

Health Policies for Reducing Air Pollution in Iran

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Abstract

Introduction: Regarding the increasing evidence on the detrimental effects of air pollution on human's health and environment, it is necessary to identify ways to reduce these effects. The aim of this study was to provide effective solutions to control and decrease the effects of air pollution.

Material and Methods: This study was in the form of narrative review. Documents were searched using the following key words: air pollution, adverse effects, environment, public health and solutions to control, in databases PubMed, Google scholar, Science Direct and SID in a given period of time. After collecting evidences and documents, the data were analyzed and alternative solutions were recommended.

Results: The results of the present study got categorized in five groups. At the end, solutions were recommended to policy makers about controlling air pollution and reducing the effects of it.

Conclusion: However, some studies have implied short and long-term effects of air pollution on human's health. Supplementary investigations are needed to shed light on the direct and indirect effects of air pollution on people's health and even on environments having a role in human ecology. Many required measures taken to decrease the level of air pollution need long- running commitments and plans. Some interventions are implementing in local or national levels, permanently or temporarily, in order to reduce exposure to air pollution. Definitely, the reduction in air pollution will decrease most of the diseases at the present time and also in the future. Hence, making decisions about public health policies now would be better than tomorrow.

Keywords: Air Pollution, Adverse Effects, Environment, Public Health

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Submission Date: 22/03/2017

Accepted Date: 25/06/2017

Introduction

Air pollution has been a common concern in the recent decades. The recent evaluations of the burden of diseases showed that air pollution is one of the causes for mortality and morbidity in the world (1),(2) and encountering with it has a big effect on people's health in every age group. Early mortality arises from a variety of causes, including cardiovascular and respiratory diseases which are the most important elements (3). On the other hand, non-communicable diseases including cardiovascular diseases and cancers in developed and developing countries are increasing. Certainly, in this point it should be said that air pollution plays a significant role in the aforementioned diseases.

From the public health point of view, air pollution specifically in developing countries is a significant determinant of health which has led to increasing the risk of developing heart and pulmonary diseases (4). This issue is one of the types of environmental pollution that can have an effect on health both in long and short term and brings about an increase in cardiovascular, lung and respiratory diseases, eye irritation and skin diseases caused by acid rains (5), (6).

Air pollution is a global concern that has affected all urban and country people in devolving countries. Evidences indicate that inequality while encountering with air pollution exists not only in national levels but also in local levels. Also, this type of inequality while encountering with high levels of air pollution between people having poor

health and less access to healthcare is great (7), (8). It is more likely that the intensity of pollutants in metropolitan areas of developing countries is more than the average pollution of US. So, it is hard to evaluate the effects of air pollution in developing countries due to the lack of policy aims at improving air quality, weakness in environmental monitoring and deficiency in data about diseases. The lack of data is a major concern in developing countries since these countries are more affected by air pollution and from the other side, have a considerable potential to improve individual's health through increasing the quality of air. Big cities in Asia, Africa and Latin America are experiencing higher levels of air pollution in relation to cities located in Europe and North America (9),(10). Several studies having been conducted in the scope of the biological effects of air pollution on human health and have illustrated that air pollution has negative effects on the respiratory system, lungs, heart, blood, vessels and brain (11),(12).

Recent studies have shown that air pollution in cities has resulted in early death of more than 3 million people all over the world. This vital finding was published in the Nature Journal by Lelieveld et al. (from the Max Planck Institute for Chemistry, the Department of Atmospheric Chemistry) in September 16, 2015. They also predict that if interventions are not made for air pollution control, the numbers of early mortality figures arising from that are expected to reach 6.6 million deaths by 2050 and the biggest increase would be in Asia. They also found the relationship between air pollution and seven other factors (13). The



effect of air pollution on mortality and diseases stemming from that provides a good reason to attempt to control its effect and maintain the community's health. Depending on what was explained, it is essential that extensive effects of air pollution on communities' health as well as economic burden placed on communities are paid attention by policy makers. So, taking necessary measures to improve quality of air and improving community's health as well as providing solutions to reduce negative effects of air pollution are issues which has been addressed in this study.

Materials and methods

This is a descriptive review study. Its data was obtained and categorized by searching in valid databases. By relying on research purposes, the data were identified, collected, categorized and analyzed. In this study, descriptive review of documents and appraisal of data in connection to the matter and aims of the study were examined. In these types of studies, there is no common method in contrast to systematic review studies to examine documents. Therefore, selecting the topic and study's framework depend on the author's perspectives and experiences. In the present study, in the form of narrative review, documents were searched using key words: air pollution, health effects, and solutions to control. These keywords were searched in the following databases: PubMed, Google scholar, Science Direct and SID in a given period of time. After collecting evidences and documents, the data were analyzed.

Results & Discussion:

The results of the study were categorized in five groups. Finally, solutions were recommended to policy makers about controlling air pollution and reducing its effects.

1. The effects of air pollution on public health
2. The influences of air pollution on sensitive people
3. The impact of air pollution on mortality rates
4. Socio-economic effects of air pollution
5. existing solutions, and challenges of controlling air pollution effects

The effects of air pollution on public health

From the perspective of public health, air pollution is one of the central determinants of health, specifically in developing countries which results in increasing the risk of developing a variety of diseases like cardiovascular diseases (8). Exposure to polluted air both in long and short term periods has some effects on health. The elderly and infants are vulnerable groups. Air pollution is of important environmental health concerns which influence all individuals. It is estimated that two million people have died due to air pollution, more than half of which are living in developing countries. In addition to early mortality, air pollution is linked with respiratory diseases such as asthma attack, pneumonia, reduction in the lung performances and increase in hospitalization by reason of pulmonary disorders (14). On the other hand, some cardiovascular diseases including heart attacks and hospitalization resulting from heart failures are in association with air pollution. Even short term exposure to air pollution (specifically for vulnerable people) has a relationship with growth in mortalities arising from cardiovascular and other diseases

(15). Giving attention to this matter that cardiovascular is a health-related issue has importance since 2 percent of yearly hospitalization and 30 percent of mortality rates are attributable to cardiovascular diseases. At the same time, patients suffering from heart diseases tend to be very sensitive to air pollution (11). The health sector can play a central role in leading multispectral view about preventing from exposing to air pollution. This sector can involve and/or support other related sectors (e.g. transportation, housing, industries) in developing and implementing policies in line with the reduction of air pollution health risks. Exposing with air pollution has a negative impact on cardiovascular diseases, respiratory and nerves systems. However, it is possible to have more direct and indirect effects on human health (16). As it is known, obesity has detrimental effects on health such as developing cardiovascular diseases, Type 2 diabetes, many kinds of cancers and other diseases (17). Physical activities are key elements in reducing mortalities and morbidities from obesity and result in improving health status. On the other hand, physical activities lead to more breathing and, at the presence of air pollution, will increase the dose of pollution breathed (18). This subject is highly problematic in some sports like biking and walking as well as about professions and jobs that are placed on sites with low-quality air. Some studies have investigated the rate of respiration and physical activities in exposure to air pollution.

It is hard to evaluate the effects of air pollution in developing countries due to the lack of policy aims at improving air quality, weakness in environmental monitoring and deficiency in data about diseases. The lack of data is a major concern in developing countries since these countries are more affected by air pollution and from the other hand have a considerable potential to improve individual's health through increasing the quality of air. Adverse effects of air pollution on sensitive groups such as children, adults and even healthy people should be considered.

The influences of air pollution on sensitive people

Air pollution is a problem in connection to the environment which is able to impact on the health of different groups in a community. It's serious and sever effects are on those who suffer from diseases. The elderly and infants are vulnerable groups. Adverse effects of air pollution on sensitive groups such as children, adults and even healthy people should be considered. It is worth mentioning that real exposure to air pollution and dose of pollutant taken by a person depend on the time spent in a polluted site.

The effect of air pollution on infants and Pregnant Women

The exposing of pregnant women to polluted air leads to an increase in premature birth and low birth weight (LBW). More than twenty million babies in the world (who make up 15.5 percent of total births) were born with LWB (19), (20), (21). The prevalence of this disorder in developing countries is equal to 16.5 percent that is two times more compared to developed countries(LBW% =7 percent). One of the factors creating LBW is premature birth that is accounted for a reason of infant mortalities. One of the risk factors affecting LWB, accompanied by other known medical elements, is polluted air in environments and

homes. Several case-control and cohort studies have found a strong relationship between exposure to air pollution and its adverse effects during pregnancy periods (22), (23). In a study by Lamichhane et al., a systematic review and meta-analysis was conducted using 44 studies about the effect of air pollution on pregnancy and labor. Results showed that a reduction of 10 and 22 grams on LWB is attributable (after removing the effect of smoking) to exposure to air pollution in pregnant women. These effects originating from air pollution are accompanied by increasing in mortalities and morbidities during infancy period and risk of developing diseases such as depreciation and mental disorders during adulthood (24).

The effects on elderly people, respiratory and cardiovascular diseases

Heart diseases, as an important problem in the public health has affected more than 23 million people in the world. Its prevalence is the most common in aged people (1), (16). Harms and effects of air pollution on heart and vessels have been confirmed in sets of epidemiological studies (25). In a way, air pollution, along with other factors, is known as a serious risk factor for cardiovascular diseases. The World Health Organization predicted that air pollution is responsible for 3.1 million premature deaths each year all around the world (26).

The effect of air pollution on heart failure and the mortality arising from that may be underestimated. It is possible that assessments and estimations would be carried out based on acute and critical problems in short term, harmful effects stemming from continuous and chronic exposure to air pollution not considered (27). The exposure to air pollution creating cardiovascular and Myocardial infarction diseases, the effect of air pollution on other heart failure like acute heart disease have been less investigated (28). Shah et al. having conducted a systematic review and meta-analysis on the relationship between air pollution and heart failure diseases illustrated that reduction in daily average density PM_{2.5} at a rate of 3.9 micrograms per cubic meter prevents 8000 cases of heart failure in the United States and saves costs by about one-third million dollars. In the big cities of developing countries, the rate of PM_{2.5} is ten times more than the national standards of air quality in the US. By contrast to average PM_{2.5} density at the rate of 15 micrograms in per cubic meter, metropolitans like New Delhi and Beijing (in china) have PM_{2.5} density at the rate of 100-300 micrograms per cubic meter (15).

According to a study entitled "Air pollution and cardiovascular disease" published in the European Heart Journal (EHJ) in January 2015, the European Society of Cardiology (ESC) announced that air pollution is a serious risk factor for cardiovascular diseases independent of other known risk factors. The ESC congress held in London for discussing about the issue of environment and the heart in the same month stated how environmental hazards such as air pollution have an impact on cardiovascular diseases. The congress clearly pursued the matter of needing to create a healthy environment for heart health protection and tried to encourage policymakers to take serious actions. In response to this subject, ESC joined with the Network European Heart (NEH) and European Association for Cardiovascular

Prevention (EACVP) in organizing a petition to make a commitment in the Europe union policy makers to take decisive actions (29). Hossein pour et al. in a study using time series data of 25 university hospitals found that the more levels of carbon monoxide emissions, the more in the number of hospital admissions (30). Given that heart disease is among the most important causes of morbidity and mortality in Iran, so air pollution control has a considerable impact on reducing the number of deaths caused by this disease.

Air pollution and the poor

Air pollution puts a heavy burden of disease on specially developing countries. These countries are facing a variety of problems such as poverty, social deprivation and inequality. Inequality in exposing to air pollution and its aftereffects in communities as well as burden of diseases placed on the poor is remarkably higher than other people. This kind of inequality and the exposure to high degree of air pollution between people having poor health and/or less access to healthcare is more intensive. Inequality in exposing to air pollution among different people and communities, together with other social and physical aspects, creates an asymmetrical burden of disease in the deprived and poor section of societies. Studies have shown that there is inequality in exposing to air pollution. Actually, it is very likely that poor people are living in areas with high levels of pollution. The poor often have low health status and may have less access to healthcare (8), (31).

Mortality rates attributed to air pollution

Recent assessments of the burden of diseases ranked air pollution as a factor effecting mortalities and morbidities (16). The World Health Organization predicted that air pollution is resulting in more than one million early deaths each year in the world. Based on the findings of the global burden of disease studies in 2010, air pollution causes the early death of 3.2 million people (Confidence Interval, in level 95%, between 2.8 and 3.6 million people). This matter ranked air pollution as the second most environmental risk factor and the ninth overall risk factor (10). The prior studies predicted that in case of sustaining air pollution, it is expected that mortality and morbidity will increase. According to Bell et al. on average, by 2050, .031% increase in mortalities coming up cardiovascular disease will be attributable to air pollutants (32).

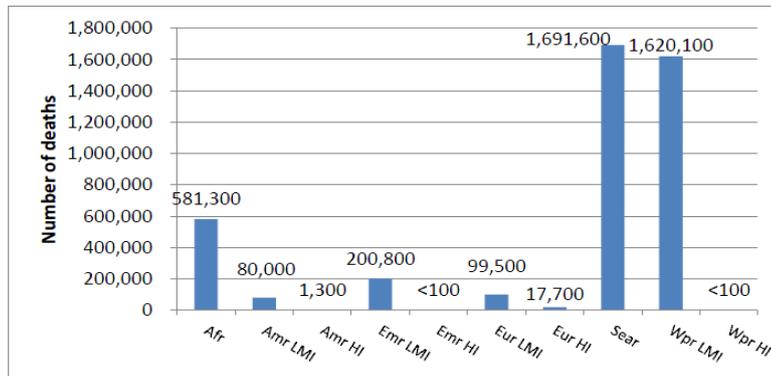
In Shanghai, the estimated causes of mortality due to PM₁₀ ranged from 13 to 55 cases per day and from 300 to 800 cases per year (33). Salien et al. examined health and economical outcomes of air pollution resulting from Ozone by 2050. They found that Ozone changes being created by changes in the climate and pollutants will result in 817000 mortality and loss of productivity about the value of 120 billion Dollars. They also concluded that previous studies, due to not considering the long term effects of air pollution on health cost, underestimated the cost of air pollution. Economic effects of variation in air pollutants are outside the atmospheric effects (34).

In 2012, totally, 4.3 million mortalities attributable to indoor air pollution, the most shares of those happened in low and middle countries. These countries are mainly located in the Southeast Asia and Western Pacific regions

(14). More than 600000 deaths occur in Africa, 200000 cases in Eastern Mediterranean, 990000 in Europe, 810000 in America and the remaining 190000 deaths occur in the high- income countries (8).
 A strong growth on the number of mortalities in comparison to previous studies is due to the following reasons: 1. Some health problems like cerebrovascular and ischemic heart

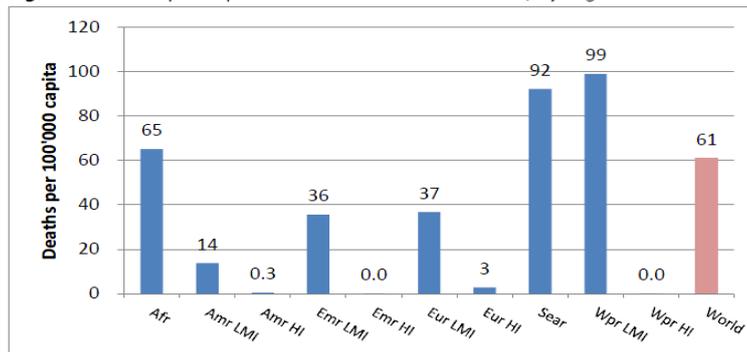
diseases have been entered for analysis. 2. Compelling evidence exists for the relationship between exposure and health outcomes, and dose-response relationship. 3. A growth in the number of non-communicable diseases (8).
 The Tables below show mortalities that are attributable to air pollution in 2012.

Figure 1. Total deaths attributable to HAP in 2012, by region



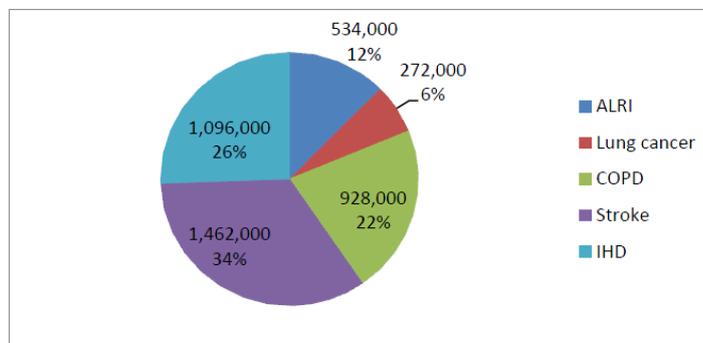
HAP: Household air pollution; Amr: America, Afr: Africa; Emr: Eastern Mediterranean, Sear: South-East Asia, Wpr: Western Pacific; LMI: Low- and middle-income; HI: High-income.

Figure 2. Deaths per capita attributable to HAP in 2012, by region



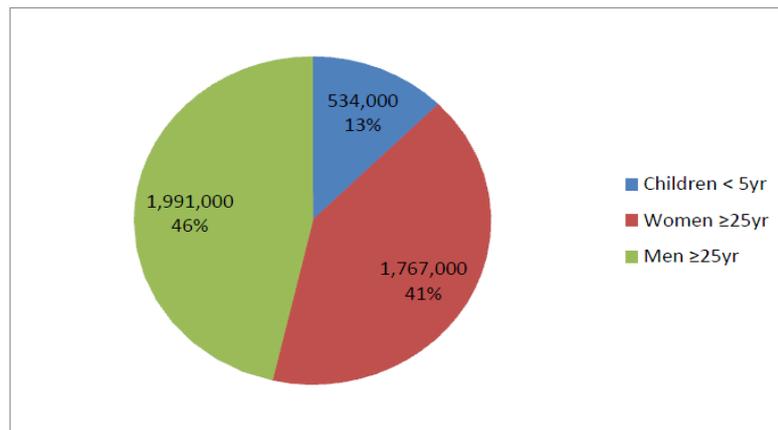
HAP: Household air pollution; Amr: America, Afr: Africa; Emr: Eastern Mediterranean, Sear: South-East Asia, Wpr: Western Pacific; LMI: Low- and middle-income; HI: High-income.

Figure 3. Deaths attributable to HAP in 2012, by disease



Percentage represents percent of total HAP burden (add up to 100%).
 HAP: Household air pollution; ALRI: Acute lower respiratory disease; COPD: Chronic obstructive pulmonary disease; IHD: Ischaemic heart disease.

Figure 4. Deaths attributable to HAP in 2012, by age and sex



Percentage represents percent of total HAP burden (add up to 100%).
 HAP: Household air pollution; yr: year.

Socio-economic effects of air pollution

Air pollution is a global concern that has involved all people residing in urban or rural regions of developing countries. On comparison, the large cities located in Asia, Africa and Latin America experience more problems of air pollution subject to Europe and North American ones. This concern is one of the environmental health problems that all people are overwhelmed by that and is a reason for extended burden of diseases all over the world. According to some estimation, more than two million people mainly living in developing countries are annually dying from air pollution (8), (35).

In Shanghai, the avoided cases of all causes of mortality had an estimated monetary value ranging from 170 million yuan (1 US dollar=4.2 yuan Purchasing Power Parity) to 1200 million yuan. Avoided hospital admissions had an estimated value from 20 to 43 million yuan. Avoided emergency department visits had an estimated value from 5.6 million to 15 million yuan. Avoided outpatient visits had an estimated value from 21 million to 31 million yuan (33). A study conducted to examine the relationship between economic growth and quality of environment and impacts of this relationship on development plans showed that economic growth has the most impact on air pollution. One percent increase in economic growth is associated with increase in the air pollution level by 5.54 percent. They considered the aforementioned finding as a serious threat to economic policy makers. Since a surge in economic growth is the main economic goal in each period of time, it is necessary for policy makers to take measures to minimize effects of economic growth on the environment and sustainable development objectives are properly to be fulfilled (34).

Studies found that an improvement in standards of air quality has big advantages and apparently leads to a reduction in healthcare costs. The United States alone has funded all public and personal costs of controlling air pollution and has satisfied the requirements of constitutional amendment of clean air expected to reach 65 billion Dollars (8). In a study in China, assessing the economic effects of air pollution showed that health-related economic impacts resulting from air pollution in 2009

reached to 106.5 billion dollars or in other words 2.1% of China's GDP (36). By reducing some air pollutant levels from 70 micrograms in per cubic meter to 20 micrograms (as mentioned in the new guideline), it is predicted to reduce the mortalities arising from air pollution by 15 percent. Furthermore, a reduction in air pollution levels can help reduce the global burden of diseases from respiratory infections, heart diseases and lung cancer (8).

Challenges that governments are facing and in-coming barriers to air quality improving

Exposure to air pollution is outside personal control and requires action by public authorities at national, regional and even international levels. In the majority of developing countries, yet, giving attention to pollution missioning from home heating, power and fuel generation, transportation and urban development plans have not yet become an instruction. The lack of respect to air pollution effects puts several obstacles in the way of defining actions and national and international resource mobilization. Low-quality fuel used in cooking, heating, and disposing of waste leads to widely early deaths in crowded areas of Asia (e.g. China, India, Bangladesh, Indonesia and Nepal). Some simple actions to combat air pollution, including improvements in domestic stoves or heating system can reduce exposure to air pollution and improve people's health with low cost. Karbowasi et al. in a study done in two big cities of New Zealand found that domestic heating is the most significant factor in the high level of air pollution in winter. At the end, they pointed to the need to change the use of domestic heating systems (37).

Roll of the World Health Organization (WHO) in the control of air pollution

Exposure to air pollution is beyond personal control and requires actions by public authorities at national, regional and even international levels. Based on the existing evidence, the World Health Organization has developed some guidelines and instructions for quality of air in order to mitigate the effects of air pollution on health. These guidelines can be a reliable source for policymakers to develop national strategies as well as for investigators to provide valuable resources for studies (8). The key role of

the WHO is to identify the air pollution effects that have a big impact on people's health. This function helps organization members to focus on actions that are the best and most effective way to prevent or reduce the risks of air pollution. The World Health Organization is ready to cooperate with all the countries of the world in order to revitalize this undesirable situation and to come with a proposed new standard for air quality. The role of the WHO is to examine and analyze scientific and expert recommendations and conclusions based on risk levels. Furthermore, the WHO makes an attempt to inform policy-

makers and to present suitable targets for a range of policy alternatives towards air quality management in different regions of the world. The international guidelines published in 2005 provided new scientific evidence in relation to air pollution. The guidelines set targets for air quality in order to preserve a large number of people's health from the adverse effects of air pollution. These guidelines can become as applied procedures for policy-makers to provide national strategies and is also valuable resources for researchers (4), (8), (16).

These guidelines are summarized in the following table:

Annual mean level	PM ₁₀ (µg/m ³)	PM _{2.5} (µg/m ³)	Basis for selected level
WHO interim target 1 (IT-1)	70	35	These levels are estimated to be associated with about 15% higher long-term mortality than at AQG levels
WHO interim target 2 (IT-2)	50	25	In addition to other health benefits, these levels lower the risk of premature mortality by approximately 6% (2% to 11%) compared to IT-1 levels
WHO interim target 3 (IT-3)	30	15	In addition to other health benefits, these levels reduce mortality risk by approximately another 6% (2% to 11%) compared to IT-2 levels
WHO air quality guidelines (AQG)	20	10	These are the lowest levels at which total, cardiopulmonary and lung cancer mortality have been shown to increase with more than 95% confidence in response to PM _{2.5} in the ACS study, which included data from 151 US metropolitan areas in 1980 (Pope 1995). The use of the PM _{2.5} guideline is preferred.

Interventions to reduce ambient particulate matter air pollution and their effect on health (Protocol)
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The required solutions in the management of problems arising from air pollution

Interventions that are designed to improve air quality may include many elements and involve various government departments such as the environment, transportation, energy and the health sector. While such interventions may not have quick effects on human health. Based on the existing evidence, the World Health Organization has developed some guidelines and instructions for quality of air in order to mitigate the effects of air pollution on health. These guidelines can become a reliable source to the policymakers to develop national strategies as well as for investigators to provide valuable resources for studies. To reduce the exposure to air pollution and its side effects, different interventions can be designed and implemented in local, national and even international levels. These interventions in terms of their goals can be divided in long and short term goals and also are scheduled for permanent or temporary deadlines. By reducing some air pollutant levels from 70 micrograms in per cubic meter to 20 micrograms (as mentioned in the new guideline), it is predicted to reduce the mortalities arising from air pollution by 15 percent. Furthermore, a reduction in air pollution levels can help the global burden of diseases from respiratory infections, heart diseases and lung cancers (8).

Nowadays, the pattern of urban development having created a social and physical environment, and the use of machine has become as a necessity for access to goods and services. The remarkable dependency of the transportation system on machines has led to changes in the weather. One of the striking signs of it is health outcomes arising from the use of nonrenewable energy (38). Low-quality fuel used in cooking, heating, and disposing of waste, leads to widely early deaths in crowded areas of Asia (e.g. China, India, Bangladesh, Indonesia and Nepal) (8).

Some studies offer behavioral change programs to reduce air pollution in cities. The main goals of such programs designed by behavioral and structural interventions are to decrease the use of single-seat cars and propagate alternatives including public transportation and biking (39), (40). Also, these programs are pursuing for traffic reduction resulting in a decline of air and sound pollution and consequent fall in mortalities and morbidities. This program also has effects on mental health, social relationships, population's growth and childbearing. International guidelines published in 2005 provided a new scientific evidence in relation to air pollution. The guidelines set targets for air quality in order to preserve a large number of people's health from the adverse effects of air pollution (4). Many of the required measures taken to decrease the level

of air pollution need long- running commitments and plans. Expecting a sharp fall in the level of air pollution after the publication of WHO's instructions is a narrow-minded attitude. According to available data, it can be said that the level of air pollution in this decade has been less than the previous decade. The term of "travel plan" is referred to behavioral change programs through behavioral and structural intervention to reduce air pollution in cities. The main goals of such programs designed are to decrease the use of single-seat cars and propagate alternatives including public transportation and biking. Also, these programs are associated with the decline of air and sound pollution and consequent fall in mortalities and morbidities. This program also has effects on mental health, social relationships, population's growth and childbearing. Cairns in a study, concluded that implementing "travel plan" in schools may lead to a reduction in car use at a rate of an average for 8 to 15 per cent (39). Domestic air pollution which is often raised from burning fossil and solid fuels is employed by half of the people on the world for their daily use such as cooking, heating and lighting. Burning these fuels as an ineffective method can lead to producing incomplete combustion such as carbon monoxide and other compounds.

Conclusion

A few studies have implied short and long-term effects of air pollution on human's health. This means supplementary investigations are needed to shed light on the direct and indirect effects of air pollution on people's health and even on environments having a role in human ecology. Many required measures taken to decrease the level of air pollution need long- running commitments and plans. Expecting a sharp fall in the level of air pollution after the publication of WHO instructions is a narrow-minded attitude. According to available data, although there is no monitoring for air quality in relationship with health in different areas, we can see that the level of air pollution in this decade has been less than previous decades. Some interventions are implementing in local or national levels, permanently or temporarily, in order to reduce exposure to air pollution. Definitely, the reduction in air pollution will decrease most diseases at the present time and also in future. Hence, decision making about public health policies now would be much better than tomorrow.

However, using clean energy and industrial technologies and measures are suitable for averting from air pollution but at the same time can be expensive (41). Many cities do not have the capital to make such investments or may prefer to invest that capital elsewhere.

Proposed policies to control air pollution and improve health encompass the following ideas:

1. Strengthening the mail system
2. Strengthening the e-government
3. Creating suitable green spaces for planting and supply saplings
4. Improving the vehicle inspection system and avoiding automobile polluting in the cities
5. Reinforcing the administrative management system: in the sense that all activities become lower as air pollution happens.

6. Facilitating the culture of using public transport, subway, bicycle and adopting incentive policies for the public to use public transport
7. The strategy for public engagement in reducing indoor pollution (regulate room temperature at 15 ° C as maximum temperature in summer and 25-30 ° C in winter)
8. Providing facility for urban and public services (at least within the range of 2 kilometers) to avoid dispensable traffic.

Acknowledgement

The authors would like to thank the Health Management Research Center in the Baqiyatallah University of Medical Sciences and would also like to thank Dr Maryam Yaghoobi, NooredinDopeykar and Mr Mesgarpour-amiri for their kind assistance.

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