and Validity of the instruments

Reliability refers to the degree to which an instrument yields consistent results (Smith, 2010). According to Smith (2010), common measures of reliability include internal consistency, test-retest, and inter-rater reliabilities, which will be used in this study. Meanwhile, validity is the extent to which an instrument measures what it is supposed to measure and performs as it is designed to perform (Gakuu, 2018). There are numerous statistical tests and measures to assess

the validity of quantitative instruments, and for this study, it involved pilot testing. This ensured the researcher modified, developed, and interpreted the content in light of the study variables.

The pilot study was done to identify elements of study population and unit of analysis. During the study, draft questions were pre tested to remove ambiguity and achieve high degree precision. On the other hand, questions, which were not yielding the required data were altogether discarded. All the units of analysis were comprehensively studied and whole population taken into account. Before the questionnaires were administered, they actively underwent pretesting with ten respondents to confirm validity and reliability of the research instrument and more so, ascertain whether the target population would be able to comprehend and give information needed by the researcher.

4.8 Data Collection Procedures

The researcher collected primary data to complete this project using well structured questionnaires via a survey. To access the respondents to respond to the questionnaire, the researcher obtained the email addresses of students and employees of the researcher's school, and leaders from The Institute of Transport Economics, the Norwegian Institute of Air Research, and the Norwegian Institute of Public Health. Accordingly, an email survey was conducted.

The survey was mainly comprised of quantitative questions, such as Boolean's yes/ no and the Likert scale. Structured questionnaires were used since their questioning and layout are fixed hence the content of questions and the order of the questions cannot be changed. The questionnaires were designed with close ended questions, which were clear and straightforward. Closed ended were used to ensure that the given answers would be relevant.

A survey was conducted using email questionnaires because it allowed speedy collection of primary data. Via the emails, the researcher was able to collect significant amount of data within fast (Gakuu, 2018). The method was cheap, and with the positivism research philosophy adopted for this study, questionnaires ensured high levels of objectivity.

However, some respondents assumed they clearly understood the questions before responding, and this led to wrong markings that did not make sense to the researcher. These questionnaires were discarded. Moreover, since the questionnaires administered were close ended there was limited room for the research participants to add their independent thoughts, which could be enrich the information collected.

4.9 Data Analysis Techniques

The researcher collected quantitative data and used quantitative analysis methods. Close ended responses from the research participants were adequately assessed using quantitative methods. Accordingly, the researcher interpreted the figures to ensure the findings were consistent and accurate using SPSS Version 17. The researcher used Pearson's chi-squared test to determine whether there is a significant difference between the expected frequencies and the observed frequencies in the various categories. The findings were presented on tables and percentages.

The following steps are the order at which the data analysis was done, the frequencies and the percentages was calculated, and the presentation of the information in tabular forms was made on each objective stated. The researcher used the formula such as: $n \times 100 / N = \%$ where n is the frequency, N is the total number of respondents and % is the percentage in the data analysis.

4.10 Operationalization of variables

This refers to how the researcher will define and measure a specific variable(s) as it is used in this study. For example, since the researcher intended to establish the respondent’s awareness on various health impacts of exposure to air pollution in Oslo, Norway.

Table 1: Operationalization of variables

Objective	Variable	Measure	Tools of Analysis	Type of Analysis	Approach of Analysis
To determine the main sources of air pollution in Oslo	Sources of air pollution	<ul style="list-style-type: none"> • Transportation • Biomass burning 	Percentage Frequencies	Quantitative	Chi-Square
To determine main health	Health problems	<ul style="list-style-type: none"> • Respiratory issues • Allergies 	Percentages Frequencies	Quantitative	Chi-Square

impacts of air pollution in Oslo		<ul style="list-style-type: none"> • Intestinal issues • Psychological issues 			
To determine the Oslo resident's awareness of health impacts of air pollution	Resident awareness	<ul style="list-style-type: none"> • Indoor behaviors • Outdoor behaviors • Attitudes 	Percentage Frequencies	Quantitative	Chi-Square
To determine possible mitigation measures against air pollution in Oslo	Pollution mitigation	<ul style="list-style-type: none"> • Reducing biomass burning • Reducing fossil fuel combustion • Public policy • Individual action 	Percentage Frequencies	Quantitative	Chi-square

4.11 Ethical Considerations

In empirical studies that involve human respondents, ethics remains a vital element researchers must consider (Gakuu, 2018). As such, the researcher aimed to ensure the highest level of social research professional ethics. The researcher sought the approval of the university administration, and leaders from The Institute of Transport Economics, the Norwegian Institute of Air Research, and the Norwegian Institute of Public Health. More so, the consent of the participant was obtained to ensure they willingly agreed to take part in the study. This was done using a Consent Form. Accordingly, the researcher respected the dignity of the research participants and guaranteed them of no harm to be caused while they took part in the study. Confidentiality and privacy were also stressed. This ensured that the research participants confidently took part in the

study. Accordingly, pseudonyms were further used to ensure confidentiality by maintaining the participants' anonymity. Furthermore, the researcher clarified the objective of the study and the role of the participants in the study. To achieve that, the researcher used a Participant Information Form. The form clearly outlined the research objectives, the research participants' role, and the researcher's role in the study. This ensured clarity, honesty, and transparency.

5.0 FINDINGS, ANALYSIS AND DISCUSSION

5.1 Introduction

This Chapter delves into reporting, assessing, and discussing the findings on Oslo residents' awareness of impacts of exposure to air pollution on the health of Oslo. The data presented on this section focused mainly on primary data obtained via survey, in which questionnaires were administered to the respondents. Besides elaborating on demographic data of the research participants, the findings reflect on the main sources of air pollution, the main impact of air pollution, awareness of health impact, and possible mitigation measures against air pollution in Oslo.

5.2 Data Presentation

The findings were based on the reactions of respondents who are 18 years old and above and have lived in Oslo for at least 4 years. All their reactions were established via questionnaires designed in line with the literature review.

5.3 Response rate

Rubin, A. (2011) suggest that response rate of above 50% is adequate enough for research and reporting. He adds that anything thing below 50% is highly suspect and biased. In the current study, a total of 300 successful individuals, which is 75% responded to our questionnaires (Figure 1). Consequently, it can be deduced that the respond rate is significantly okay.

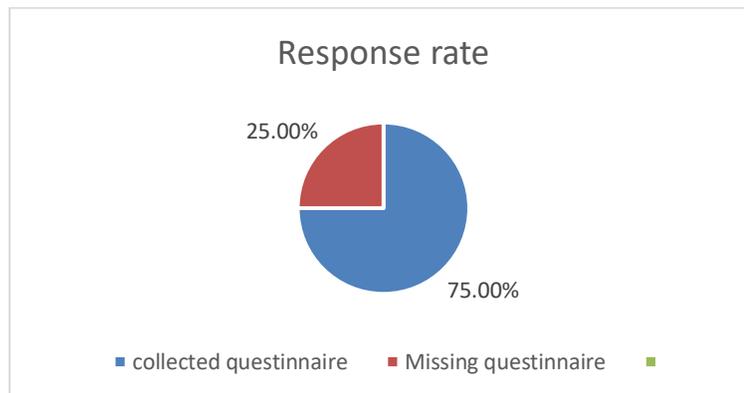


Figure 1 Response rate

5.4 Social economic data

5.4.1 Nationality

In Oslo, the majority of residents are Norwegians with a few foreigners who visit, live, work, and study in the city (Mapes, 2018). Agreeably, the current study showed 75.7% of the

respondents sampled were locals. Consequently, the high number of the local respondents is good because this indicates the respondents sampled are well aware of pollution dynamics.

Table 2 Respondent’s response rate

	Total number of respondents	Locals	Foreigners
Respondents	300	227	73
Percentage	100%	75.7%	24.3%

5.4.2 Gender

Goldbach *et al.*, 2015 elucidate the need for gender equality in any research. According to figure 2, a 56.7% (170) and 43.3% (130) males and female respondents respectively satisfy the gender equality.

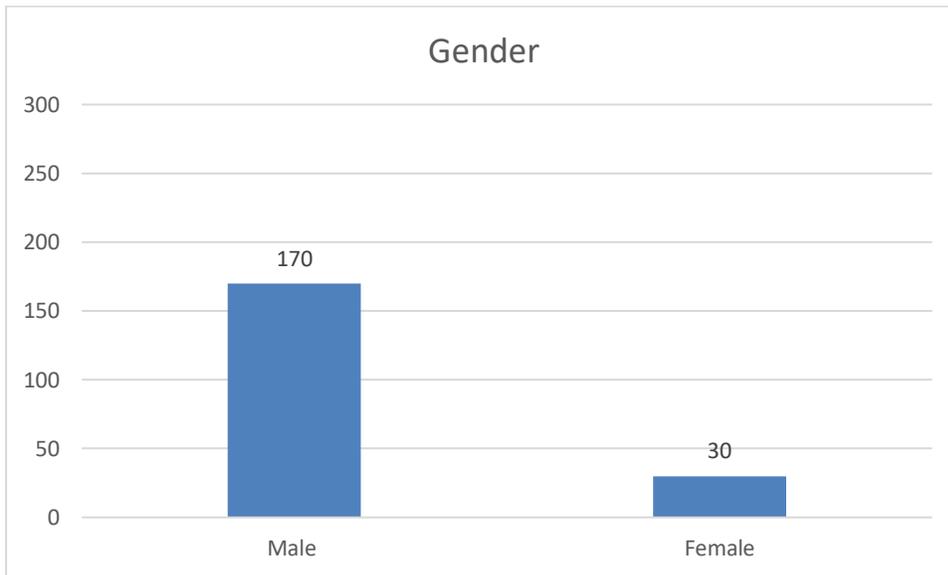


Figure 2 Respondent’s Gender

5.4.3 Age

The target age bracket for respondents was 18 to 70. Ethically in most nations across the world, an individual above 18 is considered mature enough and hence able to take an informed consent. As indicated in table 3, majority of the respondents fell in the 18-50 years bracket.

Table 3 Age distribution of respondents

Age	Range	Males	Females	Total	Percentage (%)
	18-28	58	21	79	26.3
	29-39	38	63	101	33.7
	40-50	61	30	91	30.3
	51-61	9	8	17	5.7
	62-70	4	6	10	3.3
	71 and above	0	2	2	0.7
	Total	170	130	300	100.0

5.4.4 Education

Evidently, table 4 shows that the most respondents had achieved the most basic education. Notably, most of them (65.7%) were graduates. These implies that the respondent were well knowledgeable to acknowledge their environment.

Table 4 The level of education of the research participants

Education	Range	Males	Females	Total	Percentage (%)
	Elementary	2	5	7	2.3
	Intermediate	4	5	9	3.0
	High school	31	27	58	19.3
	Graduate	113	84	197	65.7
	Post graduate	20	9	29	9.7
		170	130	300	100.0

5.4.5 Pollution menace awareness

According to Table 5 and figure 3, more people are aware of the issue of pollution in Oslo. This study shows that 69.3 percent of the respondents were aware that air pollution was a matter

of concern for the city residents. Only 30.7 percent of the respondents were not aware of the problem. In addition, more men than females are aware of the problem of pollution in Oslo, Norway. The study further shows that more men than women are aware of the air pollution menace in Oslo. The results revealed that 131 male respondents knew that air pollution is a major city problem. That is compared to only 77 female respondents who were aware of the menace. What is more, more females (53) than men (39) are not aware that air pollution is a problem in the city.

Table 5 Respondent’s Awareness

Awareness	Males	Females	Total	Percentage (%)
Aware	131	77	208	69.3
Not aware	39	53	92	30.7
	170	130	300	100.0

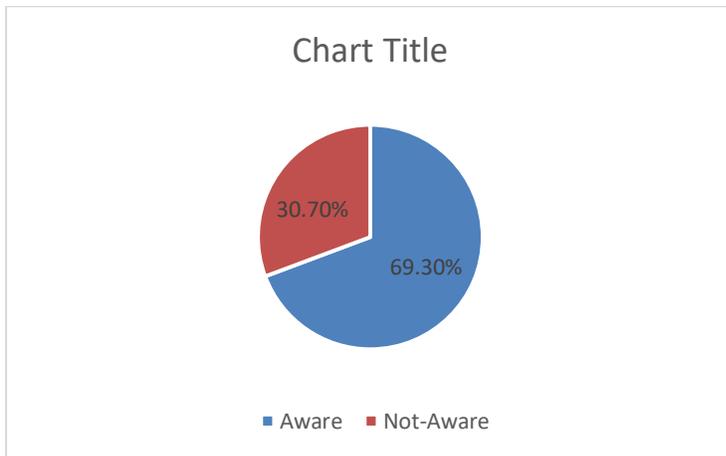


Figure 3 Respondent’s Awareness

5.4.6 Sources of air pollution in Oslo

According to Table 6, the most people believe that transportation is the major source of air pollution than biomass burning in Oslo. The results show that 68.3 percent of the research respondents believe that transportation is the main cause of pollution, compared to 31.7 percent who believe biomass burning was a major cause of pollution in the city. Apparently, more males

(116) than women (89) believe that transportation was the major source of air pollution in Oslo. A similar trend was found among in reference to biomass, where more men (54) than women (41) responded that biomass burning was the cause of air pollution in the city.

Table 6 Sources of air pollution in Oslo

Sources of air pollution	Range	Males	Females	Total	Percentage (%)
	Transportation	116	89	205	68.3
	Biomass burning	54	41	95	31.7
		170	130	300	100.0

5.4.7 Health impacts of air pollution in Oslo?

According to Table 7, more people maintain that the main health impact of air pollution in Oslo is allergies (48 percent), followed by respiratory health issues (20.3 percent), psychological issues (18.3 percent), and intestinal issues (13.3 percent). Meanwhile, more male respondents (83, 41, and 30) than female respondents (61, 20, and 25) believe that allergies, respiratory issues, and psychological issues are the main health impacts of air pollution in Oslo. However, in terms of intestinal issues, more female respondents (24) than male respondents (16), concede that these are the main health outcomes of air pollution in the city.

Table 7 Health impacts of air pollution in Oslo

Health impacts	Range	Males	Females	Total	Percentage (%)
	Respiratory issues	41	20	61	20.3
	Allergies	83	61	144	48.0

	Intestinal issues	16	24	40	13.3
	Psychological issues	30	25	55	18.3
		170	130	300	100.0

5.4.8 Mitigation measures against air pollution in Oslo

Table 8 shows what measures Oslo residents believe would assist in mitigating air pollution in the city. The main mitigation strategy agreed upon by the residents is public policy, which constitutes of 34.3 percent of the respondents. Other subsequent mitigation measures included reducing fossil fuel combustion (27.0 percent), individual action (23.3 percent), and reducing biomass burning (15.3 percent). However, both male and female respondents have varying perspectives on the best mitigation measure against air pollution in Oslo. Table 6 shows that more males (63, 51, and 43) than females (40, 30, and 27) maintain that public policy, individual action, and reducing fossil fuel combustion, respectively, are the best ways to mitigate against pollution in the city. On the other hand, more female respondents (33) than male respondents (13), assert that reducing biomass burning was the best way to mitigate against air pollution in the metropolitan.

Table 8 Mitigation measures against air pollution in Oslo

Mitigation Measures	Range	Males	Females	Total	Percentage (%)
Reducing biomass burning		13	33	46	15.3
Reducing fossil fuel combustion		51	30	81	27.0

	Public policy	63	40	103	34.3
	Individual action	43	27	70	23.3
		170	130	300	100.0

5.5 Discussion

5.5.1 Pollution Menace Awareness

Air pollution is a major problem in Oslo which many people are aware of. This study showed that 69.3 percent of Oslo residents are aware of the problem in the city. According to Mabahwi et al. (2014), people are not ignorant about the impact of their actions on pollution. They are able to tell about the problem by following news, websites, blogs, weather forecast, and via smartphone tools and apps (Mabahwi et al., 2014). Specifically, air pollution campaigns such as by the Environmental Protection Agency, the Institute of Transport Economics, and the Norwegian Institute of Air Research make it possible for millions of people to know the problem exists. Moreover, the impact of air pollution is visually evident. Visible pollutants include emitted ash, gas clouds, exhaust fume emissions, and so on (Morgenstern et al., 2008). What is more, the residents are aware of the sources and the health impacts of air pollution in Oslo.

Clearly, there is a widespread concern about air pollution among the participants. Kelly et al. (2012), noted that the local environmental authorities in have established that air pollution is a major problem in Oslo, a notion that is also perceived by the local residents. This is because air quality departments have taken a primary role in ensuring that the city residents are informed about the quality of air in their community. This information is disseminated via different forms of media include television, online reports, newspapers, and mobile applications to have an impact on the perception of the populace (Department for Environment, Food and Rural Affairs, 2002). Moreover, the high awareness of air pollution in Oslo is a contribution of both health and environmental authorities in implementing educative measures to ensure urban dwellers aware of air quality around them (EC, 2013). As such, Oslo residents deliberately avoided spending time outdoors (Bell et al., 2004).

Even so, some people apparently, are not aware of air pollution as a problem. This study showed that 30.7 percent of Oslo residents are not aware of the problem. Research has shown that people are barely interested in the subject matter, especially among the ‘healthy people’ (who do

not have any illnesses related to air pollution) (McDermott et al. 2006). This can be a major reason why a good proportion of people in Oslo do not know about air pollution as an issue. Nevertheless, Oslo the residents agree that something can be done to address the problem in their city.

The research further shows that more men than women are aware of matters air pollution in the city. For instance, the results revealed that 131 male respondents knew that air pollution is a major city problem compared to only 77 female respondents who were aware of the menace. According to Morgenstern et al. (2008), women are less informed regarding current affairs than men. Mills et al. (1999) assert that women are still recovering from the historical hangover where men delved into knowledge search while women concerned themselves with domestic work. Moreover, considering that women are perceived as the busier sex, they have less time to look at the news, papers, and weather reporting platforms (Morgenstern et al., 2008). Based on the results in the study, it is apparent that Oslo residents are aware of air pollution problem in the city.

5.6.2 Sources of Air Pollution

In Oslo, the residents are aware of the major sources of air pollution, which include transportation and burning of biomass. Of the two, the main cause of pollution comes from road traffic, including public and privately owned cars. The results showed that 68.3 percent of the research respondents believe that transportation is the main cause of pollution, which aligns with studies that have shown that transportation is the main cause of air pollution in urban areas. NIPH (2013), established that road traffic comprised of high levels of particulate matter in densely populated towns. Similarly, Stranden (2014), added that privately owned cars spew toxic gasses from their diesel and petrol engines, contributing to high air pollution in the city. This is compared to 31.7 percent who believe biomass burning was a major cause of pollution in the city. For one thing, biomass burning of biomass is common in Europe, especially within the Nordic countries (Karlsson et al., 2013). Even so, it is apparent that Oslo residents consider biomass burning, which includes wood burning and crop remnant burning, as lesser source of air pollution. Accordingly, 31.7 percent pointed out that biomass burning was a cause of air pollution in the city.

One factor that participants associate with air pollution is the city activities. Apparently, urban areas have a higher probability of causing air pollution than rural areas (McDermott et al. 2006; the Joint Research Center, 2007). This is consistent with previous comparative studies assessing pollution and activities that cause pollution in urban and rural areas. Specifically, the

Forouzanfar et al. (2016), point differences in population size, besides physical (structures) and sociocultural (vehicles) activities.

The variance between the main cause of air pollution in Oslo is influenced by the urban setting. A Swedish study comparing household car ownership in the city and rural area established that there are more cars in the city than in rural areas (Pyddoke & Creutzer, 2014). According to Pyddoke & Creutzer (2014), higher income households that own cars are found in the city. As such, it is highly likely that city dwellers would associate air pollution to vehicles. Meanwhile, activities, such as wood burning and crop remnant burning, mainly occur in rural areas than in cities. Urbanization has been associated with limited farming activities, which translate to burning of crops (Satterthwaite et al., 2010). More so, burning of wood is rare in urban areas, where the main source of heat is electricity and renewable energy sources (Satterthwaite et al., 2010). The fact that urban dwellers are barely exposed to biomass burning contributed to the higher rating of transportation as the main source of air pollution in Oslo.

Other authors have pointed out that air quality is a major problem in all major cities because of the city dynamics (Pyddoke & Creutzer, 2014). When assessing the main causes of air pollution, participants agree that both transportation and biomass burning are the major sources of particulate matter that cause pollution in their city. This result is consistent with various reports by local agencies in Norway as well as empirical studies around the world, which demonstrate substantial health implications to humans (Karlsson et al., 2013).

5.7.3 Health Impact of Air Pollution in Oslo

Air pollution contributes to major health issues, such as allergies (48 percent), followed by respiratory health issues (20.3 percent), psychological issues (18.3 percent), and intestinal issues (13.3 percent). Apparently, allergic diseases such as asthma are common in children and young adults that results from exposure to air pollution (Nielsen et al., 2002). As such, city dwellers easily associated with allergies as the number one outcomes of air pollution in the city. Respiratory issues are also a major problem resulting from air pollution. Significant studies show that both outdoor and indoor activities, such as driving, cooking, cleaning, and movement of people contribute in the generation of particles that lead to respiratory health issues (Forouzanfar, 2016). The variance in response between allergies and respiratory diseases is founded on the premise that allergies are prevalent in the city than respiratory diseases (Thomassen et al., 2017). Psychological and intestinal issues received lower rating because these impacts are barely noticeable. For instance,

some studies show there is no relationship between intestinal disorders and air pollution (Lipsett et al., 1997) while air pollution only triggered rather than caused psychological problems (Brealey, 2002).

In light of the impact of air pollution, everyone believes that air pollution indeed has an impact on the health of their health, regardless of the variance in their responses about the actual health impacts. Clearly, health remains a major concern for people (Department for Environment, Food and Rural Affairs, 2002). This contributes to their awareness of air pollution problem in their communities, which triggers them to take appropriate measures to mitigate it. Their responses are triggered by both first hand and passive experiences, and thus, the variance in the types of diseases. Such results reinforce the notion that people are not only aware of air pollution but are also willing to take appropriate measures towards making their environment a better place for the future generation through viable initiatives (Shooter and Brimblecombe, 2009).

Apparently, a chronic respiratory disease like asthma worsens when people are exposed to allergens. Numerous epidemiological studies have emphasized that allergens are vital factors that exacerbate respiratory health and subsequent hospital admissions (Department for Environment, Food and Rural Affairs, 2002). According to Nowak et al. (2006), outdoor air contaminants, such as sulfur (IV) oxide, nitrogen (IV) oxide, carbon (II) Oxide, and particulate matter, alongside other secondary pollutants result in chemical reactions that affect the immune system. These pollutants come from emissions, not only from combustion engine vehicles, but also power plants and industrial facilities in the community (Bickerstaff and Walker, 2001). In areas where emissions from fossil fuel are high, allergen exposure resulted in respiratory disorders, cardiovascular diseases, and asthma (EC, 2013). These studies reinforce the finding that allergens are the main health concerns for the residents of Oslo because of the subsequent impact it has on other health outcomes.

5.8.4 Mitigation Measures against Air Pollution in Oslo

The study has demonstrated that Oslo residents are mindful about addressing the air pollution problem in their city. 34.3 percent of the respondents suggested public policy, while 27 percent, 23.3 percent, and 15.3 percent supported reducing fossil fuel combustion, individual action, and reducing biomass burning, respectively, as the possible mitigation measures. Public policy is given an upper hand because it promotes public participation to encourage people to switch to more energy efficient solutions. What is more, public policy influences the creation of

legislations, regulations, and incentives that compel individuals and companies to practice environmentally friendly activities. It involves the government and the media taking part in promoting community awareness on the impacts of air pollution (Anderson et al., 2004). For instance, Stranden (2014), noted that Norway was using incentives and environmentally differentiated taxes imposed on commercial and heavy cargo transport. Considering that transportation was a major source of air pollution in Oslo, reducing fossil fuel combustion and individual action were considered as imperative steps towards reducing air pollution in the city. Efforts such as efficient use of fossil fuel in industrial processes and generation of electricity (NIPH, 2013), limiting the number of private vehicles in the city (EC, 2013), and changing from diesel to electric cars (Stranden, 2014), have been highly effective in mitigating air pollution. Apparently, this mitigation measure is closely associated with individual action, which involves people taking the initiative to adopt biofuels and renewable energy sources (Johnston et al., 2004).

For one thing, air pollution issues are complex and multidimensional, and thus demand the inclusion of different perspectives when assessing its management (Brealey, 2002; Andersen et al., 2004). Zhao et al. (2015), point that the idea of pollution mitigation is not basically about curtailing the issue to relativistic approaches. It is founded on a comprehensive understanding of air quality in the local area to incorporate the perception of the residents about the problem as a part of developing mitigation measures. In Oslo, as well as other big cities in the world, establishing local police alongside the people is an effective public policy approach to encourage individual initiatives towards air quality management. Pope et al. (2009), demonstrated that public participation in policy establishment encouraged people to feel as part of environmental agenda, which can lead to generation of better strategies for quality air. This supports the findings that Oslo residents perceive public policy as the vital method for addressing air pollution in the city. This would further encourage environmental authorities to develop better strategies for engaging the public, making them know their existence, social objectives, and corporate goals. Stranden (2014), point that public policy further promotes public monitoring of data on emissions and air quality. Due to informed citizenry, people are able to make better decisions to reduce biomass burning, fossil fuel combustion, and change their outdoor and indoor activities (Bayer- Oglesby et al., 2005)

6.0 CONCLUSION AND RECOMMENDATIONS

The study shows that Oslo residents are aware of the problem, sources, health impacts, and mitigation measures of air pollution in their city. The researcher clearly achieved the research objectives and responded to the research questions. During the study, the researcher established that the major sources of air pollution in Oslo included transportation and the burning of biomass, where city dwellers are mainly exposed to vehicles than biomass burning. The study also revealed that the main health impacts of air pollution include allergies and respiratory diseases. They believed that air pollution barely contributes to intestinal and psychological issues. In order to address the issue, Oslo residents demonstrate that the best approaches include public policy, reducing fossil fuel combustion, individual action, and reducing biomass burning. To ensure Oslo residents have quality air, the researcher recommends the following:

Recommendation 1: Increase public awareness about air pollution in the city

Reducing air pollution requires public participation to encourage people to switch to more energy efficient solutions. This would increase the number of people who are significantly concerned with poor air quality to take appropriate actions towards ensuring an air pollution free society.

Recommendation 2: Enhance air pollution policy enforcement in the city

Enhancing public policy and communication could encourage the masses to adopt biofuels and renewable energy sources use to further reduce emissions. This entails active involvement of environmental agencies, such as the Institute of Transport Economics and the Norwegian Institute of Air Research, as well as the public health organizations, such as the Norwegian Institute of Public Health and the World health Organization.

Recommendation 3: Collaboration with non-governmental stakeholders

Air pollution issues are complex and multidimensional, and thus demand the inclusion of different perspective and input from various stakeholders in the society. Each stakeholder will differently participate in policy development, communication campaigns, law enforcement, funding, and other activities geared towards encouraging Oslo residents – both individuals and businesses, to take the initiative of becoming environmentally friendly.

Recommendation 4: Adoption of technology to enhance information dissemination

With recent technological advances, personal pollution monitoring can significantly improve. This can be viable with the use of affordable, portable, and easy to use apps and devices (smartphones and laptops) to disseminate information on air quality, allowing people to act promptly.

Further studies should focus on the effectiveness of modern methods of reporting in promoting air pollution awareness among the residents. Additional studies should also be done on the impact variables such as education and socioeconomic status on air pollution in the city.

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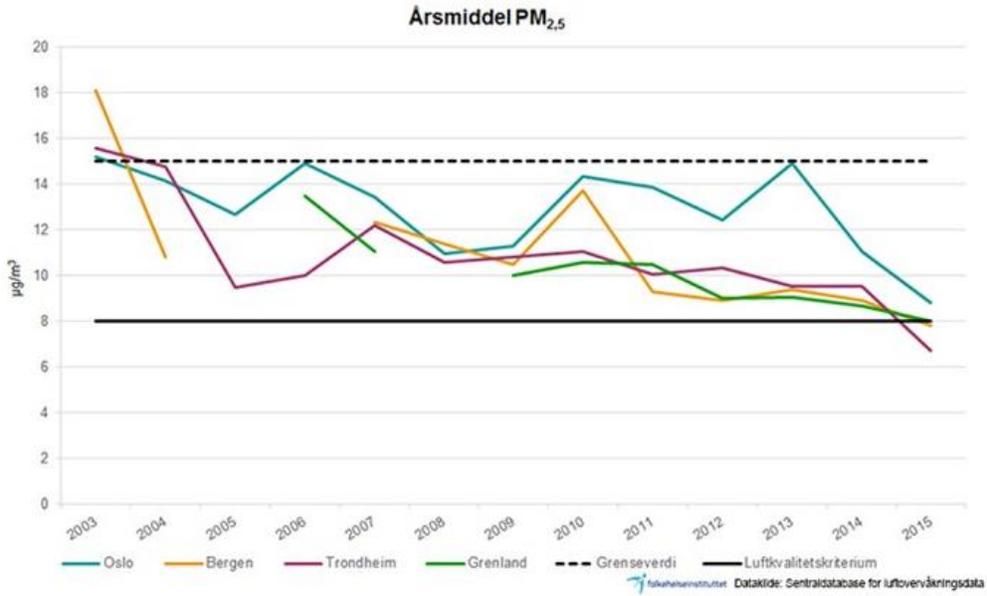
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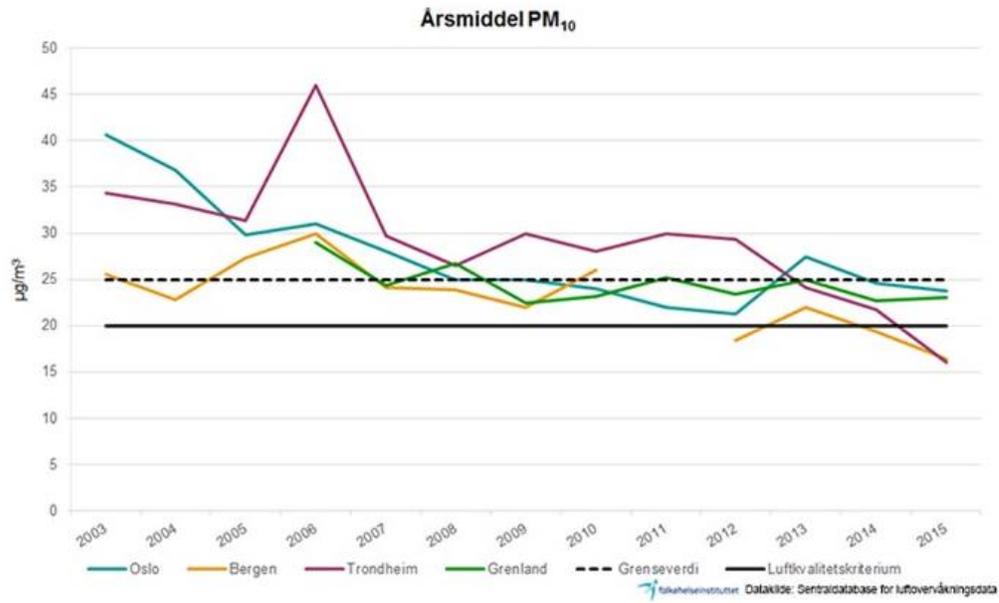
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APPENDICES

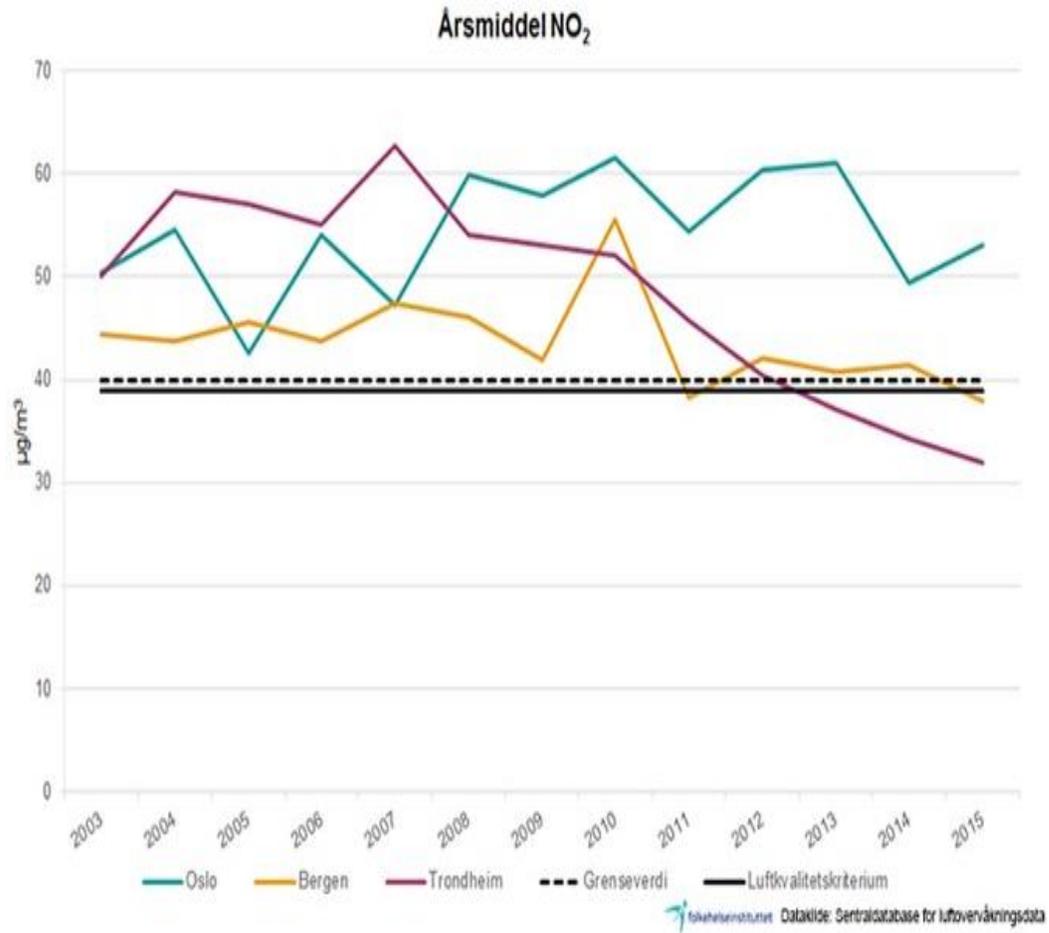
Appendix 1: Annual mean levels of particulate matter (PM2.5)



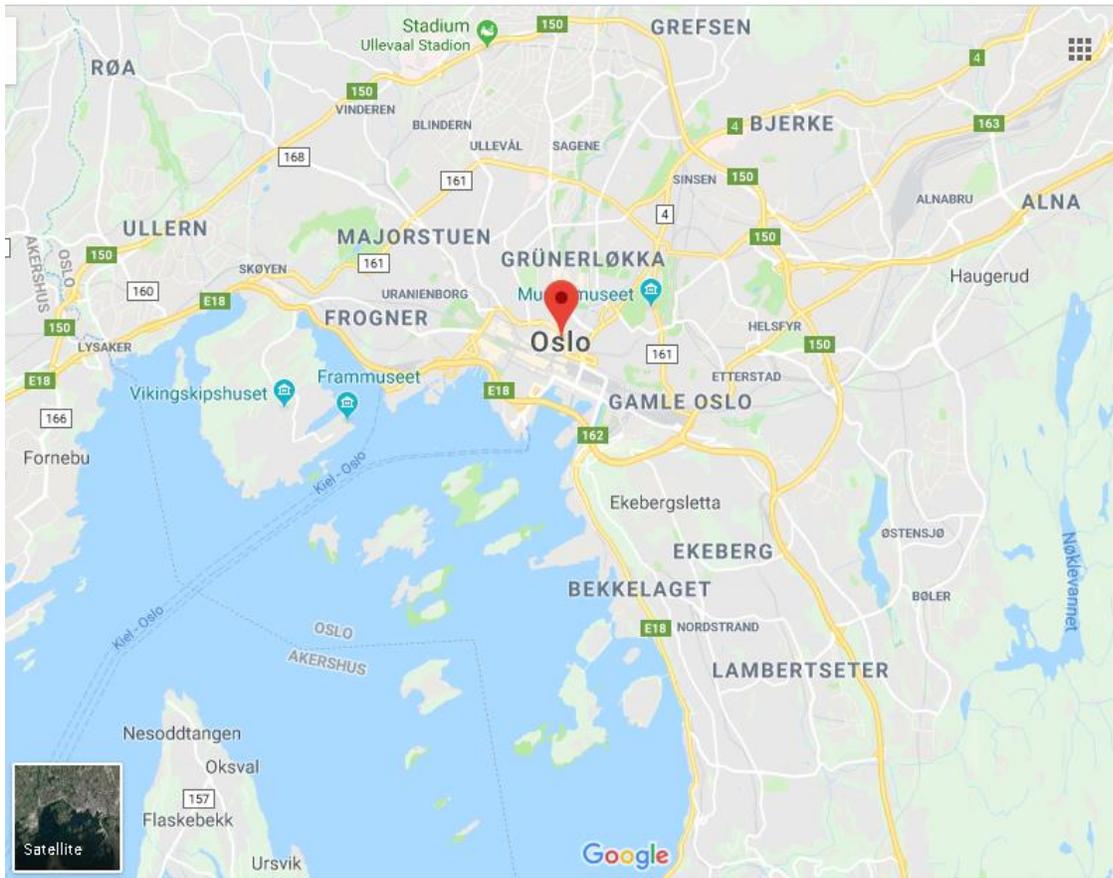
Appendix 2: Annual mean levels of particulate matter (PM10).



Appendix 3: Annual mean levels of nitrogen dioxide (NO₂)



Appendix 4: Oslo Map



Appendix 5: Questionnaire

Dear participant,

Please take a few minutes of your precious time to fill this questionnaire on various health Impacts of exposure to Air pollution in Oslo, Norway. The final outcome of this survey when summarized will help us make necessary recommendations. All responses will remain strictly confidential.

Thank you for your cooperation!

Section A: Background information

1. Your nationality

Norwegian

Foreign

2. Gender: 1. Male 2. Female

3. Your age bracket (Tick whichever appropriate)

18 – 28 Years

29 - 39 Years

40 - 50 years

51 – 61 years

62 – 70 years

71 years & above

4. What is your highest level of education?

Elementary Graduate

Intermediate Postgraduate

High school

SECTION B: Air pollution research

Objective 1: Awareness

1. Are you aware of the various health Impacts due to Air pollution exposure. Kindly tick where appropriate

Awareness	Description	Response
	Aware	
	Not aware	

N/B: kindly tick in the appropriate box

Objective 2: Sources of air pollution

2. Among the two main sources of pollution listed below, which is the most important in Oslo.

Sources of air pollution	variable	response
	Transportation	
	Biomass burning	

N/B: kindly tick in the appropriate box

Objective 4: Health impacts of air pollution in Oslo

3. Among the 4 main air pollution's health impact, which is the most significant in Oslo.

Health impacts of air pollution	Description	response
	Respiratory issues	

	Allergies	
	Intestinal issues	

N/B: kindly tick in the appropriate box

Objective 5: Mitigation measures against air pollution in Oslo

4. Among the numerous mitigation strategies listed below, which is the most significant against air pollution.

Mitigation measures against air pollution	Description	response
	Reducing biomass burning	
	Reducing fossil fuel combustion	
	Public policy	
	Individual action	

N/B: kindly tick in the appropriate box