Investigation of Children with Lower Respiratory Tract Infections by Geographical Information System: The Case of University Hospital

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Abstract: - The decisions to be made regarding public health during the planning process of urban areas are crucial for the sustainability of plans. While an industrial area located within city and accelerating urbanization can affect negatively public health, a green area usage can affect the latter positively. It is required to examine the spatial distribution of diseases which impact on public health in that process. The geographical information system (GIS) is a crucial scientific instrument for the formation of database about the variation of diseases, the latter's association with the causes, and monitoring the latter's spatial distribution. In this study, the spatial distribution of lower respiratory tract infections which are critical for public health in Konya city of Turkey and the former's association with air polluters (SO2 and PM) inducing the infection were examined by the means of ArcGIS 10.2 software. It is considered that this study would make contribution to local governments about how urban planning processes should be developed within the framework of efforts to protect the public health.

Keywords: - air pollution, GIS, lower respiratory tract infections, urban planning.

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I. INTRODUCTION

Air pollution can be defined as the reach of the conventional polluters such as sulfur dioxide (SO2), particular matter (PM), nitrogen oxides (NO2), and ozone (O3) to the level affecting negatively the environment and health (WHO 1992; Zou et. al., 2014; Fischer et. al., 2011). Nowadays, it is well known that air pollution is one of the threats which have adverse impacts on the health of urban population (Cohen, et. al., 2005; Saniei, et. al., 2016). As the polluters spreading from a source into the atmosphere are inhaled by humans, their negative effect starts to operate. Traffic, transportation, industry, and fuels used for urban heating comprise the main sources of air pollution (Kopar and Zengin, 2009). Air pollution is associated with a lot of health problems, notably asthma attack, degradation in pulmonary functions, and cardiac diseases (Gorai, et.al., 2014; Timonen, et.al., 2002). Although there are not any certain evidences with respect to air pollution furthering directly lower respiratory tract infection and asthma development in adults and children, many researches reveal that there is a relationship between asthma infection and air pollution (Delfino et. al. 1997; Demiraslan, and Akıncı 2016; Demir, et. al., 2011). It is well known that the pulmonary functions of children growing up especially in an area with air pollution degrade (Tecer, 2011).

The air pollution in Turkey, growing with rising urbanization rate, increases the probability to be infected with asthma and other similarly coded diseases. If asthma disease is not controlled, it leads patients' life quality to degrade (Keddem, ae. al., 2015). This state affects the life quality of urban habitants adversely. In order to create livable environments, it is required to monitor currently the air pollution and change. It necessitates a system collecting and storing the data about the causes of air pollution, finding out the latter's association with diseases such as lower respiratory tract infections spatially in urban area. The Geographical Information System (GIS) is an important instrument for processing data regarding health sector, the analysis of diseases'

geographical distribution and variety, and health epidemics' mapping, monitoring, and management (Johnson and Johnson, 2001).

The spatial analyses are used basically in two sub-disciplines in the health geography where GIS is employed more frequently in recent times. The first of them, named as geography of disease, epidemiology or geography of health care, is a discipline studying geographical distribution of diseases, their prevalence rate, frequency of incidence, and ecological relationships. The second one is another discipline providing a spatial perspective for health planning and health care management. GIS and spatial analyses used frequently in the epidemiological studies concerning the public health in the first category provide convenience in identifying the geographical distribution and temporal-spatial clustering of diseases (Özgür, 2008; Tağıl, 2007; Ranzi et. al., 2015), detecting diseases' incidence locations and spatial distribution (Durduran et. al., 2005; Sampaio, et. al., 2014), examining disease related geographical-environmental variables (Gorai et. al, 2014; Chang, et. al, 2015; Patel and Miller 2009), and mapping the incidence of diseases and populations at risk. In the second category, there are studies using GIS to develop public relations in health care organizations (Çelikkanat, 2006). Generally, making research about lower respiratory tract infections in terms of GIS and spatial statistics is considerable (Tağıl, 2007). Thereby, the cities livable for everybody can be created.

In a similar way to the researches in the literature, the aim of this study is to examine the spatial distribution of lower respiratory tract infections in childhood with respect to the air polluters, PM and SO2, on a spatial base by means of GIS in Konya city of Turkey. In conclusion, it was analyzed whether the air quality in Konya impact the lower respiratory tract infections in childhood in Konya.

II. IMPACT OF AIR POLUTION ON LOWER RESPIRATORY TRACT INFECTIONS IN CHILDHOOD

The antioxidants produced in our body are able to eliminate the external air pollution at lower scale. However, the more air pollution grows, the more the oxidant substance load increases; natural antioxidant mechanisms fall short hence. Therefore, body gives an inflammation reaction like a burst. This negative reaction of body results mostly in repeating respiratory tract infections, lower respiratory tract infection and asthmabronchitis.

It is estimated that lower respiratory tract infections and asthma affect approximately 300 million people around the world. In our country, their incidence is 5-7% for adults and 13-15% for children. The airways of children are physiologically smaller than those of adults, the respiratory tracts occlude faster secretion, the former's ribcage are softer, airways are more inclined to be occluded, and respiratory muscles are sooner tired. Furthermore, the rate of being affected by air pollution is higher for children, since they respire more quickly and spend more time outdoors during game and sports activities.

In Turkey, Saraçlar et al. (1998) involved 3154 children aged between 7-14 in their study of the asthma and lower respiratory tract infections' prevalence among children, it is found 14.4%, 4.7%, 8.1% for cumulative wheeze, current wheeze, and lower respiratory tract infection and asthma diagnosed by physician, respectively. So, it can be claimed that air pollution leads the development of respiratory functions in children to degrade, and asthma, the most critical chronic disease among children, to emerge. It has been observed that the pulmonary functions of children growing up in an environment with intense air pollution (indoor and outdoor environment) degrade. Besides, the sensitive airways can be transformed in time to lower respiratory tract infections and asthma in the children suffered air pollution. A minor external stimulus (smoke, infection, chemical odors) can be easily resulted in cough, wheeze, and dyspnea that are the sign of bronchi constriction.

In Turkey, 28045 and 28945 people died in 2005 and 2010, respectively, due to air pollution (OECD 2014). The lower respiratory tract infections rank the second among the preventable child mortality in Turkey. Thus, the problems emerging in urban areas such as air pollution should be prevented and the required precautions should be taken during the children's treatment process for preventable lower respiratory tract infections. GIS is used as an important instrument in assessing diseases' spatial distribution and effects in urban area.

III. MATERIALS AND METHODS

The city center of Konya, selected as the implementation area within the scope of study purpose, consists of three central districts (Figure 1). Konya is a city with a rising urbanization rate due to its immigration rate, historical fabric, and touristic identity. The environmental factors such as increasing urbanization rate, fossil fuels used in heating, state of industrial sites, exhaust gases of vehicles in traffic etc. exacerbate the air pollution in Konya. In addition, Konya's topographical structure and meteorological conditions affect this situation.



Fig. 1. General view of Konya Province (URL 1)

Air pollution assessed as one of the first ten risk factors affecting the health around the world appears as a critical environmental problem at the present time (Özşahin et. al., 2016; Taylan et. al., 2010). Considering the fact that a person respires approximately 13,000-16,000 liter in average per day and 400-450 million liters in average for life, the significance of air quality for human's health is comprehended better (Öztürk, 2005). The air polluters such as PM and SO2 exacerbate lower respiratory tract and asthma infections (Gorai, et. al. 2014). Particular matter (PM) are the polluter group consisting of small sized solid particles and liquid drops which can be suspended in air (Ahrens, 2000; Zeydan, et. al., 2014). SO2 is a polluter spreading from the industrial treatments into the atmosphere as a toxic, and causing undesirable effects on health even in very low level (Zou et. al. 2014; Demiraslan and Akıncı, 2016). In order to estimate the spatial distribution and impacts on infections of these polluter substances, a lot of studies have employed GIS.

This study is comprised of two sections suiting its aim to find out the association between the air pollution and lower respiratory tract infections in Konya. The study was conducted by examining the information of patient files and analyzing the air quality information for those years through GIS. In the first stage, the data was used to examine the spatial distribution of patients with lower respiration tract infections in childhood. This data was obtained from The Meram Medical Faculty, Departments of Child Chest Diseases, Child Allergy and Immunology, and General Pediatrics by retrospective file screening of patients (sex, ages, address, hospital visit dates, etc.) who applied to the hospital between 2010 and 2011 and with the diagnosis code J00-J99, J45-46, J12-18, J20-22 (WHO, 2008) of International Classification of Diseases. The study was approved by the ethics committee. Then, the data of patients, who had applied to or stayed in the policlinics due to lower respiratory tract infections, was coded and evaluated in the electronic environment by the researchers at the medical faculty. The researchers at the engineering faculty processed on the point base the data about the patients with lower respiratory tract infections, obtained at district level, to the software ArcGIS 10.2 through the Konya's map of 1/20,000 scale and online base maps; a database was formed (Figure 2).



Fig. 2. Positional marking of data on lower respiratory tract diseases

In the second stage, the air quality data for 2010 and 2011 (SO2 and PM) was acquired from Konya Municipality and the Provincial Directorate of Environment and Forestry in order to assess the concentration distribution of air polluters. The data was organized as distinct parameters being station, county, and annual in the excel files. The data was processed on the point base to the ArcGIS 10.2 software by the means of Konya's map of 1/20000 scale and online base maps. The layers for SO2 and PM were created with respect to 2010 and 2011 (Figure 3).



Fig. 3. Air quality measurement stations and measurement values layer in Konya

IV. RESULTS

Although there is not any study unfolding the impact of air pollution, seen especially in winters in Konya, on the habitants, it is well known that particularly respiratory tract infections' prevalence is high. In the report "Health Statistics" published by the Ministry of Health in 2003, 2004, and 2005, it is shown that Konya is among the first ranks according to the average values of respiratory tract infections' symptoms per city around Turkey. It was reported that the children suffer particularly respiratory tract infections such as lower respiratory tract infections, asthma, allergy, allergic rhinitis in the city.

In the database, compiled by processing the data concerning the children with lower respiratory tract infections within the study, these patients' spatial distribution in three central counties of Konya was presented visually (Figure 4). It is observed on the maps that the patients with lower respiratory tract infections are mostly clustered in Selçuklu county. It can be assessed that the presence of industrial sites in Selçuklu county, such as Konya organized industry, Anatolia industry, carpenters industry induces the increase in lower respiratory tract infections' incidence in this region. In the temporal analysis, it is notable that the incidence of lower respiratory tract infections is higher in 2011 in Selçuklu.



Fig. 4. Point distribution map of lower respiratory tract patients for 2010 and 2011

In the Figure 5, the data analysis of three stations created to assess the air quality values of Konya were displayed.



Fig. 5. PM and SO2 values of air quality stations for 2010 and 2011

PM values are on the rise in the station of Meram county, while on the decline in Selçuklu and Mevlana stations (Figure 6). SO2 values are higher in the station of Selçuklu county, while lower in other counties (Figure 6).



Fig. 6. Maps of PM and SO2 values for 2010 and 2011

V. DISCUSSION

Among these results obtained from the stations in Konya, SO2 values are below the acceptable threshold of 60 ugr/m3, and PM is again below the acceptable threshold of 150 ugr/m3.

Within the scope of this research, it was observed that the threshold values of air quality in Konya in 2010 and 2011 did not exceed the acceptable threshold values, and have not directly affected the lower respiratory tract infections. It was found that the presence of industrial site at the center of Selçuklu might be a triggering cause.

The limitations in this study are the problems in reaching more extensive data to represent Konya, and the shortage of station numbers to measure the air quality values.

However, it should be emphasized that;

- enhancing the station numbers and measurement qualities,
- involving the data of air polluters, other than the data of SO2 and PM obtained from the stations, in the analysis process and

• taking into account the factors alleviating the pollution during urban planning, and the information exchange between local governments are critical for the similar studies.

VI. CONCLUSION

GIS is a significant system employed in the public health studies, and the health sector to examine diseases' spatial distribution and take the related precautions. In this research, the lower respiratory tract infections in childhood, the spatial distribution of SO2 and PM values, which are among the air polluters which are assumed to affect the former, and the relationship between two were investigated.

In this stage, it is required to conduct the researches in a multidisciplinary manner by the engineering faculties, departments of public and child health in the faculties of medicine, health directorates, and municipalities in longer term in the light of a larger scale data. Thereby, the association between especially the lower respiratory tract infections in childhood and air pollution can be monitored in more detail.

GIS studies are significant for planning the urban facility which assists the protection against diseases affecting public and child health such as lower respiratory tract infections and the open green areas, and alleviate the impacts of harmful area usage types such as industry.

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