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An Assessment of Ambient Air Quality and Health Status of Residents in Kozan District, Adana-TURKEY

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ABSTRACT

Health effects of air pollution are more directly related to human exposure to ambient air pollutants. Air quality is connected to local weather conditions as well as demographic specifications (such as age structure), motor traffic pattern, existence of fossil-fuel (specifically coal) power plants nearby, smoking habits, and building materials, etc. In this paper, the relationship between ambient air quality and health problems is questioned in Kozan, Adana. Based on traffic load and fossil fuels used for heating purposes air quality worsens frequently, especially in winter months, in Kozan. It was found that the first four months (January to May) are remarkably problematic due to respiratory function malfunction in residents as reported by the State Hospital in Kozan. After spring months, numbers of patients reported by the hospital were found to be minimal throughout the rest of the year. It is advised that not only stationary sources but also mobile sources (traffic related) should be properly controlled in terms of air pollution.

Key words: urban air pollution, inversion, ambient air quality and health, bronchitis, Kozan-Adana, Turkey

INTRODUCTION

The nonrenewable fuels used in energy production, heating and motor vehicle transportation have been noted to effect ambient air quality[1]. Although personal habits such as smoking and food preparation using barbecue are also important in health status, ambient air quality is an important parameter that affects numbers of people suffered from serious discomfort and inconvenience, such as eye irritation and chest pains . It is considerably evident that there is a chronic threat to public health from ambient air pollution [2]. Turkey has a remarkable mortality rate (8.89%) because of respiratory system problems according to Turkish Ministry of Health as of 2009 [3]. In 2004, thermal power plant, named Sugozu, started its operation in Adana. It has installed capacity of 1210 MW. It has been affecting its southern area (the Mediterranean Sea) in terms of deposition of particulate matter and gaseous air contaminants.[4] The lignite used in Sugozu Power Plant contains 9‰ combustible sulphur, 20% ash, and 23% moisture [3]. The lignite used in the power plant has a calorific value of 6150 kcal/kg [4]. The power plant is nearly 70 km away from Kozan district centre. It is assumed that the effect of Sugozu Power Plant is negligible in terms of air pollution in Kozan.

Kozan is situated in the mid-south region of Turkey. Due to its topography, time to time problematic conditions might exist in terms of air pollution related health issues. The aim of this paper is to assess the relationship between ambient air quality and health problems associated with air quality in Kozan in 2012. There is only one state hospital in Kozan and health records were obtained from its data centre.

Figure 1: Map of study area and daily traffic loads (A: automobiles; vehicle (heavy duty) vehicles M: mid-size trucks and minibusses; B: busses; T: full size trucks; TIR: long).

MATERIALS AND METHODS

Population data, health records, meteorological data were obtained from responsible authorities. Topographical information was used to predict air pollutants movement. Traffic data, provided by Turkish Roadways General Directorate, were used to predict total carbon monoxide, nitrogen oxides and hydrocarbon emissions. Health records were grouped to be successfully evaluated. Pearson correlation coefficients between health problems were obtained by using Microsoft Excel datasheet program. Health problems reported by the State Hospital were divided into weekly results.

RESULTS AND DISCUSSION

Table 1 includes information about population in Kozan district and Adana province. Kozan is situated 110 m above mean sea level. Prevailing wind direction is north-north-west based on long term observations (1975 to 2005). Average wind speed varies between 1.3 m/s (in August) and 2.6 m/s (in February). The district center is situated in a relatively flat region, surrounded by ridges 920 m to 1020 m on its northern and northwestern sides [5]. Kozan is totally dependent on fossil fuels to heat its residential and work places.

Although winter is a critical season in terms of health effects air pollution, air pollution due to field fires to remove agricultural residues in summer season is also observed. A fire started by one of local farmers, for example, caused burn of waste tires collected for a waste tire recycling facility in August 2012 [6].

The raw yearly population increase rate is 6.37% according to census results of 2007 and 2012. In 2009, 201 males; 135 females and 30 infants died although possible causes were not noted in one official record (Kozan Belediyesi 2009 faaliyet raporu) [7]. Based on this figure, the raw mortality rate is 2.86% in Kozan. It is known that ambient air quality is well correlated with numbers of patients suffer especially from respiratory diseases [8].

Table 1. Population in Kozan district and Adana province [6].

Year	Kozan-Urban			Kozan – Rural			Adana-Urban (whole province)			Adana-Rural (whole province)		
	M	F	T	M	F	T	M	F	T	M	F	T
2007	35981	36482	72463	25789	25728	51517	796212	815050	1611262	198652	196736	395388
2008	36107	36620	72727	25966	25976	51942	877021	886330	1763351	131980	130988	262968
2009	37352	37169	74521	25881	25411	51292	900605	904540	1805145	129035	128046	257081
2010	38535	38329	76864	25356	24880	50236	913248	923184	1836432	125327	123466	248793
2011	39457	39130	78587	24908	24309	49217	929442	935144	1864586	123431	120783	244214
2012	40075	39868	79943	24164	23819	47983	940465	946159	1886624	120799	118212	239011

M stands for males; F stands for females and T stands for total population

Table 2. Monthly atmospheric variables in Kozan (based on long term observations (1975-2005)) [9].

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean t (°C)	9.5	10.2	13.3	17.5	21.9	26.0	28.9	28.9	26.2	21.7	15.4	11.0
Mean P (hPa)*	1002.4	1001.4	1002.7	999.3	997.9	995.0	991.2	992.5	996.6	1000.3	1002.8	1002.8
Mean v (m/s)	2.5	2.6	2.2	1.8	1.6	1.6	1.4	1.3	1.6	2.1	2.4	2.3
RH (%)	58	58	59	63	61	60	62	62	57	51	54	59
No of smoggy days	0.1	0.1	0.1	0.4	0.5	0.8	0.2	0.2	0	0	0	0
Min t (°C)	-4.0	-5.0	-3.6	2.0	5.3	11.0	15.0	14.8	13.0	3.6	0.7	-2.2
Max t (°C)	25.0	26.9	31.2	37.3	41.5	42.1	44.4	44.8	43.4	39.5	32.4	26.7

* only for 2012 (t: air temperature; P:atmospheric pressure; v: wind speed; RH: relative humidity)

It is evident that the most problematic months in terms of number of people diagnosed with air quality related health problems are January, February, March and April (Figure 2). In order to better assess the situation, weekly totals were counted. However, the most problematic days for health problems are also assessed.

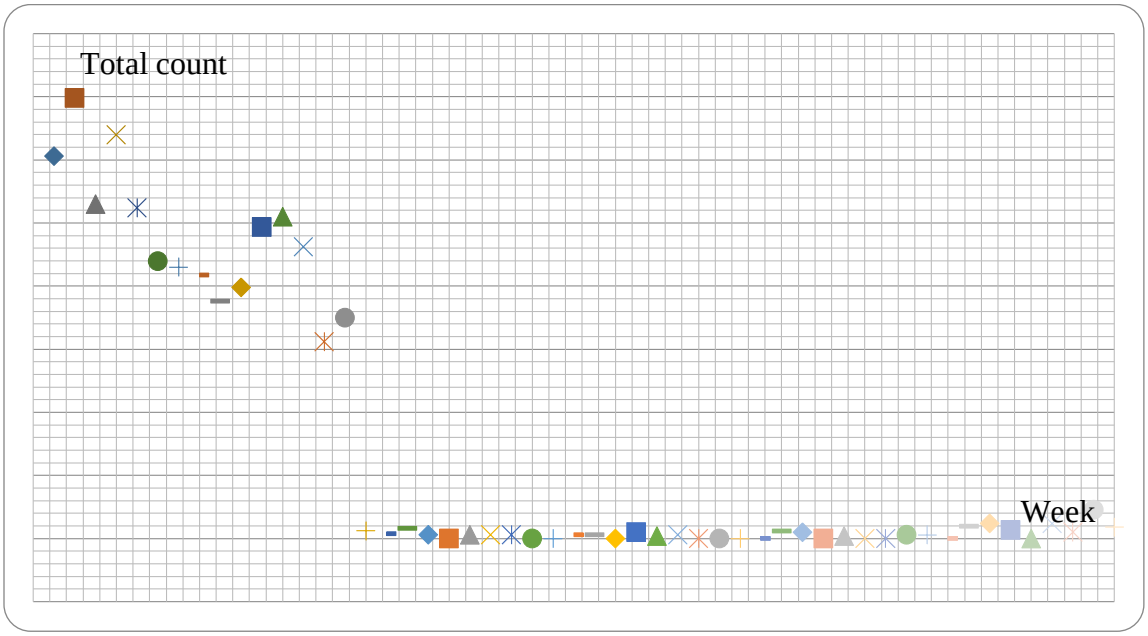

Figure 2: Number of people having respiratory health problems (weekly counts).

Statistically significant correlations were found between some pairs of health problems in Kozan. Table 3 provides Pearson correlation coefficients between health problems examined. Based on 99% confidence

interval the relationships between asthma and chronic obstructive lung malfunction; between asthma and bronchitis; between chronic obstructive lung malfunction and asthma were found statistically correlated.

Table 3. Pearson correlation coefficients between pairs of examined health problems

	Bronchiolitis	**Asthma**	**Chronic Obstructive Pulmonary Disease**	**Bronchitis**
Bronchiotilis	1			
Asthma	0.4762	1		
Chronic Obstructive Pulmonary Disease	0.3287	**0.8691**	1	
Bronchitis	**0.6394**	**0.9255**	**0.9155**	1

Bold numbers indicate 99% confidence interval.

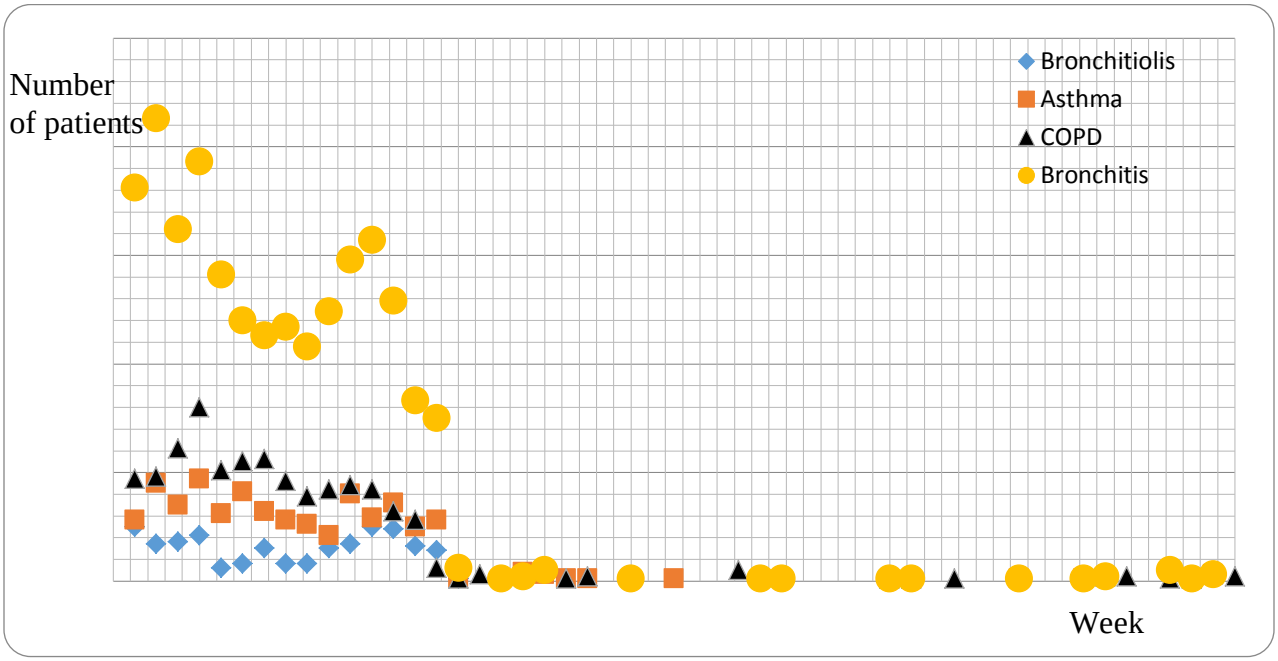

Figure 3. Time series of health problems related to air quality in Kozan (2012)

Although there is a decreasing trend in bronchitis (majority of them was reported as acute bronchitis) between January and April (Figure 3), the 11th (12th of March to 18th of March) and 12th (19th of March to 25th of March) weeks caused more counts as reported by the state hospital. The reason of this increase can be explained by inversion since climatic variables differed from other weeks. Table 4 summarizes some atmospheric variables observed in those weeks.

Table 4. Some atmospheric variables in 11th and 12th weeks of 2012 [9].

Parameter:	**Atmospheric pressure (hPa)**	**Wind speed on surface (m/s)**	**Wind speed at 10 m height (m/s)**	**Mean temperature (°C)**	**Minimum temperature (°C)**	**Maximum temperature (°C)**
In 11th week	1002.9	2.23	10.3	10.07	6.1	13.8
In 12th week	1008.9	2.24	9.5	16.98	11.6	24.1

In Table 5 weekly counts of air pollution related health problems are given. In parentheses the mean age of these patients are noted. 2nd week (January 9th to January 15th) was found to cause more problems in respiratory system than any other week in 2012 in Kozan.

Table 5. Weekly patients count and mean age in Kozan (2012).

Days	Week no	Bronchitis	Chronic Obstructive Pulmonary Disease	Bronchiotilis	Asthma	Total count
1-8 January	1	181 (28)	47 (69)	25 (4)	50 (28)	303
9-15 January	2	213 (29)	74 (70)	17 (4)	45 (27)	349
16-22 January	3	162 (26)	48 (67)	18 (3)	37 (30)	265
23-29 January	4	191 (26)	61 (67)	21 (4)	47 (24)	320
30 Jan-5February	5	141 (23)	80 (68)	6 (3)	31 (36)	258
6-12 February	6	120 (20)	51 (70)	8 (4)	41 (33)	220
13-19 February	7	113 (25)	55 (67)	15 (3)	32 (39)	215
20-26 February	8	117 (22)	56 (69)	8 (2)	28 (23)	209
27 Feb-4 March	9	108 (23)	46 (65)	8 (4)	26 (36)	188
5-11 March	10	124 (21)	39 (68)	15 (2)	21 (24)	199
12-18 March	11	148 (18)	42 (61)	17 (3)	40 (26)	247
19-25 March	12	157 (15)	44 (70)	25 (6)	29 (28)	255
26 Mar-1 April	13	129 (21)	42 (67)	24 (8)	36 (25)	231
2-8 April	14	83 (20)	32 (64)	16 (2)	25 (25)	156
9-15 April	15	75 (18)	28 (66)	14 (2)	28 (24)	145
16-22 April	16	6 (44)	6 (71)	1 (1)	1 (59)	14
23-29 April	17	-	1 (57)	-	-	1
30 Apr-6 May	18	1 (39)	3 (80)	-	-	4
7-13 May	19	2 (78)	-	-	4 (61)	6
14-20 May	20	5 (68)	-	-	3 (24)	8
21-27 May	21	-	1 (71)	-	1 (56)	2
28 May-3 June	22	-	2 (59)	-	1 (18)	3
4-10 June	23	-	-	-	-	-
11-17 June	24	1 (83)	-	-	-	1
18-24 June	25	-	-	-	-	-
25 Jun-1 July	26	-	-	-	1 (51)	1
2-8 July	27	-	-	-	-	-
9-15 July	28	-	-	-	-	-
16-22 July	29	-	5 (73)	-	-	5
23-29 July	30	1 (44)	-	-	-	1
30 Jul-5 Aug	31	1 (57)	-	-	-	1
6-12 August	32	-	-	-	-	-
13-19 August	33	-	-	-	-	-
20-26 August	34	-	-	-	-	-
27 Aug-2 Sept	35	-	-	-	-	-
3-9 September	36	1 (52)	1 (69)	-	-	2
10-16 September	37	1 (53)	1 (56)	-	-	2
17-23 September	38	-	-	-	-	-
24-30 September	39	-	1 (75)	-	-	1
1-7 October	40	-	-	-	-	-
8-14 October	41	-	-	-	-	-
15-21 October	42	1 (41)	-	-	1 (47)	2
22-28 October	43	-	-	-	-	-
29 Oct-4 Nov	44	-	-	-	-	-
5-11 November	45	1 (58)	2 (70)	-	1 (58)	4
12-18 November	46	2 (45)	2 (72)	-	-	4
19-25 November	47	-	2 (76)	-	-	2
26 Nov-2 Dec	48	-	-	-	-	-
3-9 December	49	5 (52)	1 (57)	-	-	6
10-16 December	50	1 (48)	1 (71)	-	-	2
17-23 December	51	3 (43)	3 (57)	-	-	6
24-31 December	52	-	2 (64)	-	-	2

Although mean ambient air temperature (as well as minimum and maximum temperature) increased after 11th week, wind was not able to dilute atmospheric pollutants in 12th week. Moreover, the pressure in Kozan was remarkably high in the 12th week. It is estimated that more than 100 tons of fossil fuels were consumed per day over this week in Kozan. Total sulfur from fossil fuel burning was estimated as high as 1040 kg per day. In a day, under temperature inversion, sulfur dioxide over Kozan was stochiometrically predicted to reach as high as 500 $\mu g/m^3$. On the other hand, motor vehicle exhausts were found negligible in Kozan in winter months. Based on traffic loads given in Figure 1, total pollutant emissions are summarized in Table 6. According to total traffic related emissions, NO_x concentration over Kozan can be estimated as 14 $\mu g/m^3$ under a totally stagnant urban air. It is evident that southeast and southwest traffic are dominant sources of mobile type air pollution. With respect to increasing vehicle exhaustion standards, it can be expected a decrease in mobile source air pollution in the future. Box model for an airshed over Kozan can also be developed but it was not done in this study.

Elderly people are more susceptible to exposure of pollution in ambient air [8]. Winter and Spring months were found to affect youngsters compared to other age groups in terms of bronchitis, chronic obstructive pulmonary disease and asthma. There are clear distinctions of ages of the patients. For instance bronchitis is an adult disease (mostly 20 to 28 age group); whereas, bronchiotilis is a children problem. Chronic obstructive pulmonary disease is a problem for aged people (60 yrs old or older).

Table 6. Total daily traffic emissions in Kozan based on 2011 motor vehicle data

Road	CO (kg/day)	NO_x (kg/day)	Hydrocarbons (kg/day)
Kozan north	4.05	1.10	1.41
Kozan southwest	6.75	1.83	2.34
Kozan southeast	10.19	2.76	3.53
Total	20.99	5.69	7.28

RECOMMENDATIONS

It is recommended that meteorological parameters can be used as a warning signal in Kozan and similar urban centers. Using temperature, wind speed, and pressure, especially elderly and infants could be informed not to go out when such an air pollution issue is envisaged. Since inversion is a serious problem, it should be a must to establish a warning system that is based on accumulation of air pollutants not only due to fuels used during winter but also emitted from vehicle traffic. Elderly and babies/children should be alerted when ambient air quality worsens due to pollutant accumulation and meteorological conditions that do not allow air pollutants to go away.

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