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THE HEALTH EFFECTS OF BURNING WASTES ON NEWBORNS IN LEBANON

by

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AN ABSTRACT OF THE THESIS OF

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Lebanon has witnessed a waste management crisis in July of 2015 that was predicted to have negative health effects on the whole society and specifically on vulnerable subjects. The aim of this thesis is to investigate whether a causal relationship exists between waste burning emissions and low birth outcomes. Therefore, we examine the effect of waste burning emissions on birth outcomes, probability of being low birth weight of less than 2500 grams, birth height and head circumference. We use fixed effect approaches to investigate whether a causal relationship exists between waste burning and birth outcomes in Lebanon. Our results show that exposure to waste burning emissions during the third trimester of pregnancy decreases birth weight by 2.9% which is equivalent to about a 93 grams reduction on the 3,121 average birth weight base. We also find that exposure to waste burning emissions decreases birth height and head circumference by about 0.5 cm and 0.2 cm respectively. Moreover, exposure to waste burning emissions decreases the gestational period by about 0.438 of a week and increases the probability of preterm birth by 6.1%. Due to the significance and consequences of our results, we emphasize on the importance of early lifetime interventions to enhance human capital and compensate for the negative effects of similar shocks.

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CHAPTER 1

INTRODUCTION

The global development that we are witnessing comes with an increasing amount of pollution. Environmental concerns are currently the focus of many policy decisions worldwide, shedding light on global welfare and the sustainability of life on Earth. Sustainable development is an essential topic today with all the health and environmental problems we are facing. Climate change is another alarming phenomenon that is becoming more and more of a challenge to deal with. If life continues with such increasing amounts of greenhouse gas emissions, we will never reach sustainable development and the possibility of a healthy future life on Earth will gradually decrease. Lebanon, although a small country, contributes to global pollution. Since July 2015, Lebanon has undergone a waste management crisis due to the closing of Naahme garbage landfill. As a result, millions of citizens were forced to live with the adverse effects of street garbage and the burning of wastes. Today, at the end of 2016 and the beginning of 2017, no clear sustainable solution has been reached, making Lebanon’s environmental future uncertain. Sustainable human and economic development starts with the youngest of the population for it to become sustainable. Indeed, in Lebanon, sustainable development in all sectors and at all levels is required for growth. This paper conducts a study on the current waste crisis in Lebanon in order to investigate the causal effects of waste burning on the health of newborns. This is important because it targets a sensitive age group of the Lebanese society, a whole new generation that will be responsible for the country in the near future. For instance, inputs into the human capital production function matter a lot when an individual is young and any exogenous shock to this production process can have long lasting social and economic impacts on individuals. As a result, this will affect the welfare of the society as a whole. The World Health Organization estimates that about a quarter of the diseases facing mankind today occur due to extended exposure to environmental pollution (WHO, 2015). What is alarming is that such diseases are not easily detected and have a high chance of being acquired during childhood or even before birth and manifested later in adulthood. The improper management of waste in Lebanon due to the lack of adequate regulations and disposal facilities, accompanied with random waste dumping and burning of waste beside highly populated areas increases health risks significantly. Poor waste management challenges the well-being of residents living besides open air burning sites or even dumpsites due to the high probability of waste polluting water, food sources, air and land.

From a human capital standpoint, early life disruptions to the human production function have proved to have long- lasting effects on individuals and societies. The human capital of a society includes all the knowledge, talents, skills, abilities, experiences, intelligence, potentials, cognitive abilities and everything that forms the human wealth. This concept originates from the economic model of human- resource maximization. This model focuses on the relationship between enhanced productivity and long term investments in the development of human resources. Thus any exogenous action or shock that affects human capital at any stage will affect the development of the national economic performance.

Douglas Almond and Janet Currie (2011) studied the growing literature on the effects of early life conditions and concluded that events before birth can be critical determinants of future outcomes. Douglas Almond (2006) studied the long- term effects of prenatal exposure to the 1918 influenza in USA. The study estimated that children of infected mothers were 15% less likely to graduate high school and their wages were 5 to 9 % lower than other subjects. Almond found negative effects of the 1918 influenza pandemic after 22 years of the shock which proves that early life health shocks have long- term human development effects.

Although our study focuses on waste emissions as one of the causes of general negative health effects on newborns, we are able to extend our results to the sum of human actions that release similar pollutants from the transportation sector to the manufacturing and the energy sectors thus making this research a worldwide human and economic concern. Our estimates show that exposure to waste burning emissions during the third trimester of pregnancy decreases birth weight by 2.9% which is equivalent to a 93 grams reduction on the 3121 average birth weight base. We also find that exposure to waste burning emissions decreases birth height and head circumference by about 0.5 cm and 0.2 cm respectively. Moreover, exposure to waste burning emissions decreases the gestational period by about 0.438 of a week and increases the probability of preterm birth by 6.1%.

From this point forward, the thesis continues as follows. Chapter II discusses air pollution and pollutants and relates to the waste crisis and the malfunction of the waste management sector in Lebanon in chapter III. Chapter IV then deliberates the general health hazards of air pollution and waste burning and includes the literature review about this concerning subject. Chapter V includes the data obtained for the empirical strategy that constitutes chapter VI. Results, analysis, and discussion follow in chapter VII. The thesis concludes in chapter VIII with potential future work.

CHAPTER 2

AIR POLLUTION AND ITS GENERAL EFFECTS

2.1. Atmosphere and Air Pollution

The atmosphere, in correlation with water and soil, forms the essential living environment for all organisms. The atmosphere is in a constant relation with human actions and plays an essential role in the carbon and water cycles which depicts it as the first source of oxygen for living organisms. Due to this direct relation between the atmosphere and living organisms, air quality is a huge concern for the survival of humans and living things. Air is prone to various pollutants that are emitted from different sources and most human activity generally release various toxic pollutants, greenhouse gases as well as ozone depleting substances (ODS), leading to air pollution.

The World Health Organization (WHO) defined air pollution as the contamination of the indoor or outdoor environment by any chemical, physical or biological agents that modify and change the natural characteristics of the atmosphere (World Health Organization, 2005). Air pollution is thus found when numbered gas droplets and particulates are either present in the air above their normal concentrations or introduced to the atmosphere by natural sources or phenomena such as forest fires and dust storms, along with the climatic conditions that include temperature, atmospheric pressure, humidity, wind speed and wind direction.

Pollution has been increasing over the years due to urbanization, industrialization, globalization and development in general. The development in industries and technologies has been associated with deterioration in public health and penetration of new diseases. Living in such polluted cities has detrimental effects in the long run. This has been shown historically, where during 1952, for example, London witnessed what has been known to be the London Fog which gathered pollutants from coal fires and other sources and lasted for four days. It resulted in 12,000 deaths (Bell & Davis, 2001). At the same time, many speculate that the increasing rates of disability and disease the world is witnessing today, from asthma, to autism, and other diseases, might be due to environmental pollution exposure (Rauch & Lanphear, 2012).

In this paper, we focus on open- air waste burning as a major source of air pollution. Open air burning is the combustion of any matter in the open or in an open dump. It is scientifically established that burning waste or even trees and left outs from different materials, releases toxic emissions and gases in the air, leaving toxic materials to be precipitated to underground water and plants.

Many sectors and economic activities contribute to the increase in air pollution levels such as energy, transport and industry sectors. Waste burning is another significant source of pollution alongside with tobacco smoke and indoor heating. Indoor tobacco smoke emits dangerous pollutants since it contains an array of particulates and gaseous compounds that affect the health. Additionally, smoke emitted from fires and stoves during indoor heating includes pollutants that affect the health especially the health of women and children due to the solid fuels and inefficient stoves that are used in households.

2.2. Air Pollutants

Air pollution results in various types and concentrations of pollutants. Air pollutants are generally categorized into primary and secondary pollutants. Primary pollutants include particulate matter (PM), $(PM_{2.5})$, and (PM_{10}), lead, carbon monoxide (CO), sulfur oxides (SO_x), nitrogen oxides (NO_x), and volatile organic compounds (VOCs) (MOE, UNDP & ECODIT, 2011).

Secondary pollutants are primary pollutants that undergo chemical and photochemical reactions in the atmosphere such as nitrogen dioxide (NO_2), ground-level ozone (O_3), and Peroxyacetyl Nitrate (PAN)$(CH_3C(O)OONO_2)$. Tobacco smoke, for example, emits carbon monoxide (CO), and indoor heating emits many health damaging pollutants including PM, CO, SO_x , NO_x, aldehydes and Benzene (C_6H_6) (MOE, UNDP & ECODIT, 2011).

Particulate matter (PM) is the general term for a wide category of physically and chemically diverse materials that exist as separate particles (liquid droplets or solids) over a wide range of sizes. Particles originate from a variety of anthropogenic stationary and mobile sources as well as from natural sources. These particles can be emitted directly, or formed in the atmosphere by transformations of gaseous emissions. The chemical and physical properties of particulate matter vary with time, methodology, region and source leading to a complicated assessment of health and welfare effects. Size of particulate matter is determined by its diameter. (PM_{10}), for example, has a diameter of less than 10 microns whereas fire particulates $(PM_{2.5})$ have a diameter of less than 2.5 microns (MOE, UNDP & ECODIT, 2011). Size directly determines a particle's potential for causing health problems.

Air pollutants set huge effects on air quality and leave substantial impact on human health and the environment where the World Health Organization estimates that 37 million deaths fall each year due to outdoor air pollution and 4.3 million deaths fall from exposure to indoor (household) air pollution (WHO, 2015). WHO also shows that about a quarter of the diseases facing humans today occur due to the prolonged exposure to environmental pollution. This is a significant fact especially that most of these environmental- related diseases are not easily detected and have a high probability to be acquired during childhood or even at the fetus development level, and manifested later in adulthood. Studies for example show that 90% of the health impacts are usually attributed to particulate matter $(PM_{2.5})$ that is able to enter deep into the body and affect different body systems and probably cause cardiovascular mortality (WHO, 2015). This all leads to an increasing global concern over the public health impacts attributed to environmental pollution.

A large and growing body of literature regarding this issue has highlighted the dangers of particulates to health. This body of literature mentioned that air pollutants that are of main concern for the general health, are mainly $(PM_{2.5}), (PM_{10}), (O_3)$ and (NO_2) (European Environmental Agency, 2015). Various studies have also proven that the smaller the size of the particles, the more dangerous on health they become. This is because smaller particles are not filtered out by the nose and the bronchioles and their miniscule size allows them to be breathed deeply into the lungs, absorbed directly into the blood stream and move through the cell walls and into the nucleus affecting the cell's DNA. What is also significant in this case, is that particulates carry various chemicals into the human body including poly-cyclic aromatic hydrocarbons (PAHs) (Thompson & Anthony, 2008).

Appendix A includes Table A.1. that presents the World Health Organization and NAAQs guidelines of allowed concentrations of some pollutants.

2.3. Solid Waste Management

Major health concerns arise from improper solid waste management as it is directly linked to air pollution. Improper solid waste management is one of the main causes of environmental pollution especially in developing countries (Kimani & UNEP, 2015). Such improper, random and uncontrolled disposal of waste, leads to air, soil and water pollution (Alam & Ahmade, 2013). Illegal incinerations as well as backyard burning of trash, that is done frequently, releases toxic pollutants to the air and continue to being a significant source of air pollution.

In addition to the emission of gases, waste burning as well as the decomposition of organic wastes in landfills, generate greenhouse gases. Furthermore, waste in open air attracts insects and rodents that can spread numerous diseases such as cholera (MOE, UNDP & ECODIT, 2011). The US Public Health Service, for example, identifies 22 human diseases that are linked to improper solid waste management (US Department of Health and Human Services, 2017).

Solid wastes that contain acids and bases are considered corrosive and ignitable. They are also considered reactive because of their unstable nature, leading to explosions and the formation of toxic fumes when heated. Consequently wastes are also considered toxic when ingested or absorbed.

Different ways are present to treat solid waste and the choice of a country or municipality of the disposal means, depends on refuse characteristics, available land area and disposal costs. These methods include incineration, compaction, pyrolysis, gasification and composting and are discussed thoroughly in Appendix B (Thompson & Anthony, 2008).

Waste disposal, on the other hand, is the act of removing, storing or abolishing used or unwanted products referred to as waste. There are five alternatives for regular waste disposal techniques that are landfills, sanitary landfills, waste piles, underground injection wells, and land treatment. Appendix C includes detailed explanation of waste disposal techniques.

Improper waste treatment or disposal affects populations living in areas where waste is produced and disposed especially that there are numbers of ways in which solid waste might contact living organisms. Plant intake that is soil absorption, storage biodegrading and integration of the waste with the plant roots and then its transmission to animals and human beings is one of these ways. Ventilation, leaching, and underground water absorption are also means for the transmission of wastes into different organisms.

In our research, we focused our study on ventilation as a direct way of the intake of waste burning emissions. We also focused on the effects of these emissions on the birth outcomes of newborns.

2.4. Open- Air Waste Burning

The topic of open- air burning of solid waste, being a potential source of pollution has recently become a subject of concern. Open- air burning of waste is defined as the disposal behavior of municipal refuse, construction scraps and even agricultural residues, etc. by uncontrolled combustion in an open yard or in barrels. From this definition, we come to a concerning fact that burning any material could harm the health of living things. Different studies have calculated the concentrations and emission levels of various harmful pollutants during and after the combustion of individual types of domestic municipal solid waste including paper, wood and plastics (Kaskareka et al., 2003; Kemieux et al., 2004; Otal, 2005; Park et al., 2005; Lee et al., 2006; Kim, 2008). For example, Park, Kim and Min Jo (2012) studied this phenomenon in the metropolitan area of South Korea and concluded that the emission factors of $(PM_{10}), (PM_{2.5}), (PAHs\ )$(poly-aromatic hydrocarbons) and heavy metals differed according to the combusted material. They also proved, by indicating concentrations, that open- air burning of wastes releases toxic elements above WHO standardized and accepted levels (Park, Kim, & Min Jo, 2012).

In the following part, we will give brief information about the emissions produced by the burning of specific types of wastes and the resulting general health effects and hazards. When burning plastic bottles, children's toys (plastics), vinyl tubing, flooring and siding materials, a number of foods, and household, pharmacy and cosmetic products, dioxin emissions occur. These materials contain polyvinyl chloride that forms dioxins when burned as well as hydrochloric acid. It is said that hydrochloric acid can irritate and burn the lungs and might cause fluid build-up and possible ulceration of the respiratory tract. Dioxins on the other hand can cause cancer, immune dysfunction, and a deficit in productive effects.

Additionally, burning food containers, plastic forks and spoons, and photographic films release styrene and benzene which are considered carcinogens. Styrene gas is very readily absorbed through the skin, respiratory system and gastrointestinal tract and can cause mortality if consumed in high doses as it is able to accumulate in the body throughout one's life. Furthermore, the vapor produced from this gas can damage the eyes and mucous membranes (EEA, 2015).

Likewise, burning bleached paper products, white packaging materials and boards also release halogenated hydrocarbons which are carbon compounds, chlorine and fluorine. These emissions have been linked to blood abnormalities and leukemia and may also lead to liver damage. Burning colored papers, card boards and magazines that contain synthetic inks including heavy metals like lead and cadmium also add up to the long list of cons.

Additionally carbon monoxide, the silent killer, causes dizziness, headaches and slowed reflexes and usually affects mental functions. Dioxins and furans may cause cancer, growth defects since it affects DNA as well as the immune and reproductive systems. Heavy metals such as mercury collect in the human system until a lethal dosage is reached. It leads to the inhibition of growth and development of children. Ozone (O_3) can injure biological tissues and cells while Nitrogen Oxides can cause respiratory illness and particulate matter (PMs) generally causes respiratory diseases and are considered cancer-causing agents (EEA, 2015).

Importantly, the absorption of these heavy metals and toxins by pregnant mothers has been associated with birth defects because they interfere with production of red blood cell, and may result in liver and kidney deterioration and loss of coordination (EEA, 2015). Table A.2. in Appendix D includes certain health hazards resulting from burning wastes in open-air.

Therefore, and from what has been presented, burning waste generally releases toxic pollutants that leave direct and threatening hazards on the human health.

2.5. Pollution in Lebanon

Lebanon is considered one of the most polluted countries in the Middle East according to a WHO study in the year 2013 (WHO, 2013). In Lebanon, the sources of pollution are numerous and persistent with no serious measures to curb pollution levels in the near future. Emissions from the air come from a very large number of activities; figure 1 shows all these activities and their respective toxic emission percentages.

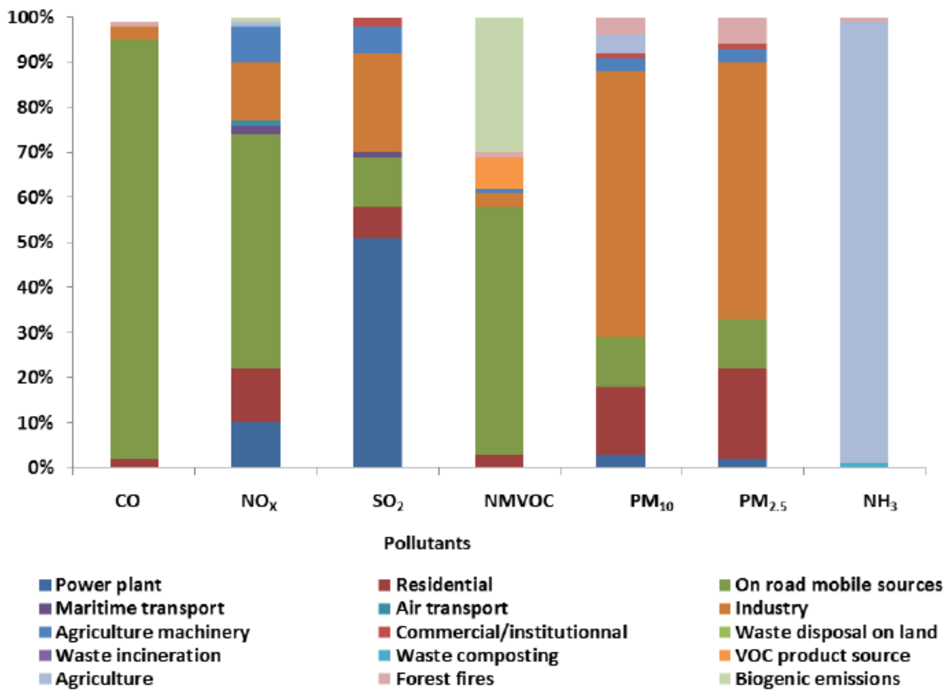

Figure 1: Emissions distribution for different pollutants for 2010 (Afif, Chabarekh, Mitri & Nagl, 2016)

The main sector that contributes to polluted air emissions is the transportation sector. The transportation sector including land, air and motive transportation, as the primary source of air pollution and accounted for more than 59% of the national (NO_x) emissions in 2005 (MOE, GEF & UNDP, 2005). This is due to the combustion of fossil fuels that release pollutants and cause damage to human health and to the ecosystem in general. Additionally, the energy sector in Lebanon is also considered one of the main contributors to air pollution and this contribution is increasing significantly due to the population growth that is occurring over the years. The energy sector emits black plumes of (CO), (CO_2), (SO_2), (NO_x), soot, (PMs) and other pollutants (MOE, GEF & UNDP, 2005).

Throughout the years, the concentrations and composition of air pollutants have differed extensively due to the on- going changes that are occurring in the Lebanese environment, community and general life styles.

Prior to the year 2000, and between the years 2006 and 2009, Lebanon had no data on pollution emissions. Moreover, data was only available for three major cities, namely Beirut, Chekka and Tripoli, depicting a major obstacle for air quality monitoring and for research to be done to develop and enhance air quality in Lebanon (MOE, UNDP & ECODIT, 2011). However, and due to all the negative effects of pollution, the Ministry of Environment (MEO) and under the Environmental Resources monitoring in Lebanon (ERML) project with the support of different UN associations, initiated “Real Time Air Quality Monitoring” in five sites in Lebanon. Two of these sites are now equipped with technological stations that are linked to online analyzers connected to a supervisory control and data acquisition system (DAS) located at the Ministry of Environment building in

Beirut- Downtown (MOE & LEDO, 2013). These stations are currently monitoring different levels of emissions across Lebanon; figure 2 shows the locations of these sites across Lebanon.

Figure 2: Distribution of some of the AQMS in Lebanon (ERLM, 2013)

Also, it is worth mentioning that some of the universities, local authorities, and companies have utilized some instruments for the measurement of airborne pollutants such as the American University of Beirut (AUB), University Saint- Joseph (USJ), University of Balamand (UOB), etc.

Figures 3 and 4, for example, show the yearly averages of (NO_2) and (PMs) in Beirut and Tripoli respectively collected by these monitors.

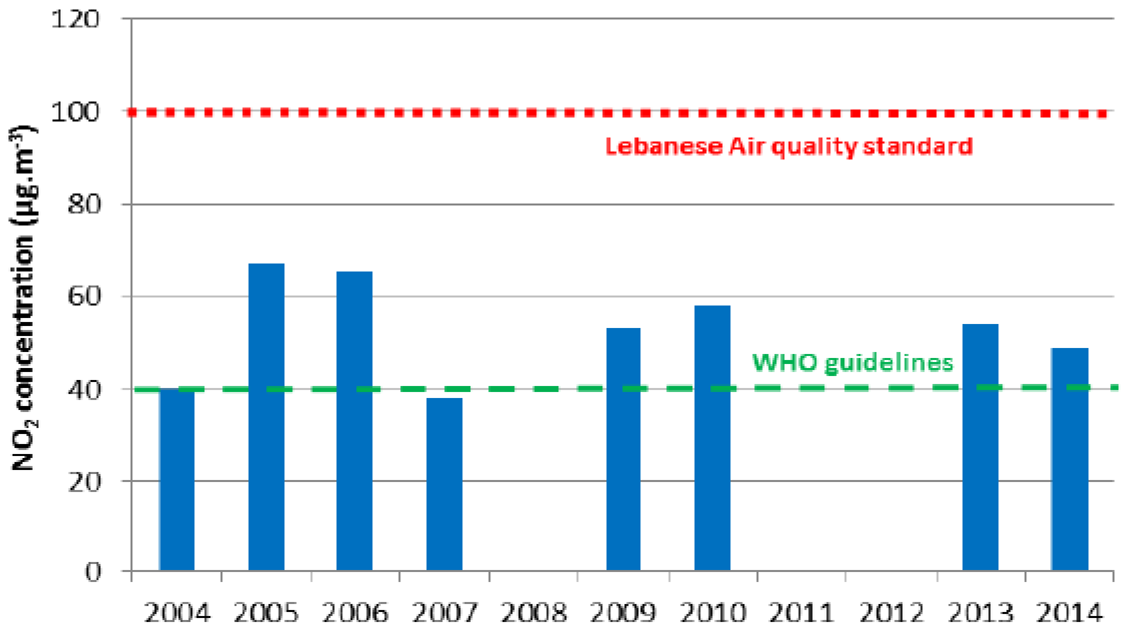

Figure 3: (NO_2) annual values over Greater Beirut Area (Afif et al., 2016)

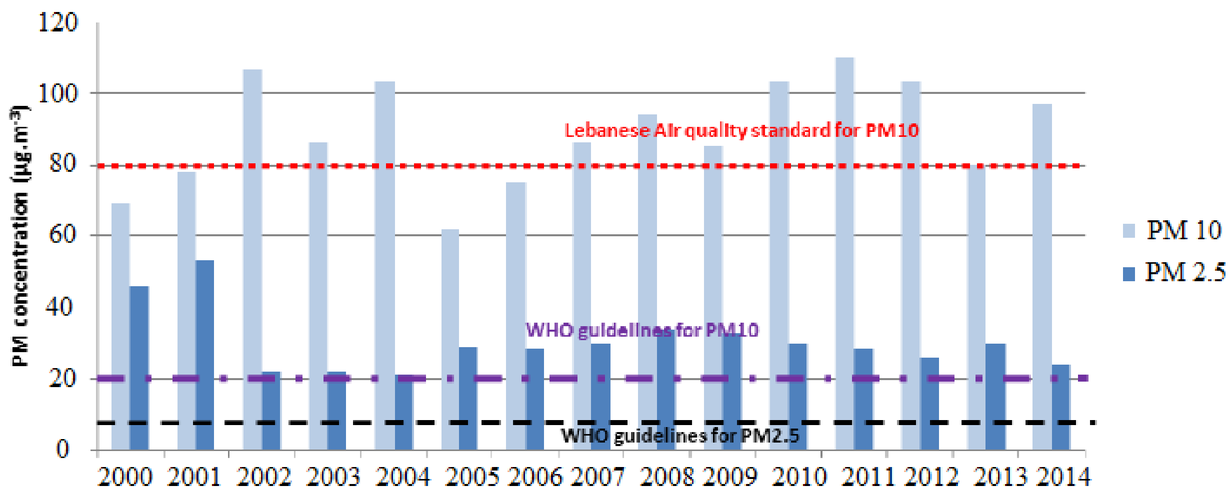

Figure 4: (PM) annual values over Tripoli (Afif et al., 2016)

Furthermore, the 2011 Syrian crisis has contributed to up to at least 20% of an increase in emissions of air pollutants in Lebanon, leading to more degradation of air quality (MOE, UN & UNDP, 2014).

Statistics regarding solid waste percentages in Lebanon show that 51% of the solid waste is disposed in open dumps, 32% is the disposed in landfills, 9% is composted and 8% is recycled (MOE & LEDO, 2013). This is because solid waste management in Beirut and Mount Lebanon is still performed according to the 1997 emergency plan that we discuss in detail later (MOE & LEDO, 2013). The improper waste management process and the inefficient tackling of this issue in the first place have been translated to around US$10 million degradation per year (Chabarekh, 2010).

However, before July of 2015, waste burning was not considered a huge concern to the Lebanese community. As a result, all previous studies performed regarding air pollution in Lebanon, did not consider the waste crisis that hit Lebanon in July 2015.

In 2016, a study was done by the Department of Chemistry at the American University of Beirut on the effects of open- air dumping and burning on local air quality and public health. This study measured the air quality during a two months period after the waste crisis of 2015 in a building near an open dump burning site east of Beirut. Results showed alarming increases in (PM_{10}), $(PM_{2.5})$, $(PAHs)$, dioxins, furans, etc. (Baalbaki et al., 2016). This can be effectively translated into an increase in short-term cancer risk and other alarming health hazards.

Although burning of municipal waste at a waste disposal site, expect for a limited number of specific materials, is prohibited under The Environmental Management and Production Act (2002) and the Clean Air Act, waste burning was performed on a regular basis throughout the Lebanese cities and villages (EMPA, 2000). It is also worth mentioning that the full requirements from burning are provided in the Municipal Refuse Management Regulations (MRMR, 1986) and the Clear Air Regulations. Yet, Lebanon, and since end of July 2015, has witnessed extensive waste burning in all cities and villages and at different increasing intensities that clearly violates all national and international standards and places great health risks on a large mass of people. Rima Baalbaki et al. (2016) provides data on the twenty – four hour averages of $(PM_{2.5})$ and (PM_{10}) levels during waste burning activities in October 2015; shown in figure 5 in comparison to the levels off annual emissions of (PM) between the years 2003 and 2014 shown in figure 6.

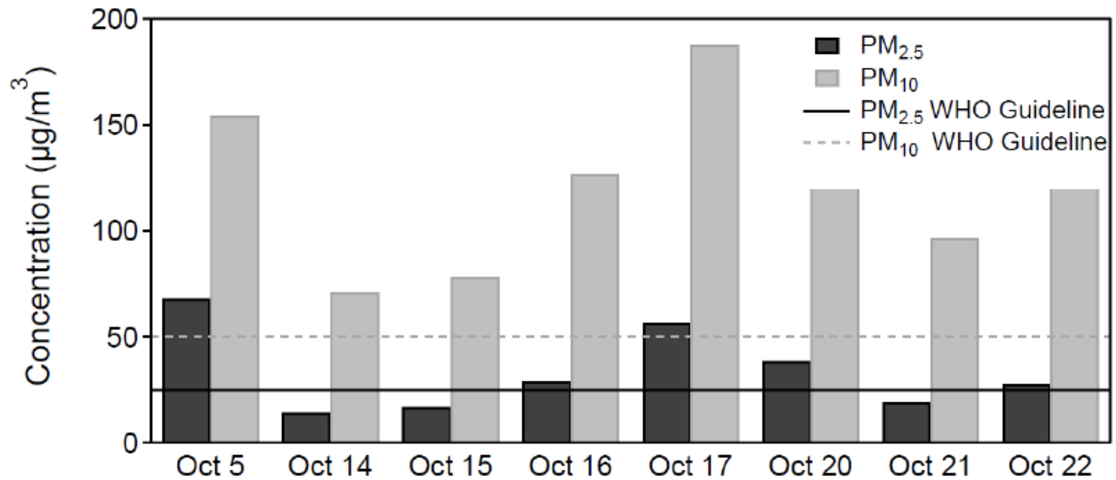

Figure 5: 24 hours averages of ($PM_{2.5}$) and (PM_{10}) during waste burning activities in Oct 2015 (Baalbaki et al., 2016)

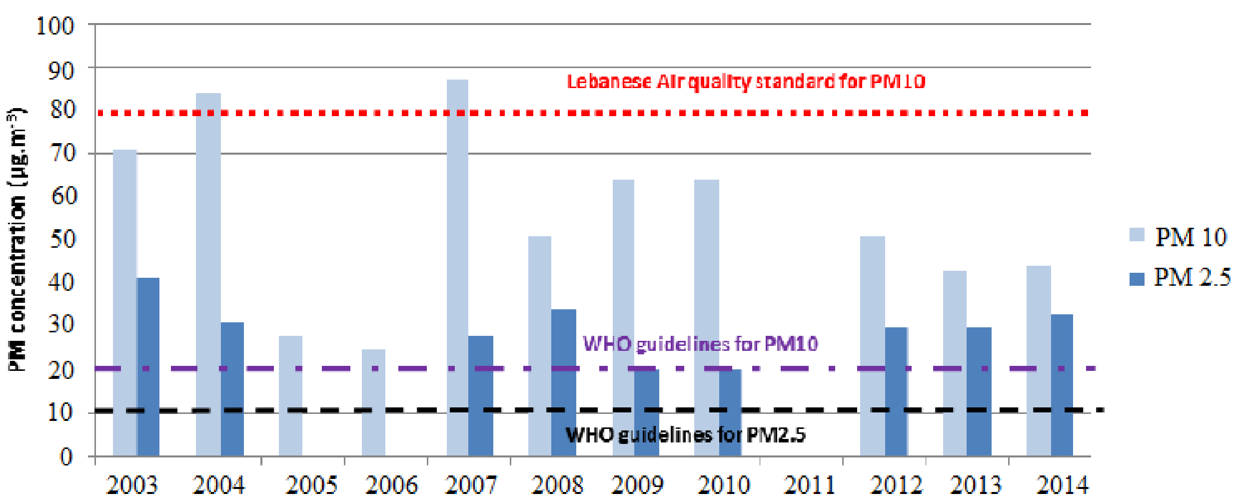

Figure 6: (PM) annual values over Greater Beirut Area (Afif et al., 2016)

In illustrating the above figures, we notice that levels of particulates in Lebanon have been, for the most part, above WHO levels and guidelines since the year 2003. Yet, in October of 2015, the monthly average (PM_{10}) levels reached $127\ \mu g/m^3$ compared to $45\ \mu g/m^3$in the year 2014. This difference in concentrations is most likely attributed to waste burning actions, since the site that was studied in 2015 was a residential site, away from major industrial activities and car traffic.

On the other hand, waste decomposition in Lebanon is as follows; 52.5% organic waste, 16% paper cardboard, 11.5 % plastics, 5.5 % metal waste, 3.5 % glass and 11% for other types of wastes. These are the percentages of 2,040,000 tons of annual municipal solid waste (MSW) (Sweepnet German Cooperation, 2014). Also, most industries in Lebanon are light manufacturing industries branched into food and beverages (20%), fabricated metal products (16%), non- metallic mineral products (12 %), furniture (11%), clothes and dyeing fur (10%), wood products (10%), leather products (16%) and textiles (4%) (Sweepnet German Cooperation, 2014). Waste generated by the industries is divided into non- hazardous wastes, with similar characteristics as municipal waste, and hazardous wastes as defined by the Basel convention that controls trans- boundary movements of hazardous wastes and their disposal (Basel Convention, 2011). Yet, most of the hazardous wastes are being mixed with the municipal wastes and gathered in collection trucks.

In addition to municipal and industrial wastes, the health care sector produces hazardous wastes. Medical wastes are highly dangerous and should be treated separately. However, in Lebanon, only 2% of the private medical laboratories, 20% of the public hospitals and 32% of the private hospitals treat their infectious wastes independently (Sweepnet German Cooperation, 2014). Shockingly, after treatment, the disposal of medical wastes is carried in municipal bins. Municipal solid waste (MSW) makes up about 90% of the total solid waste area in Lebanon. The main sources of MSW are household, commercial establishment, street markets, street cleaning, operations, and public garden pruning (MOE & LEDO, 2013).

From what has been presented, it is important to note that Lebanon has historically witnessed environmental shocks similar to that of July 2015. In 1970, for example, a similar crisis occurred and in 2006 and after the war with Israel, extensive air pollution followed. These occasions and much more were ceased after a short period of time; however, waste burning has been occurring frequently and in increased intensities after the Lebanese garbage crisis; the details of which will be discussed in the next chapter.

CHAPTER 3

THE WASTE CRISIS IN LEBANON

3.1. Waste Management in Lebanon

Every population living in a bordered area produces wastes of different types. Wastes can be categorized as organic wastes, clinical wastes, which are considered toxic wastes that include chemicals, recyclable wastes (paper, glass, plastics...), and other types. The state or municipality assumes responsibility towards properly managing population waste in the best possible way. They attempt to efficiently manage waste by recycling certain wastes and managing other wastes to reduce its effects on the environment. Unfortunately, the Lebanese government over the years has not been able to come up with a well- studied and efficient plan to manage solid wastes across the country.

3.2. History of Waste Management in Lebanon

After the civil war, the Lebanese government and in the process of rebuilding the country set a plan to manage solid wastes in municipalities. Accordingly, in 1994, Sukleen was founded by Maysarah Sukkar to manage waste in Beirut and Mount Lebanon regions. Sukleen is a private company performing public services, and funded by the Lebanese government (Sukleen, 2016).

Prior to 1997, Bourj Hamoud landfill was receiving wastes of Beirut and Mount Lebanon. Yet, in January of that year, the government gave the green light for the implementation of a plan submitted by Sukleen. The government at that time suggested ceasing the utilization of Bourj Hamoud landfill while establishing two new waste treatment incinerators;, one located in Karantina for sorting, fermenting, burning and pressing waste with a capacity of 1,100 tons per day, and the other located in Amroussieh with capacity of 600 tons per day (Boutros, 2015). The decision to launch these centers was delayed, increasing the burdens on the residents of Bourj Hammoud who were growing weary of the situation. Negotiations lead to extending the deadline for the closure of the landfill to July 15 of 1997 (Boutros, 2015). By July 20, 1997, the Bourj Hammoud landfill was closed, yet the residents of Amroussieh refused having an incinerator in their city. As a result, the country entered into a vicious cycle. Beirut's streets flooded with garbage and random dumpsites that filled most villages and cities in Lebanon as well. This was exacerbated by the fact that Sukleen halted waste collection because there was no landfill for proper or regular functions of waste management. With all the social anger and rejection of inefficient solutions and with the government's inability to come up with a sustainable solution, Al-Maramel area by the airport road became the de facto waste site (Boutros, 2015). The government permitted Sukleen to transfer waste to a temporary landfill on a state- owned property in Al- Maramel area, until the Amroussieh plant was equipped with guaranteed health standards (Boutros, 2015).

After a month of the closure of Bourj Hammoud Landfill at the end of August 1997, the unmanaged waste was burned in different regions. The government then came up with a solution. It signed a contract with Sukleen and Sukeme after supplying them with two landfills, one in Naameh and the other in Bsalim. However, environmental studies showed that the Bsalim site was not appropriate. Thus, Naameh became the only landfill that accepted Beirut and Mount Lebanon’s waste with no other site supplied by the government (Sukleen, 2015).

Furthermore and although the 1998- contract that was signed to use Naameh as a landfill for only six years, it was extended to last for seventeen years. The government and all responsible parties and institutions were knowledgeable about the deadline of the usage of this landfill; July 2015, so they had ample time to come up with a sustainable environmental plan to manage waste. However, since July 17, 2015, Lebanon has been reliving the same waste management problem it had in 1997. Similarly, Sukleen ceased waste collection resulting in mountains of garbage on streets, all gathered besides houses and schools, etc. Random, illegal landfills and open air incineration sites have dominated since (Hilal, Fadlallah, Jamal & El Jardali, 2015).

On the attempt of finding solutions, the Lebanese government suggested the transfer of wastes of Beirut and Mount Lebanon to different landfills distributed on different areas around Lebanon such as Costa- Brava landfill located on southern entrance of Beirut, Srar landfill in Akar, a landfill in Bekaa, and a landfill in Bourj Hammoud (Hilal, Fadlallah, Jamal & El Jardali, 2015). But the civil society and citizens refused to hold this burden that clearly didn’t have a specific solution in the near future. As a result, this crisis persisted and became even worse despite numerous solutions presented by ministers, environmentalists and social workers. These solutions included suggestions to exporting garbage to European countries; a bid that was ceased as it added huge financial burdens and was mainly refused by the civil society.

As a result, and instead of one landfill, for example, 21 dumpsites existed in Akkar alone since July 2015 according to the ministry of agriculture. Random dump-sites spread all over the country and the most significant sites were the ones in Jdayde-Sad El Boushriye, Jal El Dib, Antalyas, Aldawra, Sin el fil, Almansoriyeh, Bourj Hammoud, Hazmeyeh, Forn el Chibak, and Baabda (Hilal et al., 2015).

The numerous dump-sites included 38 dumpsites in Matin Caza alone and another 38 dumpsites in Kisirwan Caza, a dumpsite in Mkallis, municipality of Mansoriyeh in Matin, Ghazir in Kisirwan, and a dumpsite in Chouf. Also, Choifat and the united municipalities of Beirut suburbs chose to dump their wastes in an area beside the airport. While Horj area that used to be full with trees with an area of 20 thousand meters was transformed into random, illegal dumpsites by municipalities (Hilal et al., 2015). Therefore, and based on a study done by "Earth Association" and funded by UNEP for the municipality and environment included the work of twelve engineers and geological experts over a period of ten months, and stated there are 670 random dumpsites in Lebanon, 504 of them include organic, industrial, and clinical wastes and 166 include building wastes. All these random dumpsites round up to around 6,750,000 m^3 of waste (Hilal et al., 2015). The study listed the most dangerous dumpsites in Lebanon as follows:

- Saida
- Srar-Akkar
- Bar Elias-Zahle
- Qib Elias-Zahle
- Dayr Qanoon al Ayn (Sour)
- Adwa- Alminyeh
- Hamat-Albatroun
- Al Ghaziyeh-Saida
- Hableen-Jbeil
- Kfartibneet-Nabatiyeh
- Baalbak
- Alminyeh-Fnaydeq (Akkar)

- Hawsh rafqa-Baalbak
- Tamneen-Baalbak
- Zouk al Khrab – Matn
- Berfal-Akkar
- Rwaset al. Ballout – Baabda
- Bslooqeet- Zgharta

(Hilal et al., 2015)

After a month of the closure of Naameh landfill, wastes burning started taking place by municipalities on one hand and citizens on the other, with the aim to decrease the odors that have been accumulating and to take care of rodent and insect issues. Waste burning became the new norm in different regions and it took place in all random and illegal dumpsites across Lebanon. In short, this is how waste burning became a recurring and dangerous phenomenon in Lebanon.

CHAPTER 4

DIRECT PROVEN HEALTH EFFECTS OF WASTE BURNING EMISSIONS

4.1. The Fetus: Most Vulnerable Member of Society:

Unborn children are the most vulnerable members of the population. The fetus's exposure pattern and physiological immaturity are uniquely susceptible to having life-changing consequences if exposed to toxic damage. Biologically speaking, the fetus has no protective fat tissues until very late in the pregnancy stage and the majority of pollutants that we discussed in chapter II are considered fat soluble. This leads to the storage of these pollutants in the nervous system and in particular, the brain of the fetus that is considered the only present fatty tissue at this stage. At the same time, the fetus's organ system is in constant development and is thus considered much more vulnerable to environmental pollutants which lead to certain cases of cell proliferation and alteration in metabolic capabilities (Thompson & Anthony, 2008). This is because many pollutants are transported actively across the placenta; from the mother to the fetus. This particularly happens when the mother's body is subjected to heavy metals as the body mistakes these metals for essential minerals and absorbs them. This usually leads to neurodevelopmental problems in the new born (Thompson & Anthony, 2008). Furthermore, any environmental condition that interferes with trans-placental delivery of nutrients, from oxygen to other nutrients, may lead to varying degrees and types of intrauterine growth retardation (IUGR) that causes low birth weight (Thompson & Anthony, 2008).

4.2. Pollution and Low Birth Weight:

Birth weight is considered the main index determining the potential development and life quality of a newborn (Hizel & Coskun, 2000). However, birth outcomes are likely to be highly affected by conditions during the brief interval of pregnancy. So, birth weight is affected to a great extent by the mother's health conditions and exposures during pregnancy because it represents an end point of intrauterine growth, which develops on maternal, placental and fetal factors, as well as on a sequence of the constitutional and environmental influences (Wang, Ding, Ryan & Xu, 1997). Therefore, mother's exposure to pollutants during pregnancy has been shown to have adverse health effects on newborns biologically and theoretically especially because many factors affect the duration of gestation of a fetus. These factors affect the mother or the environment she is living in and play a significant role in determining infant's birth outcomes and thus future health.

A long list of pollutants that result from open- air waste burning cause certain and ever- lasting effects on the health of the newborn. One of the pollutants released from waste burning is carbon monoxide (CO). Carbon monoxide results from the incomplete combustion of any biomass, including tobacco and bio-fuels such as wood, and fibber residues, as well as fossil fuels such as coal and gas (EPA, 2010). Once inhaled, carbon monoxide combines with hemoglobin to form carbon-hemoglobin $(COHb)$ (EPA, 2010). Carbon-hemoglobin is a very stable compound that strongly captures oxygen (O_2) and ceases its path towards the peripheral tissues and organs, including the fetus . Thus, the resultant tissue, hypoxia, has the potential to reduce fetal growth. Similarly, particulate matter (PM), which is another pollutant emitted from waste burning, can enter the blood and lymph circulations, affecting sensitive targets such as the bone marrow and the heart and can cause damage in DNA as well (Boy, Nigel & Delgado, 2002). The damage that these pollutants can cause becomes dangerous to health because they are occurring at a very critical developmental period for the fetus where some important defenses against toxic pollutants, such as the blood- brain barrier, are not present yet (Curie, 2013). Moreover, another pollutant that is emitted from waste burning is ozone that is considered a highly reactive compound able to cause impairment of body tissues and reduction in lung function (Curie, 2013). Similarly, the relation between nitrogen oxides and sulfur oxides manifests itself in unfavorable effects of nitrogen oxides metabolites leading to strong oxidative stress forming “Reactive sulfur species (RSS)” that targets the embryo in its earliest phase of growth and development affecting its antioxidants enzymes (Mohorovic, 2004).

The most vulnerable time during human gestation is the period of organ formation during weeks 3, 8 and 12 following fertilization. The health consequences will usually depend on the nature of pollutants, their targets in the human body and the timing of the exposure that could range from a short period when the embryo is subjected to toxic agents or a long period where the effects become irreversible (Mohorovic, 2004).

In general, the factors that increase fetal susceptibility are higher rates of cell proliferation over immunological competence and decreased capability to detoxify carcinogens and repair DNA. This susceptibility is increased usually in the first 12 weeks after fertilization where tiny amounts of pollutants are able to threaten the delicate balance of the fetus’s body. Therefore, the pollutants or chemicals in general that do not place direct harm on an adult are of an excessive effect on the embryo. This has been shown by Porterfield (2008) who documents that small amounts of dioxins and PCBs at low toxic doses, can affect thyroid hormones and thus neurological functions (Thompson & Anthony, 2008). Furthermore, respiratory health effects of inhaled pollutants, for example, depend on the depth of penetration, deposition and retention in the lungs along with the simultaneous biological reactions triggered by the deposition of the materials. Since air pollution is able to affect the maternal respiratory system and general health, it is also able to harm utero-placental and umbilical blood flow, trans- placental glucose and total insulin formation, which are considered the major determinants of fetal growth (Wang, Ding, Ryan & Xu, 1997). All these factors could lead to low birth weight, intrauterine growth retardation and impaired growth and would influence the mere health status of a child, especially if these consequences occurred at early stages in life. This may also lead to mortality and morbidity in childhood with an increased risk of coronary heart diseases, diabetes and hypertension (WHO, 2005).

It is also worth mentioning that besides air pollution that affect the birth outcomes of the newborn and in particular, the birth weight; other factors from which we could list maternal age, pregnancy weight of the mother, history of adverse pregnancy outcomes, low social class and tobacco smoking are also associated with adverse birth outcomes (Wang, Ding, Ryan & Xu, 1997). Figure 7 shows the possible mechanisms that might cause adverse pregnancy outcomes.

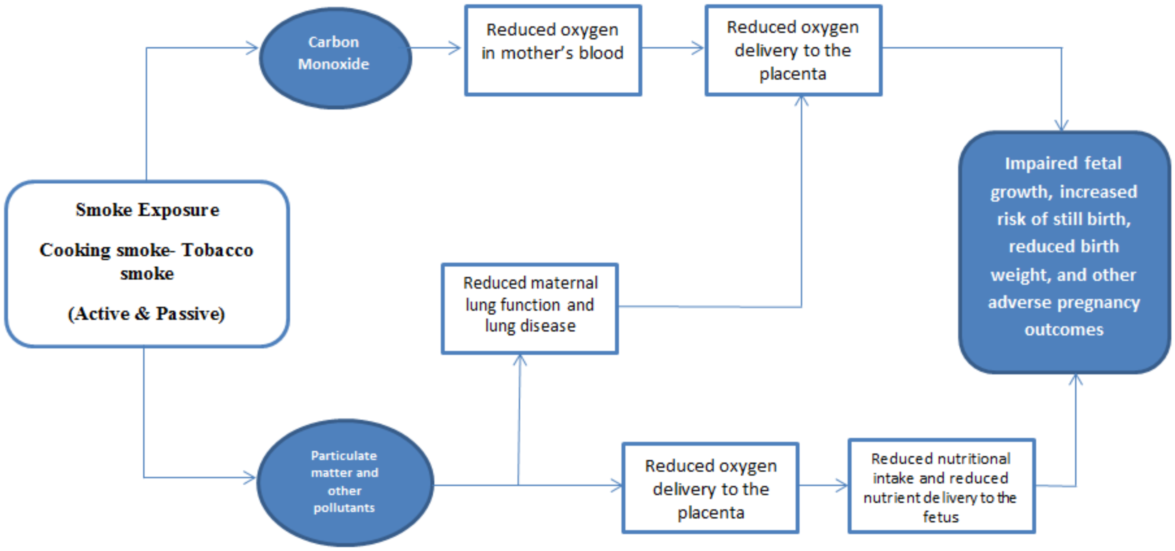

Figure 7: Possible mechanisms that might cause adverse pregnancy outcomes (WHO, 2005)

4.3. Literature about the Effect of Pollutants on Birth Weight:

As mentioned before, air pollution may affect infants either because pollutants cross the protective barrier of the placenta or because it affects the health of the mother by weakening her immune system. These same pollutants that affect the fetus can as well directly affect the infants after birth. This is why pregnant woman, fetuses and young children along with elderly people are the most vulnerable subjects to any environmental shock.

Previous epidemiological research done on the effects of moderate pollution levels on prenatal health suggests negative effects. Yet these results are not consistent at all times (Currie, Neidell, & Schmieder, 2009). Molecular and epidemiological research has shown that fetuses, infants and young children are more susceptible than adults to the negative effects of a number of pollutants including polycyclic aromatic hydrocarbons (PAHs), lead and environmental tobacco smoke (ETS) (Currie, Neidell, & Schmieder, 2009).

In previous chapters, we have discussed the risks of inhaling pollutants such as polycyclic aromatic hydrocarbons (PAHs) that are toxic, mutagenic and carcinogenic air pollutants that are released due to incomplete combustion of coal, diesel and gasoline and are produced by waste burning (Saliba, 2005). When pollutants reach the placenta, body enzymes act on chemicals and process them into toxic or non- toxic metabolites that can enter the fetal blood stream and accumulate (Sexton et al., 2011). The greater risks of (PAHs) are that they are able to mutate DNA leaving a direct link to cancer and neurodevelopment malfunction. This has been documented by experimental animal studies that have shown that some elements of (PAH) (benzopyrene Ban) are reproductive toxicants that are able to produce a number of neurodevelopment effects and reduce birth weight, birth length and head circumference (Sexton et al., 2011). The exposure to toxicants in air may take time to develop diseases, so this exposure might originally appear harmless but its accumulation throughout the years results in the formation of chronic diseases such as bronchitis, emphysema and most cancers that usually take up to 20 years to develop, not to mention the potential for long-term damage to the lungs, nervous system, kidneys and liver.

Much of the literature, since 1970, focuses on six classifications of air pollutants: Particulate matter (PMs), carbon monoxide (CO), ozone, lead, sulfur dioxide, and nitrous oxide (Currie, 2013). Moreover, dosimeter studies by Wilhelm and Ritz (2005), indicate that the total deposition part of ultrafine particles increases as particle size decreases. This is because ultrafine is able to escape barriers and translocate to extra pulmonary organs. At this stage, they transfer potentially toxic compounds linked to these particles (PAH) to the fetus and the placenta. These studies have also shown that similar compounds are able to interfere with placental development and subsequent nutrient and oxygen delivery to the fetus (Wilhelm & Ritz, 2005). Additionally, infant health effects might reflect pollution exposure that occurred in previous times and thus the link between cause and effect is much more immediate than adult diseases (Currie, 2013). Therefore, infant health outcomes are the ideal criteria to study whether existing environmental pollutants have detectable negative effects on human health or not (Currie, 2013).

4.4. Studies and Low Birth Weight:

In developed, industrialized countries, extensive epidemiological studies have been conducted on the issue of low birth weight. Yet, limited studies have been done in less developed countries due to the limitations of reliable data on birth weight and on pollution levels. In developing countries, more than 40% of babies have incomplete vital birth data and registration information because they are born at home (WHO, 2015). Further, birth weight should be measured within the first hour of life, before significant weight loss occurs and this is not done properly in developing countries (WHO, 2015). This is despite the fact that, in developing countries, air pollution is of greater intensity and effect as we have shown earlier. Additionally, developing countries, not only suffer from outdoor pollution, but also suffer from extensive indoor pollution as well as they mostly rely on bio-fuels as a primary source of heating (WHO, 2015).

Wiedinmyer, (2014) investigated air pollution produced by burning different materials in developing countries. In her results, she has found that around 1.1 billion tons of waste, which sums up to more than 40 % of the world's garbage, is burned in open piles, contributing to more emissions than is shown in regional and global inventories. An estimated 40 to 50 % of the garbage is made up of carbon by mass, which means that carbon dioxide is the major gas emitted by waste burning. Those emissions are released by other sources globally, such as cars and power plants in greater amounts. But the carbon dioxide that comes from waste burning can be a significant source of emissions in some countries or regions in addition to a significant number of other pollutants. 29% of global anthropogenic emissions of small particulate matter which are defined as tiny solid particles and liquid droplets from dust to metals that can penetrate deep into the lungs come from waste burning (Wiedinmyer et al., 2014). Wiedinmyer's (2014) results show that about 10 % of mercury emissions come from open air burning, as well as 40 % of polycyclic aromatic hydrocarbons (PAHs). These results were emphasized by Baalbaki et al. (2016) work on open air burning sites in Beirut, Lebanon. This study, which is considered an innovative one, alarmed all concerned parties about the catastrophic effects of open air waste burning on health in general. Their results show that combined short-term (2 years) incremental cancer risk from exposure to PAH and PCDD/Fs averaged at 20 cancer cases per million people compared to 1 cancer case per million people when no burning waste were carried out---a remarkable twenty-fold difference. More alarming results show an increase in the risk of cancer to 65 cases per million people merely due to inhalation of PCDP/Fs.

Additionally, emissions from burning trash including tires and plastics and other manufactured articles are considered extremely toxic according to Indiana Department of Environmental Management. Even burning clean wood and yard waste, including leaves, yields smoke that can harm human health, the community's health and the environment. In studying the air quality in Indiana, they found that smoke from burning household trash is very toxic and found dioxins, arsenic, mercury, chromium, PCBs, lead and other dangerous emissions.

In developing countries, open air waste burning occurs frequently. However, in Lebanon, these results were arguably more drastic as the country was faced with a sudden shock, where open air waste burning occurred after a month of the garbage crisis and continued till today's date with different intensities according to the regions. It is the first time that the Lebanese population faces such high amounts of pollutants in such a short time and thus we expect that this exposure will have adverse health effects on newborns in the short and long run.

Although it has been recognized worldwide, that low birth weight is of high importance and significance in developing countries, reliable data on its intensity and occurrence are still limited. It has been estimated that 20.5 million low birth weight infants were born in 1995 and that 16% of all newborns in developing countries are considered low birth weight (Kramer, 2003). This topic thus becomes of great importance today due to population growth coupled with industrialization and development. Nowadays, around half of the world's population, about 3 billion people, depend on solid fuels such as wood, animal dung, crop residues, and coal, for every day needs. Majority of this fuel is burned in open fires and simple stoves with minimal ventilation, leading to higher levels of smoke exposure. Burning waste as well has increased recently thus drastically increasing pollution levels. Particularly in Lebanon waste burning occurred suddenly and lasted for a considerably long time, thus increasing the possibility of negative health effects. A WHO competitive Risk Assessment report estimated that exposure to such pollutants is responsible for around 1.5 million excess deaths annually (WHO, 2015). This number was limited to severe lower respiratory infections in children below 5 years and chronic obstructive lung diseases in adults with lung cancer (WHO, 2005). Yet, new evidence shows that air pollution due to waste burning and household air pollution increases the risk of other critical health conditions such as tuberculosis, asthma, cataract, low birth weight and prenatal mortality (WHO, 2005).

In our study, we focus on the effects of emissions from waste burning on birth outcomes; birth weight, birth height and head circumference. Low birth weight has been defined by the World Health Organization as weight at birth of less than 2500 grams (5.5 pounds) (WHO, 2005). This definition is based on epidemiological observations that infants weighting less than 2500 grams are approximately 20 times more likely to die than heavier babies where it is estimated that more than 20 million infants worldwide (15.5%) of all births are born with low birth weight, 95.6% of them are in developing countries (WHO, 2005).

Low birth weight is established as an important risk factor for infant mortality and morbidity and is considered as an important predictor of future health. However, it is important to mention that low birth weight also results from various factors that determine as well premature birth, intrauterine growth retardation or both outcomes (Boy et al., 2002). Also, the mortality rate of low weight infants is 40 times as much compared with normal birth weight (Boy et al., 2002). Sensitivity and low immaturity of these infants makes them vulnerable to different diseases as well (Oskouie et al., 2006). Low birth weight also remains a very important risk factor for pneumonia and other serious adverse health outcomes for infants especially in developing countries. Thus low birth weight became extensively used as an important public health indicator that includes long term maternal amputation, environmental shocks exposure and other factors.

The following formula is used to calculate the percentage of low birth weight newborns in a country:

$$\frac{Number\ of\ live\ born\ babies\ with\ birth\ weight < 2500\ g}{Number\ of\ live\ births} \times 100$$ (WHO, 2005)

Generally, the uterus is considered a secured environment that protects the fetus through development; yet this protection is not full. Besides genetic characteristics, various environmental factors result in different birth outcomes; most importantly, pollution, cigarette smoking, low caloric intake or high weight gain during pregnancy along with socioeconomic conditions.

Due to all the mentioned effects, public health significance of this research is evident, making the research on this topic a vital health issue that leaves direct impact on the development of valid risk management strategies for air pollution. The majority of studies on topic were conducted in the United States and Europe, while fewer studies were conducted in African and Asian countries. Several studies have examined how weather and pollution affect birth outcomes; yet results vary between each. Some studies identify associations between the two where others did not find a relation (Bell et al., 2007). A large body of literature has documented both severe and persistent adverse health effects of air pollution (Wang, Ding, Ryan & Xu, 1997). However, epidemiological studies regarding health and pollution exist widely yet economic studies are scarce and suffer from the endogeneity problems of pollution exposure; i.e. place of residence is not assigned randomly.

It is worth mentioning that birth weight is usually determined by two processes; the duration of gestation and the rate of fetal growth. Thus WHO defines early birth as birth before the 37 weeks of gestation and this may results in a birth weight of 2500 g or less (Kramer, 2003).

The first study was conducted in Loss Angeles; California in the early 1970s. This study showed a lower mean birth weight for newborns whose mothers lived in highly polluted areas (Oskouie et al., 2006).

Another specific group of studies focused on health immediately after birth by studying low birth weight, preterm birth, infant mortality and gestational age. A group of researchers studied the relation between maternal exposure to air pollution during periods of pregnancy and birth weight in Beijing, China between 1988 and 1991 including 74,671 live births and adjusting for gestational age, residence, year of birth, maternal age, and infant gender. They used multiple linear regressions and logistic regression to estimate the effects. They found that estimated reduction in birth weight of 7.3 grams was for each $100\mu g/m^3$ in (SO_2) concentration and 6.9 g for each $100\mu g/m^3$ increase in total suspended particles (TSP) (Wang, Ding, Ryan & Xu, 1997). Another cohort study of Chinese woman living in Beijing found a direct association between total suspended particles (TSP) and increased risk of low weight delivery.

A group of researchers in Tehran; Iran conducted a study to determine the effects of maternal exposures to essential air pollutants on low birth weight. They find that low birth weight ratios increased due to exposure to carbon monoxide, sulfur dioxide, nitrogen dioxide and ozone in the third trimester of pregnancy (Oskouie et al., 2006). However, they did not find statistically significant trends in low birth weight ratios in the case of particulate matter (PM_{10}). The logistic model they used confirmed that the highest risk for low birth weight was related to (CO). Additionally, multiple regressions revealed (CO) as the most effective air pollutant in lowering the birth weight (Oskouie et al., 2006).

Black et al. (2007) conducted a study in Connecticut and Massachusetts in order to test whether the maternal exposure to particulate matter ($PM_{10}, PM_{2.5}$) and other gases in polluted air would affect birth weight. This study controlled for different parameters such as gestation length, parental care, type of delivery and other variables and found that interquartile increase in gestational exposure to (NO_2), (CO), (PM_{10}), and ($PM_{2.5}$) lowered birth weight by 8.9 g, 16.2 g, 8.2 g and 14.7 g respectively (Black et al., 2007). They also used a linear model with birth weight as a continuous variable and a logistic model comparing low weight and non- low weight births. They concluded that maternal exposures to such pollutants even at low concentrations may increase the risk of low birth weight (Black et al., 2007).

Another paper by Woodruff et al. (2003), evaluated whether mothers at higher risk of poor birth outcomes live in areas of higher air pollution and whether higher exposure to air pollution contributes to poor birth outcomes. In this study, a simple linear regression was used to estimate associations between the air pollution index and maternal race and educational attainment as a determinant of socio- economic status, controlling for age, marital status and region of the country. This was complemented by logistic regression models both to estimate the effect of living in countries with the highest levels of air pollution for different racial groups and by educational attainment, adjusting for other maternal risk factors and the estimate effects of living in countries with higher levels of air pollution on paternal delivery and births small for gestational age (Woodruff et al., 2003).

Bharadwaj et al. (2008) studied the effects of air pollution on birth weight in Santiago; Chile, that is considered one of the most polluted cities in the world. They used IV estimation method with rainfall as an instrument for pollution exposure. They found that a one standard deviation increase in pollution decreases birth weight by 125 grams. They thus linked low birth weight to negative long run impacts to the Chilean GDP. They also examined the impact of waste burning (PM_{10} measures and other pollutants) on birth weight, probability or the likelihood of being low weighted at birth and very low birth weight. They found out that rainfall has a strong diluting effect on atmospheric air pollution where rain reduces air pollution by about 90% for that day and few days coming (Bharadwaj et al., 2008).

Basu et al. (2003), researchers extended the research using data on ambient air toxins and criteria pollutants provided by a network of monitors managed by the California Air Resources Board (CARB), to estimate exposures for a larger number of births and a time span of 12 years. They conducted exposure estimates for the entire pregnancy which is on a period of three trimesters. This study found that mothers living in Los Angeles, who get exposed to higher levels of exhaust fumes due to traffic in the third trimester, have greater odds of delivering a low-weighted baby (Basu et al., 2003). They observed approximately 5% increase odds of term low birth weight of estimated levels of nitric oxide, nitrogen dioxide, and nitrogen oxides, and 1 to 3% increased odds per increase in measured levels of PAHs, benzene, xylene, and toluene.

Mohorovic (2004) conducted a study to define the most critical gestation period for adverse effects of environmental toxics in terms of preterm delivery (defined as less than 37 weeks) and low birth weight in a human beings. They did this study on pregnant woman living in the area where a coal power plant is utilized. They found out that greater and larger exposure to (SO_2) emissions during the initial two months of pregnancy resulted in a significantly shorter gestation and in low body mass of the newborn. They concluded that the results of the study confirm the role of environmental pollutants in the early development of human and embryo (Mohorovic, 2004).

Currie, Neidell, & Schmieder (2009) studied air pollution and infant health in New Jersey. The estimates of this study confirmed that carbon monoxide has a significant effect on fetal health even at relatively low levels of pollution experienced in New Jersey in recent years. They estimated that a one unit change in mean carbon monoxide (CO) during the last trimester of pregnancy increases the risk of low birth weight by 8% (Currie, Neidell, & Schmieder, 2009).

Boy, Bruce, & Delgado (2002) look at the effect of bio-fuel smoke on birth weight. They consider that it is essential to examine the effect of indoor smoke exposure and low birth weight in developing- countries, taking Guatemala as their study field and using linear regressions with the GLM procedure. They find that children born to mothers cooking in open air fires had the lowest mean birth weight of 2.819 g (Boy et al., 2002).

Similarly, a study done by Dugandzic, Dodds, Steib, & Doiron, (2006) in the city of Nova Scotia in Canada found in the investigation that in this city where the primary local sources of air pollution are the industrial sector, generation of electrical power, residential fuel, wood combustion and transportation, increased risks of low birth weight are noticed for mothers living in the highest exposure quartile of (PM_{10}) and (SO_2) during the first trimester. They also found a 33- 36% increase in the risk of low birth weight linked with maternal exposures during the first trimester to the greater 75th percentile for (PM_{10}) and (SO_2) respectively. So, (SO_2) exposures during the first trimester exhibited a significant association with low birth weight (Dugandzic et al., 2006).

The World Health Organization (2005) expanded a paper by using the findings of representatives of research groups that perform studies of biomass smoke pollution and low birth weight in developing countries. They built as well on recent works on air pollution and low birth weight from the state of California. From the five studies they received, all estimates were statistically significant showing that exposure to pollutants by mothers lead to low birth weights (WHO, 2005).

The majority of the literature studying the effects of air pollution on health outcomes has focused on the relation between pollutants and birth weight. Liu et al. (2003) found out that (SO_2) in the first month of pregnancy increases the risk of the birth of a low weight baby. Mainsonet et al. (2001) found that (CO) inhalation in the last trimester of the pregnancy and (SO_2) inhalation in the second trimester also increase incidence of low birth weight. Brauer et al. (2008) associated low birth weight with ($PM_{2.5}$).Parker et al. (2005), found out that exposure to ($PM_{2.5}$) is associated with low birth weight. Parker & Woodruff

(2008) found that (PM_{10}) is associated with low birth weight and Rogers and Dunlop (2006) found that (PM_{10}) is associated with very low birth weight in rural countries in Georgia. Similarly, Wilherm and Ritz (2005) found that (CO) and (PM_{10}) are associated with low birth weight if the mother during pregnancy was living within 1 mile of a polluted area.

Other studies have also looked at the effects of specific pollutants of specific groups of mothers. A study done in Brownsville, Texas by Sexton et al. (2011) concentrated on the relation between poly cyclic aromatic hydrocarbons and its concentrations in the body of Hispanic mothers and their fetuses to show that such pollutants, regardless of health effects, is found and accumulates in the body upon exposure. They have shown that low exposure results in accumulation of PAHs in both the mother's and fetuses' body and that this fact definitely raises public health concerns.

Another study conducted in the city of Ankara; Turkey by Hizel & Coskun (2000) found out that the difference between birth weights was greater if the fetus was exposed to air pollutants during the third trimester. Wang et al. (1997) also showed the significance of the third trimester on fetal growth. Additionally, in Zimbabwe, one of the studies done by Mishra, Dia, Smith & Mika (2004) examined the association between the indoor use of biomass fuels and birth weight. They used a multiple regression method after controlling for education nutritional status, pregnancy care and other factors. They found out that newborns who are born to mothers exposed to indoor smoke from the combustion of biomass fuel were 175 grams less on average compared with the mothers living in households that depend on electricity (Mishra, Dia, Smith & Mika, 2004).

Three reviews summarized scientific evidence regarding the association between air pollution and birth weight. The results were inconsistent. One review concluded that the effects of air pollution on low birth weight are not fully apparent and that current scientific knowledge is limited. Moreover, the present scientific knowledge is still limited and needs further studies (Maison et al., 2004). Another study determined that particulate matter (PMs) has generally no effect on fetal growth and the topic needs more research (Glinlalaia et al., 2004). A much more recent review showed, in relevance to the existing literature, that there exists a causal link between air pollution and birth weight. However, further investigation is still needed as well (Sram et al., 2005).

Other studies done in California (Salam et al., 2008), and in Nevada (Chen et al., 2002) found no significant effects of (PM_{10}) pollution on birth weight and other birth outcomes. Nishijo et al. (2002) focused on Cadmium as a cause for low birth weight and low birth height. This study found out that the height and weight of new born infants of mothers with higher urinary cadmium were significantly lower compared with mothers with lower cadmium in their body. So, they concluded that maternal exposure to cadmium favors the risk of early delivery that leads to low birth weight (Nishijo et al., 2002). In a recent paper, Currie, Neidell, and Schmieder (2009), studied the fetal exposure to toxic releases and infant health. They controlled for country-year means of indicators for maternal age, race, ethnicity, education and other factors. They also controlled for year and country fixed effects. All the coefficients of different pollutants showed negative effects on birth outcomes that were previously estimated. They also studied cadmium exposure and found that a two standard deviation change in cadmium emissions would increase the probability of low birth weight by 1.2% and the probability of very low birth weight of 1.4%.

On the other hand, it is important to note that not only birth weight is studied, but also birth height is considered, though not in the same intensity and extent. Bobak et al., (2004), for example, studied the relation between children's height and outdoor air pollution. After controlling for socioeconomic factors, they found out that air pollution was associated with children's height at several ages. This association was most evident at the age of seven years, when in comparing the height of children in polluted and unpolluted areas; it was shown that children in polluted areas were 1.2 cm shorter than those in least polluted areas. In this study and in accordance with other papers who reviewed the studies that examined the association between air pollution and height of children, it has been shown that air pollution is associated with low birth weight and thus leads to shorter stature in children. At the same time, frequent respiratory illness due to air pollution might also cause shorter stature in children as Rona found in 1981. A cross-sectional study of preschool children in the Czech Republic, for example, found an inverse relation between outdoor levels of nitrogen oxides and sulfur dioxide and average heights of children. Thus, a 50 $\mu g/m^3$increase in annual mean sulfur dioxide concentration was related to 0.7 cm reduction in height (Pikhart et al., 2002). Similarly, another study done by Jedrychouski et al. (2002) followed a group of nine year old children in Poland for two years. This study found out that the growth rate of children living in a polluted region was 1.5 cm lower than in a controlled area.

Other papers have as well looked at young children and not just at the fetus only. Coneus & Spiess (2007) examine the impact of outdoor and indoor pollution on children's health from birth until the age of three years in Germany. In this paper, researchers were able to study the effect of pollution exposure on child's health during the first three years of life. The results show a significant negative impact of pollution exposure on infant health during childhood. Researchers also find that indoor pollution is more harmful on children but this fact changes at adulthood where outdoor pollution becomes much more harmful. It is significant that papers in the epidemiological literature carefully control for observable characteristics, yet they are not able to tackle the issue of bias due to unobservable factors.

Today, it has been generally accepted that it is essential to reduce air pollution in all possible methods in order to reduce the consequent burden of disease and disability. Birth outcomes become a monitored health indicator for environmental shocks if our study shows a causal relation between pollutants and these birth outcomes. These outcomes will also indicate the long term impacts on the overall growth of the society as well as the productivity of individuals alongside to skill formation and development among children.

CHAPTER 5

DATA

No comprehensive data for waste burning locations and emissions in Lebanon currently exists. Air quality monitors are limited in Lebanon and results are not shared with the public. However, evidence of the huge adverse environmental spikes due to the waste crisis have been documented by Baalbaki et al. (2016) for certain areas. For data on waste burning, we construct a new dataset of waste burning sites in Lebanon, using the universe of fires listed on the Lebanese Civil Defense's website. This includes "daily chores" and all the regions and locations where fires due to waste burning have been put out. As a result, one limitation of our data, is that it is limited to fires that the civil defense were able to reach. To the extent that the civil defense did not reach all waste fires, this will most likely understate our results.

5.1. Data on Waste Burning Sites:

The Civil Defense in Lebanon has thirteen stations all over Lebanon: Antelyas, Al Hadath- Ashrafiyeh, Al Dikwani, Sad El Bawshriyeh, Baabdat, Hamra, Ras Al Harf, Ras Al Matn, Aramoun, Bsaleem, and Bhamdoun. Table A.3. in Appendix E contains all the regions where civil defense stations are located.

5.2. Data on Birth Outcomes:

We collected detailed data on all newborns delivered at the American University of Beirut Medical Center, one of the largest hospitals in Lebanon serving patients from all regions of Lebanon. This data was collected from the medical records of AUBMC from the beginning of 2014 until March 2017. Knowing that the shocks started occurring at the end of July 2015; 2014 is used as a control year. Data consists of birth weight, height, head circumference, mother's age at delivery, occupational status of the mother during pregnancy (region of residence), weeks of pregnancy (gestational age), and delivery costs funder. In our study, we exclude families with hereditary diseases from our sample. Table A.4. in Appendix F includes the complete data set of waste burning regions in Lebanon.

CHAPTER 6

EMPIRICAL STRATEGY

Interest in studying the effects of early lifetime shocks on infant health has increased over the years. This is partially due to the growing interest in environmental policies as well as mounting evidence that early lifetime shocks have huge impacts on human capital formation, especially at birth. This study identifies off of one such large and recent shock; the Lebanese waste crisis. Pollution is not random and variation in pollution exposure correlated with other factors that affect the health of an infant. For instance, (Currie, 2011) documents that infants born in polluted areas have simultaneously younger mothers with less education and thus are seen as less likely to ask for or receive prenatal care. Such differences and other unobserved factors could explain the poor outcomes of infants living in polluted areas that are independent of pollution exposure. Thus, a simple cross section comparison of those exposed and not exposed to pollution will not allow us to derive a causal link between pollution and outcomes; rather we would most likely be observing a simple correlation.

What is significant in Lebanon, and after looking at the regions where burning wastes was taking place, is that burning wastes occurred in rich and poor areas rather equally as the locations in Appendix F show. As a result, the overall health outcomes of poorer residents might be worse, due to omitted factors, but the garbage shock should affect the poor and rich equally. At the same time, the literature has shown that smoking mothers tend to have newborns with lower birth weights and heights- however to the extent that we are able to compare within regions that have similar mothers' characteristics; this will not be a significant problem in our study.

In this paper, we report results using the most basic OLS model, a comparison of means between exposed and non- exposed mothers to a more saturated OLS model with controls. In our saturated models, we use fixed effect regressions to study the relationship between burning wastes and birth outcomes during the waste crisis in Lebanon. The main treatment of interest in all models is exposure to waste burning during pregnancy. Finally, it is essential to mention that during data collection, we excluded newborns that could have received some heredity diseases from their parents.

In this thesis, we aim to study the relationship between waste burning emissions and birth outcomes. Endogeneity occurs when the dependent variable is correlated with the error term. This means that the exception of the error term (u_i) with (x_i) is different than zero and thus there is a relation between them. In our context, it is highly possible that other factors affecting infants' health are also correlated with exposure to pollution. For example, living in a poorer area increases the likelihood of pollution exposure. At the same time, poverty alone could cause poor health outcomes for infants, through poorer nutrition for example. Thus if we use the simple OLS model; $Y = Bx_i + u_i$ to study the effect of waste burning (x_i) on birth weight (y_i), $\widehat{B}$ will most likely be a biased estimate. This is because there are unobserved factors that affect birth weight other than waste burning. For example, newborns of a poor community are predicted to have low birth weight due to mothers' malnutrition and thus a simple OLS regression would bias the estimate upwards. From this we know that one source of endogeneity is omitted variables bias.

In our model, “treatment” variable is defined as whether the mother was exposed to waste burning emissions during her pregnancy, or not. The outcomes are all observed at birth: Birth Weight (BW), Birth Height (BH), gestation and Head Circumference (HC). Therefore, our simple OLS regression equation becomes:

(1) $y_{irt} = a + \beta_1 treatment_{irt} + u_{irt}$

Where y_{irt} is birth weight less than or equal to 2500 grams for individual (i) in region (r) at time (t). We are concerned with (β_1) the coefficient of the treatment variable that shows the relation between the exposure to waste burning and low birth weight.

For the percentage effect, we take the logarithm of the dependent variable.

$$log y_{irt} = \beta_1 treatment_{irt} + u_{irt}$$

The OLS regression with controls becomes:

(2) $y_{irt} = a + \beta_1 treatment_{irt} + \beta_2\, maternalage_{irt} + u_{irt}$

$$log(BW)_{irt} = \beta_1 treatment_{irt} + \beta_2\, maternalage_{irt} + u_{irt}$$

We then attempt to control for unobserved heterogeneity by estimating year, region and month fixed effect models:

(3) $y_{irt} = a + \beta_1^*\, treatment_{irt} + \beta_2^*\, maternalage_{irt} + \gamma_t + \delta_r + \emptyset_m + u_{irt}$

$$\log(BW)_{irt} = a + \beta_1^*\, treatment_{irt} + \beta_2^*\, maternalage_{irt} + \gamma_t + \delta_r + \emptyset_m + u_{irt}$$

Where (γ_t) is a time is fixed effect, (δ_r) is a region fixed effect and $\emptyset_m$ is month of birth fixed effect and BW is birth weight.

(γ_t) controls for year specific conditions and events, (δ_r) controls for all region specific characteristics that differ between the different regions included in our study and $(\emptyset_m)$

controls for seasonality of birth outcomes. For example, if January babies have, on average, worse outcomes.

An important condition to study the effect of waste burning is that the change in mother's exposure is uncorrelated with other specific characteristics of families and regions and time that may affect newborn health outcomes. A comparison between the results using equations (1), (2) and (3) will indicate whether omitted variable is a huge issue in this study.

Finally, we look at heterogeneous treatment effects to test the significance of the trimester exposure in order to check whether exposure during one of the three trimesters has greater effects on birth outcomes. The equations used are the following:

$$y_{irt} = a + \beta_1^* \, treatment\ 1_{irt} + \beta_2^* \, maternalage_{irt} + \gamma_t + \delta_r + \emptyset_m + u_{irt}$$

Where treatment1 is the exposure to waste burning emissions during the first trimester

$$y_{irt} = a + \beta_1^* \, treatment2_{irt} + \beta_2^* \, maternalage_{irt} + \gamma_t + \delta_r + \emptyset_m + u_{irt}$$

Where treatment2 is the exposure to waste burning emissions in the second trimester

$$y_{irt} = a + \beta_1^* \, treatment3_{irt} + \beta_2^* \, maternalage_{irt} + \gamma_t + \delta_r + \emptyset_m + u_{irt}$$

Where treatment3 is the exposure to waste burning emissions during the third trimester.

CHAPTER 7

RESULTS, ANALYSIS AND DISCUSSION

7.1. Results and Analysis:

In Table 3, the first column represents the simple OLS regression. The second column reports the OLS regression with controls, the third represents the fixed effect model with time fixed effects only and the fourth column represents the fixed effect model with time and region effects. In all models we cluster standard errors at the regional level to account for correlated shocks within individuals residing in the same region.

For the simple OLS model in Table 3, the coefficient of the treatment variable, defined as exposure to waste burning emissions during pregnancy, is significant. The coefficient of the treatment variable with respect to the logarithm of birth weight shows that if a mother lives in an exposed region during pregnancy then the newborn's birth weight is 5.2% less as compared to woman not exposed to pollution during pregnancy. This 5.2 % reduction is equality to a 167 decrease in birth weight off of an average birth weight of 3212 grams. Further, if a mother was exposed to waste burning during pregnancy, she experiences an 8.5 percentage point increase in the likelihood of having a child with low birth weight, defined as a child birth below 2500 grams.

Many factors make the investigation of a causal effect between waste burning pollutants and low birth outcomes a complicated process. Both variables that determine air pollution in a specific region and other region specific characteristics, family specific conditions or year specific shocks, can directly affect the outcome. For instance, poorer families are more likely to reside in less affluent and more polluted location. At the same time some regions might be industrialized with factories that emit pollutants. Another scenario could be that the region's supermarket sells expired food that affects the mother's diet during pregnancy. At the same time mother's job occupation is another factor, where some mothers work while others do not. Some working mothers might be living far away from their residential area and thus are exposed daily to traffic pollution. Another scenario could be the "AC effect" where people living outside Beirut witness more electricity shortage and thus depend on outside air during summer and thus are more exposed to the open air waste burning emissions. For seasonality control, it might be the pattern that birth in a specific season or month is coupled with lower birth outcomes due to season characteristics. These scenarios are few of infinite unobserved events that the OLS model cannot control for. Moreover, we have limited information on the background of the subjects included in the study, thus it is likely that our OLS estimate will be positively biased. So this 5.2% decrease in birth weight is not the true effect of exposure of waste burning emissions on birth weight due to mentioned unobservable. It is significant to mention that even if we could control for all these factors, there will still be factors that we are not able to control for since we cannot quantify them or give them numbers or units.

The second step was to control for the maternal age. We notice that the OLS coefficient increases to 5.3% with minimal effect of maternal age on the birth weight of newborns. It is important to mention that in reality we may not have controls for mother's behavior, yet given our identification strategy (within region) we do not expect, on average, to be significant average difference among women who gave birth during exposure compared to who did not.

However, even with maternal age controls, OLS coefficient could be biased upwards and therefore, we run a fixed effect model and look at the coefficient of the treatment variable. Now, and after controlling for all common year differences and for region specific effects and for month of birth effects that we mentioned some scenarios previously, our effect goes down to 3.3 percentage points which is consistent with our theoretical prediction. This 3.3% reduction in birth weight is equivalent to a 106 gram decrease off of a base birth weight of 3212 grams. Moreover, from Table 3, we notice that exposure to waste burning emissions leads to an increase in low birth weight of 0.079; an 8% increase in the incidence of low birth weight. The coefficient was biased upwards previously and this fixed effect coefficient is now closer to the true effect of exposure of waste burning emissions on birth weight. As our results show, all the coefficients of the treatment variable are significant at the 99% confidence level.

To put these estimates into context, we compare them with the broader literature birth outcomes. Basu et al. (2003), observed a 5% increase in the odds of low birth weights of specific estimated levels of pollutants in California which is one of the most polluted states, using a univariate linear regression model. Our estimate is 8 %, slightly higher than theirs. Bharadwaj et al. (2008) find that a one standard deviation increase in pollution in the city of Santiago, Chile, using a fixed effects model, decreases birth weight by 125 grams. Additionally, in order to see the intensity of our results, we could compare them to the effects of smoking. Women who smoke 10 cigarettes per day, for example, tend to deliver newborns 61grams lighter (Currie et al., 2009). Our estimate is about twice as large as the impact of smoking 10 cigarettes per day.

Additionally, Table 4 shows the effect of the treatment variable on the birth height and head circumference of newborns. The fixed effect model shows that exposure to waste burning emissions during pregnancy decreases birth height by 1.3% (significant at the 1% level) and decreases the newborn's head circumference by 0.7% (significant at the 1% level). The latter variables are studied since growth measurements include the measurement of weight, height, and head circumference. Therefore, the relation between these variable will indicate if further investigation or actions must be taken. What is important to look at is the body mass index that shows the relation between these variables.

Although part of literature has shown that mothers less than 20 years and above 40 tend to deliver lighter babies, our estimates give us statistically insignificant effects of this condition. Table 5 shows the gestational age variable. Preterm birth is defined in literature at birth before 37 weeks of gestation. Preterm births have been linked to low birth outcomes. In our results, the fixed effect model shows that exposure to waste burning emissions during pregnancy decreases the gestational age by 1.3% (significant at 1%) and thus a reduction in gestation by 0.4953 week (from a base of 38.13 weeks) and increases the probability of preterm birth by 7% (significant at 1%). This implies that the pollution shock shifted the distribution of the society at a high percentage, where mothers that would have delivered under normal conditions after 37 weeks of pregnancy was pushed back to deliver earlier that 37 weeks. Currie et al. (2009), found that a one unit change in the pollutant (CO) is shown to reduce gestation by 0.074 week; a 0.2% reduction in mean gestation. In comparison, our results are 6 times greater, showing the severity of our case. On the other hand, our results might underestimate the true effect this is because when studying the effects of pollution exposure on birth weight and gestational age because of the evidence that exposure to air pollutants during pregnancy affects gestational age and therefore affects the date of birth. Therefore, and to get better estimates, we can assign our treatment variable based on the expected date of birth rather that actual date of birth. This is done by calculating each newborn's estimated date of conception by subtracting the number of gestation days from the date of birth (Persson and Slater, 2016). We predict that by applying this our estimates will become more precise.

Tables 6, 7 and 8 show the heterogeneous treatment effect of the three pregnancy trimester exposure to waste burning emissions. Exposure during the first trimester (week 1 through week 12) of pregnancy decreases birth weight by 1.9% (significant at 10%). Exposure during the second trimester (week 13 through week 27) tends to be insignificant. This might be consistent with previous literature that focused on the first and third trimesters. Exposure during the third trimester (week 28 through week 41) of pregnancy decreases birth weight by 2.9% (significant at 1%). Our results show that exposure during the third trimester has the greatest effect on birth weight. Thus, the only robust statistically significant trimester is the third trimester. However, the estimates of the first and second trimester, although with high standard errors, could be imprecise. This is because due to the sample reduction which could mean that the estimates are economically significant, through statistically insignificant. Hopefully, increasing the data set and consequently increasing the sample size would decrease the standard error. Moreover, our third trimester estimates might have captured the effects of the exposure during the first two trimesters. Additionally, since miscarriage is said to occur in the first and second trimester and because there are environmental reasons behind miscarriage, then our estimates might be again inaccurate. This is because we are not capturing the effect on fetuses that did not survive till birth. Therefore, if the miscarriages that might have occurred during this period did not occur then the effects of exposure during the first and second trimesters would have been greater.

Our results are consistent with part of the literature. Oskouie et al. (2006) find that low birth weight ratios increased due to exposure to carbon monoxide, sulfur dioxide, nitrogen dioxide and ozone in the **third trimester of pregnancy**. Currie et al. (2009) estimated that a one unit change in mean carbon monoxide (CO) **during the last trimester of pregnancy** increases the risk of low birth weight by 8%. Basu et al. (2003) found that mothers living in Los Angeles, who get exposed to higher levels of exhaust fumes due to traffic in **the third trimester**, have greater odds of delivering a low-weighted baby. According to these studies, exposure during the third trimester increases the incidence of low birth weight.

Table 1: Summary Statistics of Variables

Variable	Obs	Mean	Std. Dev.	Min	Max
Birthweight	3,581	3211.637	487.2283	1450	4880
Birthheight	3,581	49.476	2.464691	30	59
headcircum~e	3,581	34.674	1.513486	24	50
gestationa~e	3,581	38.17732	1.464515	27	42
Maternalage	3,581	31.7456	5.333337	16	49

Table 2: Summary Statistics of low birth weight dummy variable

Variable	Obs	Mean	Std. Dev.	Min	Max
Y	3,581	.0952248	.2935662	0	1

Table 3: Birth weight regression

	OLS		OLS with Controls		Fixed Effect		Fixed Effect	
	LOGBW	LBW	LOGBW	LBW	LOGBW	LBW	LOGBW	LBW
Treatment	-0.052*** [0.0082]	0.08523*** [0.0104]	-0.0533*** [0.00826]	0.0881*** [0.0104]	-0.0459*** [0.01034]	0.0856*** [0.01304]	-0.03332*** [0.01123]	0.07916*** [0.02064]
Maternal age			-0.00112*** [0.00072]	0.0026 *** [0.00092]	-0.00125* [0.00073]	0.0027*** [0.00092]	-0.0009 [0.00062]	0.00298*** [0.00101]
Year fixed effect					Yes	Yes	Yes	Yes
Region fixed effect					No	No	Yes	Yes
Month fixed effect					Yes	Yes	Yes	Yes

Standard errors in brackets, clustered at region level. *significant at 10%; ** significant at 5%; *** significant at 1%.
BW: Birth weight
LBW: Low Birth Weight defined by WHO as BW < 2500 grams

Table 4: Birth height and head circumference regression

	OLS		OLS With Controls		Fixed Effect		Fixed Effect	
	LOGBH	LOGHC	LOGBH	LOGHC	LOGBH	LOGHC	LOGBH	LOGHC
Treatment	-0.01004*** [0.00328]	-0.0083*** [0.00196]	-0.0099*** [0.0033]	-0.0083*** [0.00197]	-0.0108*** [0.00414]	-0.00484* [0.0025]	-0.0132*** [0.00340]	-0.007*** [0.00270]
Maternal age			0.00006 [0.0003]	-0.00002 [0.00017]	0.00008 [0.00029]	-0.00009 [0.00017]	4.58e-06 [0.0003]	-0.00027 [0.00019]
Year fixed effect					Yes	Yes	Yes	Yes
Region fixed effect					No	No	Yes	Yes
Month effect					Yes	Yes	Yes	Yes

Standard errors in brackets, clustered at region level. *significant at 10%; ** significant at 5%; *** significant at 1%.
BH: Birth Height, HC: Head Circumference

Table 5: Gestational Age and Pre- term Birth regression

	OLS		OLS With Controls		Fixed Effect		Fixed Effect	
	LOGGA	PRETERMB	LOGGA	PRETERMB	LOGGA	PRETERMB	LOGGA	PRETERMB
Treatment	-0.01382*** [-0.01382]	0.06236*** [0.0111]	-0.0147*** [0.00206]	0 .0666*** [0.01113]	-0.01389*** [0.0025]	0.08100*** [0.01394]	-0.0128*** [0.0027]	0.07115*** [0.02611]
Maternal age			-0.00076*** [0.00018]	0.0038*** [0.00097]	-0.0007*** [0.00018]	0.00354*** [0.0009]	-0.0008*** [0.00025]	0.00358** [0.00143]
Year fixed effect					Yes	Yes	Yes	Yes
Region fixed effect					No	No	Yes	Yes
Month effect					Yes	Yes	Yes	Yes

Standard errors in brackets, clustered at region level. *significant at 10%; ** significant at 5%; *** significant at 1%.
GA: Gestational Age, PRETERMB: Pre- term birth (Birth before 37 weeks)

Table 6: Trimester 1 Effect

	OLS		FIXED EFFECTS	
	(logBW) Trimester 1	(LBW) Trimester 1	(logBW) Trimester 1	(LBW) Trimester 1
Treatment	-0.04692*** [0.0138]	0 .10323*** [0.02104]	-0.01923* [0.03414]	0.0605 [0.0527]
Year fixed effect			YES	YES
Region fixed effect			YES	YES
Month effect			YES	YES

Table 7: Trimester 2 Effect

	OLS		FIXED EFFECTS	
	(logBW) Trimester 2	(LBW) Trimester 2	(logBW) Trimester 2	(LBW) Trimester 2
Treatment	-0.03920*** [0.0087]	0.0723*** [0.01402]	-0.02758 [0.01673]	0.0404 [0.0296]
Year fixed effect			YES	YES
Region fixed effect			YES	YES
Month effect			YES	YES

Table 8: Trimester 3 Effect

	OLS		FIXED EFFECTS	
	(logBW) Trimester 3	(LBW) Trimester 3	(logBW) Trimester 3	(LBW) Trimester 3
Treatment	-0.0433*** [0.0075]	0.0816*** [0.0113]	-0.02961*** [0.0108]	0.07425*** [0.0216]
Year fixed effect			YES	YES
Region fixed effect			YES	YES
Month effect			YES	YES

7.2. Discussion:

Similar to other countries in the region and around the world, Lebanon has had a long history of environmental degradation and hazardous health effects that places a large burden on the health of the population as well as on general economic development. Lebanon is considered an upper- middle income country based on the World Bank classification. It has a per capita GDP of around US$4000. Significantly, 90% of its population live in urban areas (World Bank, 2003).

Waste burning and the overall garbage crisis has been the main concern for the Lebanese community since the year 2015 and persists till today with the absence of concrete and enough measures to solve this issue. In our study, we focused on waste burning as a source of air pollution. Yet, Lebanon has other sources of air pollution that emit similar toxic pollutants that adds up to its pollution measure and its economic burdens. Thus, we cannot underestimate the impact that air pollution puts on public health and on the economy as a whole. Also, Lebanon is affected by a number of human activities that increase pollution, from the transportation sector to the energy industry and manufacturing sector, besides open air waste burning and burning tires. So now we are at a reality that pollution has tremendous sources in Lebanon and that it causes adverse health effects that have huge economic implications on the society; from the cost of illness to reduced productivity and restricted activity days to hospitalization and death (MOE, EU & NEAP, 2005).

A World Bank study estimated the cost of total suspended particulate on public health in Greater Beirut and found that a 10 $\mu g/m^3$ increase in the concentration of particulate lead to 80 excess deaths per year, 3000 hospitalized admissions, 2800 emergency room visits and 14,160 restricted activity days .They estimated the annual cost of these impacts as US$10,657,811. Therefore if Lebanon at 1999 has reduced the concentration of particulate by 100 $\mu g/m^3$, then greater Beirut would have saved US$ 106,578,110 annually. The study estimated that premature mortality due to 10 $\mu g/m^3$ increase in (PM) cost about US$ 4,732,400 annually, hospital admissions cost US$ 4,275,343, emergency room visits cost US$212,912 respectively and cardiac admission scores US$955,729 while restricted activity days cost US$ 481,426. This study was considered the first official attempt to quantify the health impacts of air pollution in Lebanon; yet it faced many limitations. Absence of air quality monitoring stations was one limitation and unfortunately it is still present till today with lack of air quality monitors. Two economic valuation approaches were followed in 1999 paper; direct valuation using human capital and cost of illness approaches for mortality and morbidity and the indirect approach through the willingness to pay. This study concluded that there are substantial cost due to air pollution. They also found that the number of lives saved per year due to a 10 points reduction in Lebanese urban areas is between 12 and 167 lives and an economic benefit per case ranging between US$ 55,000 and US$ 705,000 depending on the economic approach use (World Bank, 2003).

Another World Bank study applied findings from international studies to the Lebanese air pollution situation in order to produce an estimate of the cost. The study estimated the cost to about US$ 35 - US$ 38 million which is about 0.2 to 0.6% of GDP each year. They studied other pollutants such as ozone, sulfur dioxide, nitrogen oxides and lead. Unfortunately, no adequate data exists on previous pollutants. Yet, based on available information on lead concentrations in Beirut, US$ 12.8 to 40 million per year is the estimated cost of lead pollution this is 0.17–0.25% of GDP the total damage cost of urban and rural indoor air pollution on health and the quality of life was estimated to be US$ 89 - 200 million annually (World Bank, 2003).

Moreover, health is one of the most important determinants of a country's economic success, as presented by the report of the commission on microeconomics and health, chaired by Jeffry Sachs (Sachs, 2001). At the same, it is estimated that air pollution in 2012 is considered as the largest contributor to the burden of disease (DOB) from the environment and is responsible for 7 million premature deaths including almost 600,000 cases in the European Region (Sachs, 2001).

Till now, we have looked at the short term health hazards of pollutants and toxicants in air, yet long-term effects, of early exposure, have not been extensively studied. Long-term effects of early exposure to pollutants are of high significance since they affect the economy through a reduction of welfare and increase in costs. This has been shown previously in the literature. For instance, Perera (2006) shows that children who were born during the years of high air pollution in the Czech republic, had learning disorders, significantly low Bailey maternal development Index (MDI) and reduced IQ scores measured at the age of five. This was directly linked to (PAH) concentrations (Perera, 2006).

Furthermore, it is important to mention that even if evidence on the long run effects of pollution is insignificant, birth weight has been and continues to be an important measure of infant health since infant mortality rates are significantly higher for low birth weight and very low birth weight babies as compared to babies with birth weight above

2500 grams (Bharadwaj & Eberhard, 2008). The last recent years have witnessed increase in research on the long run effects of early childhood and in-utero conditions in different fields. In economics, the focus is on how early lifetime shocks affect human capital accumulation and development. This topic has been backed by a growing understanding that early life conditions may have long-term and deep effects on later life. Almond and Currie, for example, studied the growing literature on this topic and concluded that events before birth can be critical determinants of future outcomes (Almond & Currie, 2010). Similarly, (Kelly, 2009) has found negative impacts of prenatal exposures to the 1957 "Asian flu" on birth weight and future test scores in Great Britain. So, children can be permanently damaged in utero and thus events in utero are predictive of later development (Almond, Currie, 2010).

Recent studies have debated whether birth outcomes (especially birth weight) are significant for different labor market and health outcomes. Previous studies have concluded that birth weight and height are directly linked to long run labor market outcomes such as earnings, education level, and IQ development, rather than the short run labor market (Bharadwaj & Eberhand, 2008). Currie (2013) concluded that a one standard deviation decrease in total suspended particle for a child in utero was associated with an increase of 1.87% of a standard deviation in high school test scores. Bharadwaj et al. (2008) similarly studied the long run effects of pollution on the Chilean economy and estimated the losses due to cost wages to be around 90 million per year. Another study applied within twin techniques and used a hugely rich dataset from Norway. It examined the effects of birth weight on both short and long run outcomes and found that birth weight does matter especially in the long run such as affecting adult height, IQ, earnings and education with significant coefficients. Another study done in Sweden aimed to shed light on how exposure to poor air quality early in life affects adult outcomes by studying the casual impact on cognitive skills, educational attainments, and labor market outcomes among adults they have followed over the years. They found that reduced lead exposure in early life improves scholastic performance, cognitive ability and labor market outcomes.

Overall, there seems to be a consensus in the literature that low birth weight infants seem to have lower educational attainment, poorer health status, such as high blood pressure, cerebral palsy, deafness, blindness, asthma, lung disease among children, reduced employment and earnings as adults (Almond et al., 2004). This is because birth weight is the primary measure of a baby's health in most analysis of infant health and welfare in economic research. Evidence from the economics literature shows that pollution places a huge burden on society and leads to costs of several trillion dollars per year (WHO, 2015).

In economics and through the years of development of this field, "value" is the measure of priority of a thing compared to various other options and "cost" is the loss that one incurs to prioritize some things over others. Some of the options that one compares in life are the consumption of leisure, health and life. As a result, tradeoffs between different options exist on a daily basis (WHO, 2015). Since factors measured in early life are a major predicator of future outcomes, economists place a great deal of importance on analyzing human capital development in the early years. The general view is to think of a "production function" for child outcomes that turns all inputs such as nurturing the child to outputs; healthier humans (Currie et al. 2011).

Given the significance of birth weight for future outcomes in different studies that we mentioned previously as Black et al. (2007), we believe that there is a high "cost" of pollution in Lebanon that is shown by newborns with lower birth weights.

Since our results show a significant decrease in birth weight (118 grams) due to waste burning exposure, then we expect that in the long run, this will lead to huge costs on the Lebanese economy. This is consistent with the previous literature on the topic.

Understanding both the short run and long-run effects of birth weight is important from a number of perspectives. On the policy side, governments should enact policies to enhance the health of newborns and hence the future health of the society. So, by affecting birth outcomes through improved prenatal care, we would improve the development of the whole society (Black et al., 2005).

CHAPTER 8

CONCLUSION

In this study, we investigate the effects of waste burning emissions in Lebanon on the birth outcomes of newborns. Our models control for time and region fixed effects to overcome selection bias arising from the fact that exposure to waste burning during pregnancy was not necessarily random. Our results show that exposure during the third trimester of pregnancy decreases birth weight by 2.9% which is equivalent to about 93 grams reduction on the 3121 average birth weight base. We also find that exposure to waste burning emissions decreases birth height and head circumference by about 0.5 cm and 0.2cm respectively. Moreover, exposure to waste burning emissions decreases the gestational period by about 0.438 of a week and increases the probability of preterm birth by 6.1%.

Our results indicate that pollution has effects on the fetus and since it is a worldwide phenomenon, its consequences are most likely universal. From policy perspective, early life intervention is essential in order for the Lebanese state to try to compensate for this shock.

On the other hand, some limitations could bias our estimates implying that further research is needed on this topic. One of the limitations is the lack of controls in the data. Additionally, a bigger sample would have given us smaller standard errors and improved inference. This could have been achieved by adding more hospitals to the data set. Lack of adequate data on pollution monitors limited our study as well, as we are unable to show a clear first stage regression. Another limitation to our data is that it is limited to fires that the Lebanese Civil Defense reached.

Our results indicate that the Lebanese waste crisis has negatively affected the birth outcomes of the 2015-2016 newborns in a statistical and economically significant. Importantly, due to the pre-birth pollution shock, the trajectories of most exposed babies were severely altered. Today, the role of policy makers should be to intervene in exposed infants' lives to reduce the negative effects of this shock. Given the importance of birth outcomes on the future developmental status of individuals, we predict that the effects will continue to appear in the future through different forms, from lower IQ to autism and many other developmental health problems, and thus will place a huge burden on the economy. We recommend the state increase early life time interventions for the exposed groups when intervention can still be effective rather than waiting for the effects to be irreversible. This is essential to mitigate future growth and development problems for the nation as a whole.

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APPENDIX

Appendix A: World Health Organization and NAAQS guidelines for Particulate matter (Afif et al., 2016)

PARAMETER	NAAQS (1996) MAXIMUM LEVELS $(\mu G/M^3)$	WHO (2000, 2006) GUIDELINES $(\mu G/M^3)$
Sulfur dioxide (SO_2)	350 (1 hr) 120 (24 hrs) 80 (annual)	500 (10 minutes) 20 (24 hrs)
Nitrogen dioxide (NO_2)	200 (1 hr) 150 (24 hrs) 100 (annual)	200 (1 hr) 40 (annual)
Carbon monoxide (CO)	30,000 (1 hr) 10,000 (8 hrs)	30,000 (1 hr) 10,000 (8 hrs)
Ground- Level Ozone (O_3)	150 (1 hr) 100 (8 hrs)	100 (8 hrs)
Total Suspended Particles (TSP)	120 (24 hrs)	150 (24 hr)
PM_{10}	80 (24 hrs)	50 (24 hr) 20 (annual)
$PM_{2.5}$	NA	25 (24 hr) 10 (annual)
Lead	1 (annual)	0.5 (annual)
Benzene	5 ppb (annual) (equivalent to 16 $\mu g/m^3$)	UR Life 6.10^{-6}

UR: Unit Risk (UR) estimated for an air pollutant. It is defined as "the additional lifetime cancer risk occurring in a hypothetical population in which all individuals are exposed continuously from birth throughout their lifetimes to a concentration of 1 $\mu g/m^3$ of the agent in the air they breathe."

Table A.1. World Health Organization and NAAQS guidelines for Particulate matter

Appendix B: Methods for Treating Solid Waste (Thompson & Anthony, 2008)

Incineration is a controlled combustion process for burning solid waste in the presence of excess air (oxygen) at high temperature of about 1000°C and above, to reduce gases and residue containing non-combustible material. One of the most attractive features of the incineration process is that it can be used to reduce the original volume of combustible solid waste by 80 to 90%. It is important here to mention the difference between incineration and open air waste burning. Incineration occurs in legalized factories that undergo environmental tests and studies, while open air waste burning is burning waste randomly in open sites without any environmental or health considerations. Although incineration is a legal way of treating waste, many studies have speculated the effects and emissions of incineration. A report done by Dr. Jermy Thompson and Dr. Honor Anthony on the health effects of waste incinerators warned the British society from incinerators as it studied the particulates produced, the cost of incineration, and the general hazardous effects of incineration. This report concluded that the accumulated evidence on the house risks of incinerators being a major source of fire particulates, toxic metals, and hormone disputers is too strong to ignore and asked for no more incinerators to be approved because incinerators threaten basic human rights as stated by the United Nations Commission of Human Rights (Environmental Protection Act,1990).

Incinerators produce bottom and fly ash which add up to 30 - 50% by volume of the original waste and require transportation to landfill sites. With all the modern methods to decrease the release of pollutants in modern incinerators, they still transfer toxics and in particular that of dioxins and heavy metals from airborne emissions to the fly ash.

Significantly, this ash is light and readily windborne and thus penetrates to all living things easily.

Other methods of solid waste management include compaction where waste is compressed, pyrolysis that is the thermal degradation of waste in the absence of air to produce char (pyrolysis oil) and syngas, gasification that is the partial combustion of solid waste in the presence of oxygen to generate gas rich in carbon monoxide and hydrogen and compositing that follows two basic steps, hot fermentation and ripening and is considered the most responsible technical solution for many developing countries.

Nowadays, there are alternative and attractive methods of dealing with solid waste management while avoiding main health consequences of incineration and producing energy in less expensive ways in aggregate economic and health costs. It is also important to mention that waste treatment differs from waste disposal.

Appendix C: Waste Disposal Techniques (Thompson & Anthony, 2008)

Land filling is the most direct and economic measure where natural decomposition of waste occurs. Yet similar to what has been happening in Lebanon, unscientific and random land filling becomes the common practice for solid waste disposal in many developing countries.

On the other hand, there are sanitary landfills where waste is spread in layers based on a scientific study, compacted to the smallest practicable volume and covered with soil on daily basis. Underground injection wells is another disposal way where waste is injected under pressure into steel concrete encased shafts and placed deep in the earth.

Moreover, land treatment is when solid waste is incorporated into the soil surface and waste piles become the accumulation of wastes

Appendix D: Health Hazards of Burning Waste (Afif et al., 2016 & EEA, 2015)

Pollutant	Health Effects
Particulate Matter (PM)	Can cause or aggravate cardiovascular and lung diseases, heart attacks and arrhythmias. Can cause cancer. May lead to atherosclerosis, adverse birth outcomes and childhood respiratory disease. The outcome can be premature death.
Ozone (O_3)	Can decrease lung function. Can aggravate asthma and other lung diseases. Can lead to premature mortality.
Nitrogen dioxide (NO_2)	Exposure to NO_2 is associated with increased all- cause, cardiovascular and respiratory mortality and respiratory morbidity.
Sulfur dioxide (SO_2)	Aggravates asthma and can reduce lung function and inflame he respiratory tract. Can cause headaches, general discomfort and anxiety.
Carbon Monoxide (CO)	May lead to heart disease and damage to the nervous system; can also cause headache and fatigue.
Benzene (C_6H_6)	Is a human carcinogen.

Table A. 2. Health Hazards of Burning Wastes

Appendix E: Lebanese Civil Defense Stations (Civil Defense, 2017)

Beirut and Suburbs	**Beirut**	**Albashoura**
		Ras Beirut
		Cola
	Southern Matn Shore	Bourj Al Barajneh
		Al Choifet
		Al Ghbayreh 1
		Al Ghbayreh 2
		Haret Hrayk
	Northern Matn Shore	Al Jdaydeh al Iqleemeh
		Al Jdaydeh al Odwi
		Al Fanar
		Al Mansoureyeh
		Bourj Hamoud
Al Nabatehey	Al Nabatehey	Tibneen
		Al dwayr
		Masbayah
		Al Qlayha
		Bint Jbeil
		Jbah
		Kfar Seer
		Rmaysh
		Rashaya al Fokhar
		Atteebeh
		Markabah
		Shibha
		Allehyam
		Mays el Jabal
		Frour
		Zifta
		Jdaydet Marjhoun
		Alkhalwat
		Aeita Al Shaab
South Lebanon	Jizeen al Iqleemeh	Sour
		Alabasiyeh
		Alma Al Shaab
		Jwayah
		Al Qlaylah
		Dordaghiyah
	Saida Al Iqleemeh	Saida

		Sarafand
		Al qrayeh
		Anqoon
North Lebanon	Tripoli	Tripoli
		Sea Al Diniyeh
		Bakhous
		Anfeh
		Alminyeh
		Alsfeera
		Albidaweh
	Zgharta	Zgharta
		Amyoun
		Ihdn
		Dideh
		Raskifa
		Aeimar
		Karam Sda
		Kafar Hata
		Mizyarah
	Bshari	Bshari
		Hadath Al Jibeh
		Hasroun
		Qraat
	Batroun	Batroun
		Alalali
		Bshahleh
		Tanoureen
		Mirdeen
		Doumah
		Kfeefen
		Ras Nahash
	Halba	Halba
		Sidqa
		Bzibeena
		Birqayel
		Alheesah
		Bqrzalla
		Akkar Al Ateeka
		Altlayl
		Minyarah
		Tibneen
		Rahbeh

	Al Qbayat	Al Qbayat
		Dayr Jneen
		Minjiz
		Alheesha
		Andaqt
		Shadra
		Al Beera (North)
		Mrah Al Khoukh
		Aeidmoun
Al Biqaa	Jib Jineen	Jib Jineen
		Rashaya
		Al Rafeed
		Yanta
		Aein Aata
		Kfarmishti
	Baalback	Baalback (1 and 2)
		Al Labui
		Al Nabi Sheet
		Bdnayl
		Barqa
		Bretal
		Bashwat
		Boday
		Hadath Baalback
		Dayr Al ahmar
		Sireen
		Shmstar
		Ainata
		Niha
		Yoneen
	Al Hirmil	Al Hirmil
		Al Qaa
		Al Qasr
		Ras Baalback
		Irsal
	Zahle	Zahle
		Jdeeta
		Ghaza
		Ameeq
		Samhr
		Almasnah
		Sghbeen

		Ryaq
		Bar Elias
		Tarsheesh
		Qib Elias
		Tabl
		Almanarah
		Qah Alreem
		Al Qrawn
Mount Lebanon (North)	Mount Lebanon	Jonieh
		Annayah
		Jaj
		Aqaybeh
		Farayag Al Mzar
		Jrtj
		Jeita
		Zouk Mkyail
		Jounieh Al Iqleemeh
		Yahshoush
		Alaqoura
		Ghbaleh
		Alkfour
		Bijeh
		Jbeil
		Rayfoun
		Oartaba
		Ghosta
		Hrajil
	Dhour Al Shwayr	Dhour Al Shwayr
		Qurnet Shihwan
		Al Matn
		Bayt Shabab
		Kfar Aqab
		Mazraet Yahshoush
		Broumanah
		Baytmiri
		Mar Mousa
		Baskinta
		Bikfaya
Mount Lebanon (South)	Shheem	Shheem
		Barja
		Almatlah
		Aldbayeh

		Aldamour
	Baaqleen	Deir el Qamar
		Aein Zhalta
		Albinay
		Albeereh Al Chouf
		Sawfar
		Rishmaya
		Neeha
		Amatour
		Bshatfeen
		Baaqleen
		Aley

Table A.3. Lebanese Civil Defense Stations

Appendix F: Waste Burning Sites and Dates

Date	Location of waste burning
***22/07/2015**	Hay El Silom- Nahr al mout- Karantina-Zouk Mkayil- Aisha Bakkar
***23/07/2015**	Zouk Mkayil- Bsalim- Mirna Shalouhi Highway-Forn al Shibak
***24/07/2015**	Anteliyas(2*)- Baskinta-Hay el Silom- Khaldi highway
***27/07/2015**	Saintt Terese street(alHadath)- aldikwana- Qornit Shehwan(2*)- Dbayeh- Zouk Mosbh-Sarba-Ghadeer-Jonieh-almaamltayn-Ghazeer-Adma-Faraya- Ras Beirut(2*)-AlDawra- Alboushriyeh- Ras aldikwana-alfanar-alnaameh-Almrayjeh(2*)- Hadi nasrallah highway-Tareeq aljdeedeh-Alrawsheh-Almkallis-Korneesh almasraah.
***28/07/2015**	Zkak Alblat-Salim Slam-Borj Abi Haydar-Albatrakiyeh-Karaakon al drooz- Borj al Mor-hawd Lwilayah-Alnwayreh-Albashourah-Albastah-Ras Al nabh-Fardan-Albarbeer- Ras Beirut-Tareek al jdeedeh-Alkola-almsaytbeh- Aisha bakkar- Alashrafiyeh (3*)-Aldikwanah-Aldawrah-Bsaleem- Jal al deeb- Antilyas- Alnaqash Qornet Shihwan- Ain Aalak- Zouk Mkayel- Haret al.naameh-Aldamoor(3*)-Barja-Baabda-Aldikwaneh-AlKasleek-Alhamra(Beirut)
***29/07/2015**	Awkar-Alfanar-Aldikwaneh-Alnakash-Almtaylib- Borj Abi haydar-Aisha Bakkar-Alsnawbarah-Alkalamoon-Jadraa-faraya-Deek Almihhdi-Alshayeh-Aein Najm-Aljnah-Galery Simaan
***30/07/2015**	Aein w Zein- Alsimqaniyeh-Aljnahh-Alrawsheh-Albarbeer- Wata Al Msaytbeh- Baabda- Almkallis- ALDikwaneh(2*)- Jal el Deeb- Zouk Mosbeh- Kaslik- Alkfour- Ghazeer- Adonise- Zouk Mkayel- Qornet Shahwan- Jal el Deeb- Alsaint Terese (alhadath)- Jonieh Highway
***31/07/2015**	Zouk Al Khrab (2*)-Sarbah- Altohweeta- Almtaylib- Bourj Hamoud-Aldikwanah- Jal el Deeb- Antelyas- Masraat Yashouhh- Qornet Shahwaan.
***01/08/2015**	AlBawshriyeh- Zouk Mosbeh- New alrawdah- Alkafaaat- Ghadeer
***03/08/2015**	Baabda- Alhadath-Sad Albawshriyeh(2*)- Alnakaash- Almtayleb-Deek Al Mihhdi- Alrabyeh -Antelyas- Zouk Mkayel- Faytroon-Albatroon- Mar Rookoz (Aldikwaneh)- Aramoon- Jal el Deeb-Bshamoun- Alminyeh.
***04/08/2015**	Zouk Mkayel- Aldikwaneh
***05/08/2015**	Dayr al qamar- Khaldeh- Alfanar- Alrwaysat (aljdaydeh)- Sad al bawshriyeh- Bayt al Shaaar- Bshamoun (2)- Jwar Al bawashiq-Daraoon.
***06/08/2015**	New Alrawdah- Almtayleb- Aldalb(Bikfayah)- Alfanar-Masraet Yashoohh(2*)- Alkhinsharah- Bayt al Shaar(2*)- Bshamoun-

	Antilyas (2*)-Jal el Deeb- Galery Simaan- Alsaydaat- Alnabaa.
***07/08/2015**	Bourj Al Barajneh- Majdelbaana- Jal el Deeb-(2*)- Bayt al shaar- AlFanar- Jadra- Zikreet- Barja- Ghbaleh- Almtaylib.
***08/08/2015**	Aramoon- Dayr al qamar- Baabda- Qartabah- Lasaa- Jal el Deeb.
***10/08/2015**	Alnaass-Bshamoun (2*)- Antilyas- Qornet Shahwan- Lasaa- Ajaltoon- Barja- Bkirki.
***11/08/2015**	Baabda-(alhboos-Bayt al Kko)- Antilyas-Bayt al shaar- Alsimqaniyeh-Yahshoush- Almtaylib(*2)-bshamoun-almtaylib.
***12/08/2015**	jal al deeb(*2)-Alnaas-Alrabwi-Jbeil-Aldikwani- Almadeena al sinaiya(Zouk Mosbeh)-Antelyas-Baabda
***13/08/2015**	Masraet Yashouh-Alnamoura-Almtaylib-Alakaybe(*2)
***14/08/2015**	Dbayeh(*2)-alfwar(antelyas)-haret al.naameh
***17/08/2015**	alnakash(*2)-bayt shabab-antelyas-zouk mkayel-ghbala-jal el deeb(*3)-bekfaya-almtaylib(*2)-zouk mosbeh(*2)-Arayah- Alamreyeh-Alfanar-Ain Saadeh- faytroon-qornet Shihwan-Adonis- forn al shibak-wadi shahroor-almrayjeh- bayt al shaar- Tareeq aam roomyeh
***18/08/2015**	dayr al qamar-baabda-almkalis-alrabyeh-bayt al shaar-almtaylib- alamriyeh-bekfaya-antelyas-zikreet
***19/08/2015**	Baabda-zgharta-albawshriyeh-bayt shabab(alqnaytra)-moftaraq alameriyeh-bekfaya-mar rookz(aldikwaneh)-jal el deeb-amsheet- albarbara- mazraet yashouh
***20/08/2015**	almasakn alshabiyah (sour)-boutj Hamoud(*2)-alfanar-bayt alshaar(*2)-alhqaybeh-almtaylib
***21/08/2015**	Dayr al qamar-almkallis-alfanar-jal el deeb(*2)-byaqout-alrabyeh- elisar-bekfaya-bhirsaf-aldbbeyeh-aanout-marj zebdeen
***22/08/2015**	nahr al kalb
***24/08/2015**	reshmayah-baabda-betshay-sin al feel-horsh tabet- alfanar- jal el deeb(*3)- roomyeh- Almatn High way- Zekreet(wadi nahr al kalb)- bteghreen- Ghazeer- Hrajil- Aien baal
***25/08/2015**	mar rookz(aldikwaneh)-ras aldikwaneh- sad al bawshriyeh- almryjeh- Alnaameh- allwayzeh- albowshriyeh-alfanar(*2)- nahr al qalb- almadfoon high way-thoom (albatroon)
***26/08/2015**	Hay al silom- Aljamoos- Alsfyr- hadi nAsrallah Highway- Aley- Sin el fil- Alfnar- Rwaysat aljdaydah-almtaylib- adonees- alkfour Ajaltoun- Sarahmoul
***27/08/2015**	Airport road- Bliss street in Hamra- Harit Hrayk- Hadi nasralla street- Almahmourah- hay al silom- almrayjah- aldfayr- alkafaat- alrways- alamliyeh- mar mkhayil/alshiyah- alhadath(*2)- alashrafiyeh- Alnabaa- Alsaloomi- Jisr al basha- Ain al rimanah- baabdat- alnaqash- alkasleek- sarba- faqra- alma(zgharta)

***28/08/2015**	alsaydat- alhamra-vardan-bir al abd- alrways-alhadath(*2)-alfanar-aldikwanah-sab al bawshriyeh(*2)-almtaylib-alaqbyeh-dbayeh-zouk mkayil(*2)-hrajil-alaqybeh-bourj hammoud
***29/08/2015**	Alrjmeh-sami al solh- alsayd hadi highway-alhadath-rwaysat al jdaydih-nahr al mout-almtaylib-bayt al shaar-qartabah-alaqaybeh
***31/08/2015**	alnabatiyeh-forn al shibak- mirna alshalohi/sin al feel-aldikwaneh-bourj hamoud-alfanar-jal al dib(*4)- almtaylib-alnaqash-bayt alshaar-qornit shihwan-hrajil highway-bat7afarayah-aien najm-adma-alfanar.
***01/09/2015**	Baabda-baabdat- aljdaydeh-sin al fil-jal el dib(*3)-bsaleem-alrabweh-lasa-alaqaybeh-kfarsheemah-shahtoul- aein saadeh
***02/09/2015**	Baabda(*2)-alhazmiyeh-alfanar-jal el deeb-alnaqash-ghdras-zouk mkayel-aljamhour-almkalis-bayt al shaar
***03/09/2015**	Aldibbiyeh-alrhab-alhadath-allwayzeh-almkallis-aldor(*2)-Jbeil-zouk mosbeh
***04/09/2015**	Sin el Fil-Bayt al kkoo-Aley-Dahr al wahsh/Arayah-Shweet(cross)
***05/09/2015**	Alahrafiyeh-Bourj Hammoud-Bsaleem- Admah-Almkalis-Alnaqash-fatqa-Ghazeer-bijjeh
***07/09/2015**	Fassouh(Alshrafiyrh)-Sad al bawshriyeh-Alfanar- Alrawdah-Alsaloumi-Bourj Hamoud(*3)aldawrah-rwaysat al jdaydeh-mazraet yashouh-mayrouba-afqa-fatqa-admah-mijdlayah-althweeta-brimanah-almtaylib
***08/09/2015**	Dayr al qamar-Roomyeh-bourj hamoud(*2)-aljdaydeh-alnaqash-hareesah-daroon-mijdlayah(zghartah)-alkhinsharah
***09/09/2015**	alfanar-alsaloumi-alaqaybeh-bourj hamoud- bayt al shaar-alaqaybeh highway
***10/09/2015**	alkafaat-sad albawshriyeh-aldawrah-bourj hamoud-bayt al shaar
***11/09/2015**	Haret al. sit-wadi shahrour-sad al bawshriyeh-almansourah-almrouj-qannabeh bromana-ghbaleh
***12/09/2015**	Jisr al dawra- Bourj Hamoud-Nahr al Mowt-wadi Shahrour-Jaj-Bijji
***14/09/2015**	Baabda-Sad Al Bowshriyeh-Aldawrah-Aein Alsindyanah-Bourj Hamoud- Roomyeh-Ras Al Jabal-Sin El feel-Ajaltoon- Alfanar-Jbeil.
***15/09/2015**	Qbayh-almtaylib-alnbha-aldikwani-jonieh-Jbeil
***16/09/2015**	Alashrafiyeh(*2)-Hamoud-Aldawra-Sad Albawshriyeh-Aldikwaneh-Adma-Haalat
***17/09/2015**	Alsabteyeh-aljdaydeh-Sad Al bwshruyeh (*2)-bourj hamoud
***18/09/2015**	Aldawrah-nahr al klb-Adma-Zouk Mkayel-Shwaifat
***19/09/2015**	Aldawrah(*3)-Bourj Hamoud-Jeeta- Fnaydiq-Alkaranteena - Adma
***21/09/2015**	Alkfoor(*2)-Aldawra-Rayfoon-Almrayjeh-Zouk mosbeh-Alhqaybe-Aldawra high way
***22/09/2015**	Aldikwaneh-Aldawrah sea way-bourj hamoud-aljdaydeh-ras al matn-souk al gharb-Ras Al Jabal(aley)-zouk mosbeh-Jonieh

***23/09/2015**	Alfanar-Sad al bowshiyeh-Aldawra sea way- al karanteena-alnabha-Bourj hamoud bridge-baqaata- baaseer(*2)- bar Ilyas-
***28/09/2015**	Bourj hamoud- Aldawrah sea way(*2)-Galerie Khabaz- Alfanar-Baabda
***29/09/2015**	Baqaata(alshouf)(*2)- alsimqaniyeh(*3)-Kfarheem-Blaybil-Aldawrah bridge- Aljdaydeh- Sad al bawshriyeh-Alfanar- Sin al feel- masraet Yashouh(*2)- Hrajel- Ghbaleh (*2)
***30/09/2015**	Aldawrah-Sin el feel- alnabaa-alghynah- Ghidras
***01/10/2015**	Sin al feel-Bourj Hamoud-Sad al bawshriyeh- Alrawdah-Alsimqaniyeh.
***02/10/2015**	Dahr Al Wahsh-Alshbaniyeh-Almrayjeh-Alfanar-Mazraeet Yashouh-Zouk mosbeh-Alkasleek
***03/10/2015**	Alfanar-Bolooniyah-Nahr alkalb
***05/10/2015**	Alsaaydat-alghbayreh-Alchwiefat-Aladliyeh-Sad albawshriyeh-Bourj Hamoud-Alfanar-Aien Alsindyaneh
***06/10/2015**	Saida-Alchwaiefat-Dayr Al Qamar-Sad al Bawshriye(*3)-Alfanar-Mazraet yashouh-Aein Alsndyaneh-Darayah(kisirwan)-Faytroon-Hrajil
***07/10/2015**	Sad al Bawshriyeh-Sami Al Solh-Wadi shahrour-Btshay-Alshwayr-Alfanar-yhshoush-maarakeh
***08/10/2015**	khaldeh
***09/10/2015**	Rwaysat al jdeedeh
***10/10/2015**	Alashrafiyeh
***12/10/2015**	Hboub(Jbeil)-Alkhinshara-Alnaqash(2)-alfanar(2)-Qornet Shihwan-Sad albawshryeh-mazraet Yashouh
***13/10/2015**	Ghosta-Saida-Zkreet-Alfanar-Sin Al Fell-Mazraet Yashouh-Qb Elias
***15/10/2015**	Wadi Shahrour-Sad Albawshriyeh(*2)-Aldikwaneh-AlFanar-Aldawrah-Nahr al mawt-Bourj Hamoud-Almtaylib-Ghosta
***16/10/2015**	Alfanar-Aljdaydeh-Jonieh-hawsh Alomarah-Wadi Shahrour
***17/10/2015**	Sad Albawshriyeh(4)-Alchwaiefat-Alkaranteena-Alathra
***19/10/2015**	Aljamhour-Aljdaydeh(2)-Sad Albawshriyeh(4)-Aldawrah(3)-Alzalqa-Hrajil-Nahr Ibrahim-Alkaranteena
***20/10/2015**	Bromana-Aein Al safsaf- Aldawra-Aljamhour-Alfanar-QornetShihwan-Sad AL Bawshriyeh- Aljdaydeh
***21/10/2015**	Bourj Hamoud-Sin aL feel- Sad Al Bawshriyeh- Zkteert(*2)-Hrajil
***22/10/2015**	AlQlayaat(*3)-Sad Albawshriyeh-AlHazmiyeh
***23/10/2015**	Alnaqqash-Sad Albawshriyeh-Hrajil-Aein Al Rimaneh(ALEY)-Roumyeh(*2)
***26/10/2015**	Alfanar-Sad Al Bawshruyeh(*4)-Nahr Al Mout- Aldikwaneh-Baqaatah(ALSHOUF)-Aldawra(*2)-Raayoon-yhshoush-Bsaleem-AlKafaaat-Vardan- Aein Saadeh- Alfwarah-Aljnah

***27/10/2015**	Hrajil
***28/10/2015**	Sarbah-Aldawra Bridge-Ghazeer
***29/10/2015**	Zouk Nosbeh
***30/10/2015**	ALFanar
***31/10/2015**	Sad Al Bawshriyeh
***02/11/2015**	Alkhinsharah-Sad Al Bawshriyeh(*2)-Rwaysat Aljdaydeh-Aljdydeh-Bourj Hamoud- Zouk Mosbeh- Aldawrah-Admah-Sad al Bawshriyeh(madeena Sinaiyah)
***03/11/2015**	Sad Al Bawshriyeh- Alfanar- Aldawrah-Almansouriyeh-Farayah-Zarouon
***04/11/2015**	Between Alhbariyeh And Shibaa- Sad Al Bawshriyeh(*2)-Alnaqash
***05/11/2015**	Shheem-Sad Al Bawshriyeh- Alsabtiyeh-Roumyeh
***06/11/2015**	AlRawdah-Alsabtiyeh
***07/11/2015**	Shheem-Aljdaydeh-ALQaah
***09/11/2015**	Shheem(*2)-Sad Al Bawshriyeh- Bourj hamoud
***11/11/2015**	AlBoushriyeh
***12/11/2015**	Sabtiyeh-Sad Abawshriyeh
***13/11/2015**	AlRwaysat-Alfanar-Bourj Hamoud-Sad Albawshriyeh
***14/11/2015**	Alborjayn-Baabdat-Sad Albawshriyeh
***16/11/2015**	Alnaahmeh-Alchwaiefat-Sad Albawshriyeh(2)-Zaouk Mkayil-Alfanar-Sin El Feel-Roumyeh-Sreefah
***17/11/2015**	Shadra-Halaat
***18/11/2015**	Aldawrah-Aljdaydeh-Sad Al bawshriyeh
***19/11/2015**	Alfanar-Qartabah
***20/11/2015**	Rwayset al.jdeedeh-Alfanar-Albawshriyeh-Aldawrah
***21/11/2015**	Sad Albawshriyeh(*2)- Altohweetah-Aljdaydeh-Alfanar-nahr al mout-Rwaysat aljdeedah-Aldawra
***24/11/2015**	Aarayah-Rayfoun-Sad Albawshriyeh(*3)-Aldawrah-Rwaysat Aljdeedah(*2)-Bourj Hamoud- Ghosta-bzibdeen-Alathra
***25/11/2015**	aarayah-Alfanar(*2)-Sad Albawshriyeh-Aldawrah-Aljdaydeh-Bourj Hamoud-Ghosta
***26/11/2015**	Jonieh-Ghazir High way- Zikreet- Sad Albawshriyeh- Rwaysat Aljdeedah-tabarjah- AlJamhour highway- Jbiel
***27/11/2015**	Aytat- Almatar street- Dayr Shamra- Sad Al Bawshriyeh- Rwaysat al jdeedah-(*2)- Aldawrah- Roumyeh- Mazraet Yashouh
***28/11/2015**	Sad Al bawshriyeh- Jdaydeh- Nahr al mout- Alfanar
***30/11/2015**	Aldikwaneh-(Rwaysat Aljdeedeh Nahr Al mout)- Anou Meezan-Aldawrah- Albwar- Fatqa- Alnaas(Bkfaya)
***05/12/2015**	Jonyieh-Dbayeh-Alhadath-Tal indah
***07/12/2015**	Aldawrah(2)-Allwayzeh-Alfanar

***08/12/2015**	Dayr Al qamar-Albawshriyeh-Almkallis-Aldawrah
***09/12/2015**	Alfanar-Aldawrah(*2)-Aljdayde(*2)-Albawshriyeh
***10/12/2015**	Sad Albawshriyeh-Bourj Hamoud-Aldawrah- Misteetah
***11/12/2015**	Alchwaiefat-(Aljamhour-Bsous)-Aldawrah(*2)-Bourj hamoud-Jbiel-Bareesh
***12/12/2015**	Alkahaleh-Roumyeh-Zeitoun-Jbeil
***14/12/2015**	Sad Albawshriyeh- Alfanar(*2)-Rwaysat Aljdaydeh-Bourj Hamoud-Aldawrah-Roumyeh-Ash9out- Baabda-Almaysrah-Alnamourah
***15/12/2015**	Alfanar(*2)-Sad Al bawshriyeh-Aldawrah
***16/12/2015**	Qartabah-Sin Al feel
***17/12/2015**	Rwaysat aljdaydeh-Alfanar
***18/12/2015**	Dayr Al Qamar
***19/12/2015**	Sour
***21/12/2015**	Aldawra Bridge
***22/12/2015**	Boulonyah-Bshamoun
***24/12/2015**	Aley- Alfanar-Ghosta
***26/12/2015**	Aldawrah(5)- Aldikwaneh-Alrawdah-bourj Hamoud- Sin el feel-Alfanar(2)-Almkalis-Ede Jbeil-Dayr Al Qamar
***28/12/2015**	Alsabtiyeh-Alfanar(2)--Aldikwaneh-Sad Al bawshriyeh-Qraytem-Dbayeh-Bayt Miri
***29/12/2015**	Alrawdah
***31/12/2015**	Abou Mizan
***04/01/2016**	Haret al. Naameh- Sad Al Bawshriyeh
***07/01/2016**	Bayt Miri-AlSabtiyeh(*2)-Barja
***08/01/2016**	Sad Al Bawshriyeh- Forn Al Shibak
***11/01/2016**	Sad Al Bawshriyeh-Sour
***13/01/2016**	Sin El Feel
***14/01/2016**	Alnabaah-Hay Al Silom-Kfrfour
***15/01/2016**	Albawshriyeh
***16/01/2016**	Bourj Hamoud-Albawshriyeh
***18/01/2016**	Almansouriyeh-Sad Al bawshriyeh-Alyarzeh-Aldawrah-Almradiyeh
***19/01/2016**	Aldawrah
***22/01/2016**	Aljdaydeh
***25/01/2016**	Aldawrah(*2)-Mahalat Mar Mkhael(AlAhrafiyeh)
***29/01/2016**	Almatn Al sareeh
***30/01/2016**	Aljdaydeh
***01/02/2016**	Bsous-Btshay-Alsad-Dawhet al. Hos-Aramoun-jwayah
***02/02/2016**	Sin El Feel
***04/02/2016**	Sad Al Bawshriyeh(*2)

***06/02/2016**	Mar Shaayah-Broumanah
***08/02/2016**	Zghartah
***12/02/2016**	Halaat
***13/02/2016**	Aldawrah(*2)-Saida
***15/02/2016**	Sin El Feel-Dhoor Alshwayr-Bsous-Alhadath
***17/02/2016**	Sad Al Bawshriyeh
***18/02/2016**	Alkaranteena-Altayouni-Farayah-Bsharee
***19/02/2016**	Nahr Ibrahim-Roumyeh-ALJnah
***20/02/2016**	Tareeq Aljdeedeh-Sad Albawshriyeh-Ard Jloul-Roumyeh-Aljnah
***22/02/2016**	Mhreen-New Rawdah- Aldawrah(*2)-Sad Al bawshriyeh-Alfanar-Almaameltayn
***25/02/2016**	Mar Rookoz(Aldikwaneh)-Alfanar
***26/02/2016**	Alkaranteena-Aldawrah
***27/02/2016**	Alkaranteena-Nahr Al Mout- Sad Al Bawshriyeh-Alsabtiyeh-Byaqout- Tlal Aein Saadeh
***29/02/2016**	Forn Al Shibak- Almsayleh-ALDawrah(*3)-Alfanar-Roumyeh-Almrayjeh-Alathraa
***01/03/2016**	Alfanar-Aldawrah
***02/03/2016**	Roumyeh-Alkahaleh-Almadeenah Al Riyadiyah-Almnsf
***03/03/2016**	Aldawrah-Jbeil-Alkaranteena-Albashoorah
***04/03/2016**	Almrayjeh
***07/03/2016**	Aldawra(3)-Broumana-jouret bdran-Roumyeh-Bourj Hamoud-Alkaranteena-Hay Al silom
***08/03/2016**	Jeeta-Ghdras-Sad Al Bawshriyeh-Zouk Mkayil-Sin Al feel-Dayr Qoobl-Alkafaat(Alhadath)
***09/03/2016**	Alfanar-Jeeta-Jal Albahr
***10/03/2016**	Alchwaeifat-Alsabtiyeh-Roumyeh-Alfanar-Albawshriyeh-Msheekha(almatn)
***11/03/2016**	Roumyeh-Sad Al Bawshriyeh-Zouk Mosbeh
***12/03/2016**	Alfanar-Nahr Al Mout-Zouk Mosbeh-Almkallis
***14/03/2016**	Aanout-Tabarja-Alkafaat(Alhadath)-Zouk Mkayel(*3)-Sibleen-Nahr Al mout(*2)-Rwaysat al jdeedah- Alchweifat- Saida High way- Hay AL Silom-Tabarja
***18/03/2016**	Alchwaeifat
***19/03/2016**	Almkallis
***21/03/2016**	Mirna Al shaloohi(Sin El FEEl)
***22/03/2016**	Aein Al teeneh
***23/03/2016**	Kfarsheemah
***24/03/2016**	Roumyeh-Nahr Al Mout-Jal Al bahr
***26/03/2016**	Almasouriyeh-Alfanar-Aljiyeh-Nahr Ibrahim-Almkaliis-Aramoon

***29/03/2016**	Sad Al Bawshriyeh-Nahr Al Mout-Alrmayleh
***30/03/2016**	Zahle
***31/03/2016**	Roomyeh
***01/04/2016**	Zahle
***02/04/2016**	Nahr Al mout-Alkafaat
***05/04/2016**	Aldawrah-Roumyeh-Kfarsheemah-Bsharri-Bourj Hamoud
***07/04/2016**	Halat-Sad Al bawshriyeh-Almansouriyeh-Alqaraaoun-Sarba-Shheem
***08/04/2016**	Alreehanah-Jisr Al wati
***09/04/2016**	Alfanar-Almansouriyeh
***11/04/2016**	Roumyeh-Mazraat yashouh(Almadeena Al sinaeiya)
***12/04/2016**	Almaamourah
***13/04/2016**	Mazraet Yashouh
***15/04/2016**	Ard Jalooul- Bourj Albrajneh-Zkreet
***18/04/2016**	Roumyeh-Aljdaydeh-Alshiyah-Hasrout-Alkhrayeb(Sour)
***19/04/2016**	Sibleen- Ayat(Akkar)-Sour-Saida
***21/04/2016**	Alhadath-Kirkas(Ras Beirut)
***22/04/2016**	Aldawrah-Aljomhour-Ard Jloul-Aldibiyeh-Aytat-Alaqaybeh-Ansariyeh
***25/04/2016**	Aldilwaneh-Tareeq A matar-Wadi Al Zeenah-AlKafaat-
***26/04/2016**	Hay Al Silom
***28/04/2016**	Saida-Nahr Ibrahim-Aisha Bakkar
***30/04/2016**	Alfanar-Misteeta-kfarsheemah-Bsaleem
***03/05/2016**	Alchwaeifat-Aeinbal(Alshouf)-Aramoun-Bsaleem-Almkallis
***04/05/2016**	Jdayel-Zeitoun
***05/05/2016**	Alhaykaliyeh(Alkourah)
***06/05/2016**	Kfarsheemah-Albatroun-Almkallis
***09/05/2016**	Nahr Al mout-Dwar Alali-Alsfayr-Almnsf
***10/05/2016**	Albarakat(baabda)-mansouriyeh(bhamdoun)-Sin El Feel
***12/05/2016**	Aisha Bakkar high way
***13/05/2016**	Almaameltein-Almatn Al Sareeh High way-Chweifat desert-Bsaleem-Badghan
***14/05/2016**	Kfarjouz
***16/05/2016**	Albowshriyeh-Bourj Hamoud- Hadi Nasralla High way
***17/05/2016**	Ard Jaloul-Mazraet Yashouh-Alhadath(Kweit Embassy)
***18/05/2016**	ALQrayyi-Galery Simaan-Abou Mezan-Bzhl-haret al. btm(Alhadath)-Saida
***19/05/2016**	Haret al. Sakhr-Alqaa-Alfanar-Aramoun
***20/05/2016**	Aljnah-Mijdlayah(Zghartah)-Misteeta

***21/05/2016**	Aein Harsha(Rashaya)-Sin El Feel-Kfarjouz(Alnabatiyeh)-Zotr-Aljrmq-Almaaniyeh(Alshouf)-Adloun-Alqyaa(Saida)
***23/05/2016**	Alrwaysat-nahr al mout-aLdikwaneh-Alramleh Al baydah-Roumyeh-Aishah bakkar-Ard Jaloul
***24/05/2016**	Jeeta
***26/05/2016**	Roomyeh-Zouk Mosbeh
***27/05/2016**	Zeitoun- Zouk Mkayel
***28/05/2016**	Alsarafand-Bsaleem
***30/05/2016**	Baabda-Albawshriyeh
***31/05/2016**	Bourj Hamoud
***01/06/2016**	Aljnah-Hay el Silom
***02/06/2016**	Almsaytbeh-Shheem-Alghaziyeh-Dahr Al wahsh-Haret Hrayk-Jisr Al Wati-Bsaleem-Alaaqbayeh-Alhayklyeh
***03/06/2016**	Almradiyeh-Sad Al Bawshriyeh-Sreefa
***04/06/2016**	Bsaleem-Albawshriyeh(*2)-Alsaqyeh(Shheem)-Bourj Hanoud-Baqaatah(Alshouf)-Maaroub(Alhamiri)
***07/06/2016**	Zaeitoun-Baaqleen
***08/06/2016**	Alhaykaliyeh-bizhl-Misteeta
***09/06/2016**	Fnaydiq(Akkar)-Dmeet-Alsfeer-Almkallis-Alnabaah
***10/06/2016**	Botmeh-Haret Hrayk-Aljnah
***11/06/2016**	AlCola-Shheem-Alrways-Alhaykaliyeh
***13/06/2016**	Rwaysat Sawfar
***15/06/2016**	Ard Jloul-Alshiyah-Alshhabiyeh
***16/06/2016**	Ghazeer-Taalabayah-Karakas(Ras Beirut)
***18/06/2016**	ALGhsayn
***20/06/2016**	Misteeta-Bijeh-Fnaydiq-Kfarsheemah
***21/06/2016**	Alfanar-Alaqabiyeh-Bizhl-Wadi AL Zenah-Badghan-Aein W Zein-Bsharah Al khoury
***22/06/2016**	Aljnah-Alnabaa-Rwaysat Sawfar- Bsharri
***23/06/2016**	Ihmj-Bsous-Toorzaya-Nahr Althahab
***24/06/2016**	Aein Hala-Alqlyaat-Baalbak-Tareeq Al Matar- Shheem-Aljnah-Albawshriyeh-Zafta
***25/06/2016**	Barja-Alabasiyeh-Jinjl (Jbeil)-Faraya-Shheem-Sin El Feel-Youneen
***27/06/2016**	Roumiyeh-Alfanar-Wadi Al maaniyeh-Alsimqaniyeh(2)-Maarakah
***28/06/2016**	Sibniyeh(Baabda)-Kitermayah-Shheem-Hrajil
***29/06/2016**	Jeita-Dalhoon
***30/06/2016**	AlAshrafiyeh
***02/07/2016**	Alqlayaat
***04/07/2016**	Alkafaat-Bsaleem-Jal El Deeb(2)-Wadi Alzeenah-Kitermayah

***05/07/2016**	Bayt Shabab-Alkfour
***12/07/2016**	Darya(ALSHOUF)
***13/07/2016**	Makjdl ANJar-Jonieh-Maarakah-Alreehanah-Althareef-Rishmayah
***14/07/2016**	Maaroub-Zghartah-Althareef
***15/07/2016**	Wata Al Msaytbeh-Rimhala-Alswiry-Anqoon
***16/07/2016**	Tareeq AlJdeedeh-Hjoula-Nahr Ibraheem-Markabah
***18/07/2016**	Aein El Remenah(Aley0-Baaqleen-Youneen-Ghazeer-Alkayal-Alazouniyeh
***19/07/2016**	Akkar Al ateeqa-Aldamour
***20/07/2016**	Alreehana(Jbeil)-Albazooriyeh(Wadi Jilo)-Alnabatiyeh-Zouk Mosbeh-Almkallis-Dayr Al Ahmar-Dayr Al qamar-Baalbak
***21/07/2016**	Qatraboon
***22/07/2016**	Kfarsheemah-maaroub-Watah Al Msaytbeh
***23/07/2016**	Almkallis-Bhwarah-Aljnah-Baqaata(Ashqouf)
***25/07/2016**	Bizmar-Nahr Al Mout
***26/07/2016**	Alhamrah
***27/07/2016**	Faytroon-Rishmayah-Bizmar-Aley
***28/07/2016**	Baalishmay-Nahr Ibraheem-Sarba-Rishmayah(Aley)
***29/07/2016**	Baalbak-Rwaysat Al Jdeedah-Sad Al mawshriyeh-Aley
***30/07/2016**	Bkhishtay-Bourj al barajneh-Aley
***01/08/2016**	AeinBAl-Alqmatiyeh-Hadath Baalbak-Aley
***02/08/2016**	Alqlyaat-Shamat-Abou mAyzan-Bdadoon-Albwar-Baalbak
***03/08/2016**	Baabda-Alhadath-Sad El Bawshriyeh(*2)-Alnaqash-Almtaylib-Deek Al mihdi-Alrabyeh-Antelyas-Zouk Mkayil-Faytroon-Albatroon-Mar rookz(Aldikwani)-Aramoon-Jal Al deeb-Bshamoun-Almnyeh
***04/08/2016**	AlQlayaat-Bzmmar-Jib Jneen-Dahr Sarba-Dahr Al Aein-Mazraaet Yashouh
***05/08/2016**	AlChwaeifat
***06/08/2016**	Alloobiyeh
***08/08/2016**	Ras Al Dikwani-Alnabaah-Bourj Hamoud
***09/08/2016**	Almkallis-Aramoon-Baalbak
***10/08/2016**	Aljiyeh-Alkafaat-Jonieh-Kfarsheema
***11/08/2016**	Dayr Al qamar-Rwaysat Al jdeedeh-Hrajil
***12/08/2016**	Barjah-Nahr Ibraheem-Arsaoon-Zouk Mosbeh-Dalbta
***13/08/2016**	Aldikwaneh-Alkayal-Barqa-Alhadath-Abra-Ras Al Jabal(Aley)-Aein Dilbeh
***16/08/2016**	Ghadeer(2)-Jal Al deeb-Alkayal-New Rawdah-Ard Jloul-Dhoot Al abadiyeh-Mijdlayah(Zghartah)-Kfarmashoon-Ihmj
***17/08/2016**	Bibneen-Haret al. Sit-Alnaqash-Aldahiyeh Al janoubiyeh-Almina

	Tripoli
***18/08/2016**	Alkafaat-Almadeena L riyadiyah-Zouk Mosbeh(2)
***19/08/2016**	Abou Myzan
***20/08/2016**	Breeh-Jouret Bdran
***22/08/2016**	Albawshriyeh-Alaqaybeh-Aljiyeh
***23/08/2016**	Alasi(sour)-Alkasleek-Qornet Shihwan-Ghosta
***24/08/2016**	Daroon
***25/08/2016**	Jbeil-Almasnh
***26/08/2016**	Saida-Kfarmishki-Jizeen-Alfanar-Jbeil
***27/08/2016**	Aldawrah-Mar Mousa-Faytroon
***29/08/2016**	Zouk Alkhrab-Elissar-Baqaata (Ashqoot)-Sawfar-Albus
***30/08/2016**	Daroon-AlBawshriyeh-Ghazeer-Bourj Hamoud-Byaqout-Kfarbaal-Jdaydeh-babdaat-mazraet yashouh-Aley
***31/08/2016**	AlRAwdah-Bshatfeen-Aljdaydeh-Zouk Mkayel-Dbayeh-Ard Jloul-Ashqout-Ajaltoun-barjah-Aljamhour-Aljamous
***01/09/2016**	Fnaydiq-AlRwaysat Al jdeedeh-Sad Al Bawshriyeh-Dbayeh-Sin El Feel
***02/09/2016**	Bsaleem-Sin El Feel-Bourj Hamoud(2)-Dbayeh-Aljnah-Mazraet Yashouh-Nabyeh-Dhoor El Shwayr-Zouk Alkharab-Sad El Bawshriyeh-Awkar-Jbeil-Kfarsheemah-Dahr Al Aein
***03/09/2016**	Qabrshmoon-Bsaleem-Mazraet Yashouh-Byaqoot(2)-Alfanar-Bourj Hamoud-Sad Al Bawshriyeh-Dbayeh(2)
***05/09/2016**	Rwaysat Al jdeedeh-daroon-Jeita-Bsaleem(5)-Saida-Byaqoot-Jdaydeh-Bourj Hamoud-dbayeh-Saidoon-Aldikwaneh-Aljdaydeh-Bdaro-Halat-Zeitoon
***06/09/2016**	Alhamra-Dbayeh-Almnsif-Bshamoun- Aramoun-Sarahmoul-Jbeil-Alnaqash
***07/09/2016**	Bsaleem-Sad AlBawshriyeh-Bourj Hamoud-Bshamoun-Dbayeh-Antelyas-Alfraykeh-Antelyas-Alshiyah-Jadayel
***08/09/2016**	Sin El Feel-Aldawrah-Sad El Bawshriyeh(*2)-Aljdaydeh(*2)-jal Al deeb-Antelyas(*2)-Mazraet Yashouuh-Zouk Mkayil
***09/09/2016**	Antelyas(2)-maaser Bayt El Deen-Albawshriyeh-Jisr Albasha-Aldawrah-Jonieh-Nahr AL kalb-Darayya(ALShouf)-Bshamoun
***10/09/2016**	Aldawrah-Sad El Bawshriyeh(2)-Almansouriye-Dbayeh-baalbak-Aldikwaneh-Zeiton
***14/09/2016**	Sad El Bawshriyeh-Aljdaydeh(2)-Aldikwaneh-Almkallis bshamoun-Alkayal(Baalbak)-Dawhet al. hos-Byaqout-Almansouriyeh-dardaghya-kfarshouba-ihdn-Aley
***15/09/2016**	Antelyas-Almghiryah-Sad El Bawshriyeh(3)-Jbeil-Ard Jloul-Zouk Mosbeh-Albourj-Aein Saadeh-alfanar-Bshamoun-Nahr Ibrahim-Jisr Al qadi-Haret Hrayk-Sin El Feel-Byaqout-Qornet al. hamrah-Sad El

	Bawshriyeh
***17/09/2016**	Rwaysat AlJdeedeh-Aldawrah(4)-Dbayeh-Bqnaya-Nahr Al Maout-AlDikwaneh-Alnaqash-Alsabtiyeh-Mijdlaya-Bshamoun
***19/09/2016**	tabarja-Almatn Al Sareeh-Adma-Aldawrah(3)-Alfanar-fatqa-roumyeh-Halba-Rwaysat Eljdeedeh(2)-Ghazeer-Albawshriyeh-Almkallis-Misteta-Bsaleem-Bshamoun-Baalbak-Einaya-Misteeta-Bourj Al barajneh-mazraet Yashouh
***20/09/2016**	Albawshriyeh-Alfanar(3)-Toorzya-Byaqout-Sarba-Aramoun
***21/09/2016**	Jal El Deeb(2)-AlBAwshriyeh-Qartabah-Yahshoush-Alnaameh
***22/09/2016**	Bshatfeen-Antelyas
***23/09/2016**	Alaqaybeh-Almkallis-Roumyeh-Nahr Al mout
***24/09/2016**	AlDawrah
***26/09/2016**	Zghartah-Bdadoon-Alhadath-Ashqout-bourj Hamoud-Tripoli-Dayr Shomrah-Antelyas-Bzimmar-Almnsif-Tikreet
***27/09/2016**	Ghazeer-Hamat-Alkasleek
***28/09/2016**	Dbayeh(2)-AlBwar-Zouk Mosbeh
***29/09/2016**	Bmaryam-Amsheet
***30/09/2016**	Albwar-Alhaseen-Alaqybeh
***01/10/2016**	AlBwar- Tareeq Al Jdeedeh-Almnsif
***03/10/2016**	Bayt Shabab-Zahle-daroon-Rsheen-Aytat-Bayt hbaq(Jbeil)-dbaal-Bshatfeen-Aley-Bqata-Ashqoot-Zghartah-Jbeil-bntaal
***04/10/2016**	AlRmayleh
***05/10/2016**	AlDikwaneh-Misteetah-Mijdlayah(Zghartah)
***06/10/2016**	AlDikwaneh-Ard Jloul-Ashqout-Bayt AL deen-Alaqybeh-Kfaryaseen
***07/10/2016**	ihmj-Sharoon-Almrayjeh-Saidah-Alqbayat
***10/10/2016**	Roumyeh-Alnamourah-Almameltayn-Kifraya-Tripoli-Barja-Roumyeh-Halat_Nahr Ibrahim-Alqamouaa
***11/10/2016**	Bshatfeen
***13/10/2016**	Dardooreet-Bshatfeen-Alnaameh-Alrabyeh-Jdeeta-Aeintoora-Dbayeh
***14/10/2016**	Antelyas-Mazraet Yashouh-Bkhishtay-Brimanah-faytroon-nahr Al thahab-Dida(Alkora)
***15/10/2016**	Bafleh-Kitermmayah-Marj Ali-Alqamouaa
***17/10/2016**	Bourj Hamoud(2)-Deek Al mihdi-Alnaameh-Bshatfeen-Kfarnabrakh-Aley-Ashqout- Nahr Ibrahim-Qirnayil
***18/10/2016**	Tareeq Al Matar-Alshiyah-AlBawshriyeh-Wadi al Sit-Sin El Feel-daroon-Baleshmay
***19/10/2016**	Rwaysat Sawfar-Ghdras-Bayt Alkkoo-Kfarqatra

***20/10/2016**	Alzeeri(Shheem)-Bzibdeen-Ras Aldikwani-Aein Aldalbeh-Bmhrayn-Bourj Al brajneh-mijdlaya(zgharta)-daroon
***21/10/2016**	Korneesh Al mAzraah-Bourj Al barajneh-Almkallis
***22/10/2016**	Ard Jloul-Kourneesh Al mazraah-Alnaameh-Saida-Darayya
***25/10/2016**	Alnabaa-Zouk Mosbeh-Dar alaein-Aein Alrimaneh-Hadi Nasrallah High way-Alrawshi
***26/10/2016**	Bier Al Hasan- Antelyas- Aljdaydeh-Almameltayn-Alnqash-Nahr Ibrahim
***27/10/2016**	yhshoush-Alrojmeh-Bourj haoud-Alnaqash-Almrwaniyeh-Alskskyeh-Aldawrah-Jbeil-ddah(Alkora)-Sour
***28/10/2016**	Aldawrah-Aein Frdees
***29/10/2016**	Bourj Al Shmali-Alnabaah-bourj Hamoud-Ras El Jabal(Aley)-Btighreen-Dbayeh-Alnaqash-Bzibdeen
***31/10/2016**	Qartabah-Sin El Feel-Almsaytbeh-Martmooraa(Alqbayat)-Aeintoorah-Sidqeen-Bier Hasan-Alhadath-Alazooniyeh-tayrdbah-Kfarfaqood
***01/11/2016**	Mazraet Yashouh-Baabdah-Alsabtiyeh
***03/11/2016**	New halat-Alnaqoorah
***04/11/2016**	Dbayeh-Aein Alkhroobah-Alnabaah-Aley-Ras El JABAL(ALEY)
***05/11/2016**	Shheem-Aljnah-Aldawrah(*2)-Jal El Deeb-Amsheet
***07/11/2016**	Kfarfaqood-Tihweetet al. Ghadeer-Aljnah-Aldikwaneh-Ard Jloul-Roumyeh
***08/11/2016**	Aljnah
***09/11/2016**	Watah Almsaytbeh
***10/11/2016**	Alansariyeh-Alhadeeqa Alamah(sour)-Alqasmiyeh-Alshhabiyeh-Sibleen-Maaroob
***11/11/2016**	AlFAnAr-Kfarsheemah
***12/11/2016**	AlHadath-Tareeq Al Matn Al Sareeh
***14/11/2016**	AlBAwshriyeh-Bourj Hamoud-Alkhaarbeh-Blat
***15/11/2016**	Alhamrah-Ard Jloul-Bareesh
***16/11/2016**	Mijdlaya(ALShouf)-Antelyas-Aldalbeh(Aldahiyah AL janoubiyah)-Hanawiyeh-bizhl
***17/11/2016**	Hay Al Silom-Ras Al Dikwaneh-Almrayjeh-Antelyas-Allylaki-Hasroot
***18/11/2016**	Alhadath
***19/11/2016**	Aghmeed-Beir Hasan-Aldawrah-Bayt Shabab-Albatroon-Blat
***21/11/2016**	Alllylaki-Beir Hasan-Alnabatiyeh-Bourj Hamoud-Sour
***23/11/2016**	Albus-Alhawsh-bayt Aldeen
***25/11/2016**	Alkafaat-Aljdaydeh-Aldawrah-Bourj hamoud-Almansouriyeh-Maarakah

***26/11/2016**	Alkafaat-Aein W Zein-Aldawrah-Albrjayn- Alhawsh
***28/11/2016**	Alawynat-Alnaameh-Mshmsh-Sayroub-Alaqaybeh-Alawaynat-Kfarjarah
***29/11/2016**	Ras Al Dikwani
***30/11/2016**	Almrooj-Dbayeh-Almkallis-Mazraet Yashouh-Wata AL Jawz
***06/12/2016**	Kfarsheeham-Alaqaybeh-Qatrabah
***08/12/2016**	Alsafrah
***10/12/2016**	Bourj Hamoud
***12/12/2016**	Alsabtiyeh-Aley-Msheekha-Alfanar
***13/12/2016**	Darayya
***20/12/2016**	nahr Al Mout
***22/12/2016**	Zouk Mosbeh
***31/12/2016**	Alsabtiyeh
***03/01/2017**	AlHamra
***09/01/2017**	haret hrayk-sad al bawshriyeh-halta
***10/01/2017**	Alkaranteena
***11/01/2017**	AlChwaeifat
***13/01/2017**	Zouk Mosbeh
***16/01/2017**	Alkafaaat
***23/01/2017**	Abi Samra-Almkallis
***25/01/2017**	AlChweifat
***26/01/2017**	Almtaylib-Alsabtiyeh-Bshari-Mazraet al.shouf-Sahel Alma
***06/02/2017**	Rwaysat
***07/02/2017**	Aloozahi
***08/02/2017**	Alfanar-Wata Al Msaytbeh-Zouk Mosbih-Aldamour-Daroon
***10/02/2017**	Adma-Adonis-Wadi Shahrour-Zouk mkayil-AlHdath-
***16/02/2017**	Alsimqaniyeh
***22/02/2017**	Saqiyat Al Janzeer
***24/02/2017**	Majdelbaana
***27/02/2017**	Aldawrah-Ghadeer-Beir Alabd
***11/03/2017**	AlDikwaneh-Hadath Al jibeh-Albowshriyeh
***15/03/2017**	Ghazeer
***20/03/2017**	Alchweifat
***21/03/2017**	Tareeq Al Jdeedeh

Table A.4. Waste Burning Sites and Dates