Evaluation of Impact of Pollution of the Atmospheric Air on Health of Population in Large Cities of Azerbaijan

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Abstract

*The **aim** of this work is to study the impact of pollution of the atmospheric air on health of population in large cities of Azerbaijan. The spread of different deceases among the population finds its reflection in statistical data. Referring to this data and the concentration of various harmful substances in the air, as well as theoretical knowledge and **methodology** on revealing of dependency of human health on the related pollution, the author of work investigates correlations between statistics of arising of deceases of respiratory pipe, digestive organs, nervous system and sensation organs, blood and blood-reproductive organs, congential anomalies and pollution of the atmospheric air among the population of large cities of Azerbaijan. The study takes into consideration the relevant situation in large cities of the country, with using definitions 'pollution index', 'risk index', 'coefficient of correlation', 'allowed concentration' and others. The gained **results** allow identify correlation and extent of impact of air pollution on health of the population in cities.*

Keywords: air pollution, respiratory deceases, harmful pollutants, pollution index, allowed concentration, sulfur-oxide

Introduction

All pollutants in the atmospheric air have a negative impact on human health. Thus, these substances penetrate into respiratory ducts and lungs, as a result of which the respiratory organs strongly suffer from heavy impact. The studies show that substances of 0,01-0,1 mm radius are usually sinking in human lungs if 50% of them penetrates into the lungs. This process has a toxic effect, and it is connected with definite factors. The first factor is that the substances are chemically and physically toxic. Secondly, they impede normal clarification of windpipes. Thirdly, these substances are carriers of poisonous substances absorbed by the organism. As it is shown in the study works, the dependency of occurrence of deceases such as (damage of the upper respiratory tract, heart failure, bronchitis, asthma, pneumonia, lung emphysema, eye diseases) on contamination of the air is definable. Increased in the air and contained at high concentration within a few days, the substances cause mortality to grow among aged population because of respiratory and cardiovascular diseases. For example, in December of 1930, high pollution of the atmospheric air has been observed in the area of Maas River (Belgium) which lasted three days and resulted in death of 60 people (as 10 times as much) and hundreds facts of deceases. In January of 1931, the event of hard smoking has been observed in the area of Manchester (UK) within 9 days which resulted in death of 592 persons. Facts of hard contamination of the atmospheric air with high number of deaths have been fixed also in London. In 1873, the pollution of air in this city was responsible for death of 268 persons. The protection of atmospheric air and protection of human health are topical problems of ecological importance. Pollution of the air basin in cities is related to socioeconomic activity whereas the extent of pollution of air is variable depending on natural condition and meteorological peculiarities of urban territories. All changes have an effect on human health and growth of deceases among population. The definite studies confirmed that the increase of number of events of death and deceases in cities are directly connected with favorability of local environmental condition. In this occasion, more researches in medicine deals with social adaptation of population and ecopathology in recent years.

Analysis of Data

In Azerbaijan, dependency and correlation between pollution of air and human health is not sufficiently studied. The observation data showed that 2108, 5 thousand ton of wastes were emitted from stationary sources of the country in 1990 while the number of persons who died because of respiratory deceases made up 5893. Wastes emitted to the atmosphere were 515, 4 thousand ton whereas the number of deaths fixed as a result of respiratory deceases made up 4207 persons. Tendency of deceases connected with the natural environment is being conducted based on data of the Ministry of Health.

As of early 2007, the number of Baku city was 1893,3 thousand persons, of Ganja city – 307,5 thousand persons, of Sumgait city – 296,9 thousand persons, of Minghachevir city – 95,5 thousand persons, of Nakhchivan city – 70,4 thousand persons, of Shirvan – 69,6 thousand persons, of Sheki – 62,5 thousand persons, and of Lankaran city – 48,5 thousand persons. Urbanization rate is expected to be at 53,9% in 2015. In general, the tendency of enhancement of state of human health was typical for 1990es whereas the reduction in life expectancy was characteristic for 1992-1994 years. The observed situation was related with socioeconomic challenges of transitional period and in particular war condition between Armenia and Azerbaijan. The analysis by years shows that the number of events of death among the population at over retirement age reduced in 90es whereas the relevant tendency of growth was fixed since 2005 and 2006.In 1990-1993, the number of persons who died below the 5 years of age increased. Since 1995, the relevant sharp decrease in number of death was observed as well. In 90s, stagnation in the economy and temporal stopping of different industrial fields were reflected in decrease of amount of emitted wastes and eventually had an effect on human health. Infants are more sensorial regarding to the quality of atmospheric air compared to other groups of population, and hereby the state of their health sometimes is considered to be an indicator of condition of the environment. Infant mortality made up 4193 in 1990 and 1508 in 2006. Since 90s, infant mortality decreases in Azerbaijan. In 1990-2006, this indicator reduced from 769 persons to 511 persons in Baku, from 127 to 83 in Sumgait, from 61 to 38 in Ganja, from 81 to 47 in Sheki, from 70 to 22 in Lankaran, from 35 to 7 in Shirvan, from 44 to 9 in Minghachevir, and from 18 to 6 persons in Nakhchivan. However, it should be noted that the development of medical service, improvement of provision of medical appliances and application of new achievements in medicine played significant role in the reduction of death among the population and infants. There are various reasons of death in the country. In the cities of Azerbaijan, several deceases are the main reasons of infant death. Among them, deceases of circulation of blood occupy first place while cancer deceases and decease of malignant tumor are the second. The following places are occupied by deceases of respiratory pipe, digestive organs, nervous system and sensation organs, blood and blood-reproductive organs, congential anomalies and others.

In 1990, deceases of blood circulation were responsible for death of 11802 persons, whereas in 2006, the corresponding indicator was 16129. The number of cancer-related deaths has also increased since 1990. As statistics shows, the number of deaths connected with respiratory deceases was 1641 in 1990 as well as 978 in 2006. So, in 2001-2005, the facts of death have reduced by 901 as less. Deceases of nervous system have been increased from 44144 to 48470 while eye deceases have increased from 24433 to 29304 as much, and ear deceases have grown from 22653 to 29304. In the meantime, the jump has been observed on deceases of blood circulation (from 98056 to 117345) and congential anomalies (from 2559 to 2694). Cancer deceases are holding the second place among other deceases for the scale of spread in Azerbaijan. However, the related tendency of slowdown has been observed. Thus, 148 facts of death per 100 000 persons were fixed in 1980. 18 years later the corresponding indicator made up 105 persons. In 2001, the corresponding statistical data made up 111 persons. Malignancies were observed in 68 persons among each 100 000 persons. Among the rural population, the number of people who suffered from such kind of decease made up 1967 persons in 1990 as well as 2831 persons in 2006. The number of incidences of malignant neoplasms made up 35132 persons in 1995, as well as 29365 persons in 2005.Malignant neoplasms were revealed for the first time in body of 7405 persons in 7405 whereas it made 6616 4 years before. Among infants, children and teens of 0-14 years of age, such deceases were revealed 151 times in 2001, as well as 194 times in 2005.

Deceases of different kinds, namely related to esophagus, stomach, rectum, larynx, trachea, bronchial tubes and lung are being observed among the population of Azerbaijan. The number of persons in body of whom cancer of esophagus was revealed made up 345 persons in 1995 and 293 persons in 2005. The corresponding indicators were: by stomach-related deceases – 725 and 715 persons; by rectum-related deceases – 273 and 234 persons; by laryngeal-related decease – 221 and 154 persons; by trachea, bronchitis and lungs – 615 and 765 persons. As seen, within 1995-2005, the numbers of facts of cancer decease and the related events of death have been increased. The malignant tumor of trachea, bronchial tubes and lungs significantly exceeds other kind of malignant tumors in number. Harmful toxic substances in the air are negatively influencing on human health and may even killing effect. The dependency of quality of the atmospheric air on human health is reflected on statistical data, as it is shown above. Among the rural population, the number of patients was 4252 persons in 1990 whereas 1882 persons in 2006. The analysis of tendency shows that within this period, the number of respiratory deceases has been decreased year by year. Concerning the responsible factors of such deceases, it is notable that the throwing of pesticides from planes onto agricultural fields was stopped since the 90s.

Meanwhile, the tendency of reduction in number of respiratory deceases was observed since 2000.It is mentionable for comparison that the number of this kind of deceases is 66 persons per each 100 000 people while the corresponding number is 75 in average per 100 000, 63 in average in Europe, and 58 per 100 000 in European Council (the data of 2001). In Azerbaijan, the relevant highest figure was registered in 1994 (113 persons per 100 000 people). In 2001, the number of patients with the revealed diagnosis of respiratory decease made up 599946 persons whereas the corresponding indicator 5 years before equated 677123 persons. The number of infants under 1 year of age who died due to respiratory deceases made up 730 persons in 2000 as well as 581 persons in 2006. In contrast to this tendency of reduction, the growth was observed in number of patients under 14 years of age, in body of whom respiratory deceases were revealed. Thus, their number was 313408 persons in 2001 and 349254 persons in 2005.

The deceases of digestive organs have been increased compared to 1980. In 1996, 39 persons per 100 000 people faced such deceases. In 2000, the figure was 33. The number of patients with diagnosis of decease of digestive organs was falling in the second half of 90s. The number of such revealed deceases made up 80278 in 2001 and 107162 in 2005. The number of patients under 14 years of age who suffered from the noted kind of decease was 29531 persons in 2001 and 37000 persons in 2005. Since the beginning of 90es, the decrease of cancer in number was revealed in Sumgait as well as other territories of Azerbaijan (the tendency was characteristic also for the population of Georgia and Armenia). After the breakdown of the soviet regime in 90es, in the condition of heavy social and economic condition, diagnoses of cancer were not conducted in time and properly among the population with low income. Low treatment of cancer was conducted in that period. The recent observations show that the number of facts of cancer has been reduced.

Data Processing

It is considered that deceases tend to be increased by 30-40 as much if the atmospheric air is deteriorated. In this connection, the definition of 'risk index' is used which plays a role of indicator of deterioration of human health due to pollution of the atmospheric air. The analysis of correlation between pollution index of the atmospheric air (PIA) and deceases of malignant deceases is carried out. PIA is evaluated based on the average annual concentration.PIA is measured based on annual indicators of the concentration. This indicator reflects chronic and long-term rate of pollution of the air.PIA considers not only n – the concentration of different concentrations of substances but also rate of threat of relevant impact on human health. It is measured as follows:

$$In = \sum_{j=1}^{n} I_i = \sum_{j=1}^{n} \left(X_i / YQH_i \right) C_i \quad (1)$$

Where X_i is the medium concentration of substance of 'i' within a year; C_i is the coefficient that allow define the rate of pollution with SO_2 on the basis of 'i'-related pollution of the air; and I_n is PIA (incommensurable quantity). The results of model assessment are shown on Table 1.

Table 1: Results of the Analysis of Dependency between PIA and Deceases of Malignant Tumor within 5-year Period

Year	a	σ_a	b	σ_b	R	r^2	n
2002	1,59	1,06	0,11	0,03	0,69	0,48	
2003	1,47	1,17	0,13	0,03	0,58	0,34	
2004	1,94	0,95	0,10	0,02	0,69	0,46	
2005	1,93	1,25	0,11	0,04	0,42	0,18	
2006	1,58	1,16	0,11	0,02	0,66	0,43	
Overall period	1,80	1,11	0,11	0,01	0.60	0,36	
Medium within 5 years	1,67	1,00	0,12	0,02	0,62	0,38	

In this table, a is free limit of equation of regression; b is coefficient of PIA; r is coefficient of correlation; and n is the number of cities by which the calculation were conducted. As the Table 1 shows, the correlation between pollution index of the atmospheric air and malignant deceases is high and sustained. All statistic parameters ($(a, \sigma_a, \ b, \ \sigma_b, R)$ are changing a little. In 2002-2006, the correlation index made $0{,}60 \pm 0{,}07$. Dependency between PIA and malignant deceases is shown on Figure 1.

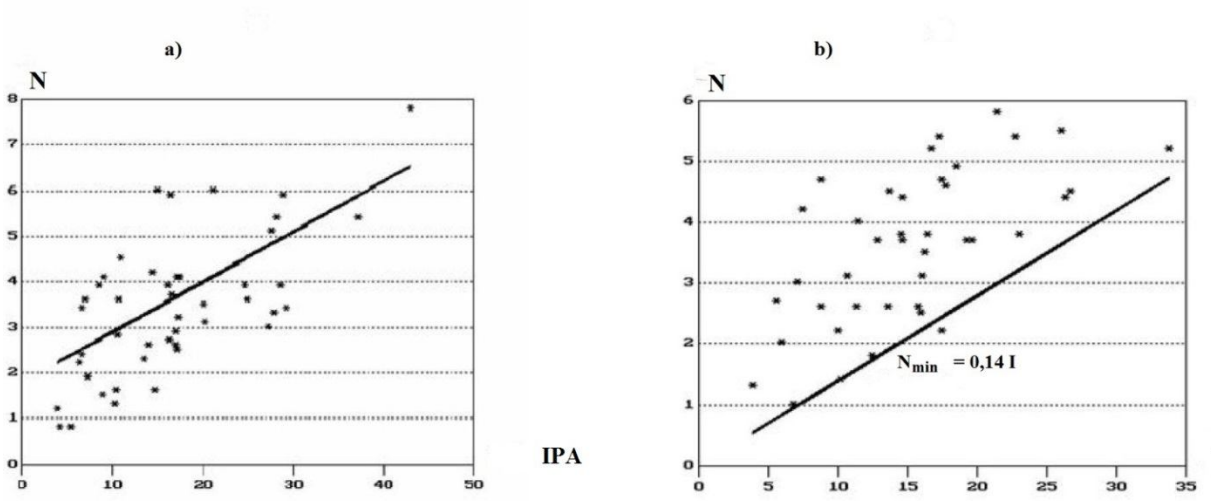

Figure 1: Dependency of Number of Deceases of Malignant Tumor from PIA (per 1000 Persons): a) in 2006; b) within 2002–2006

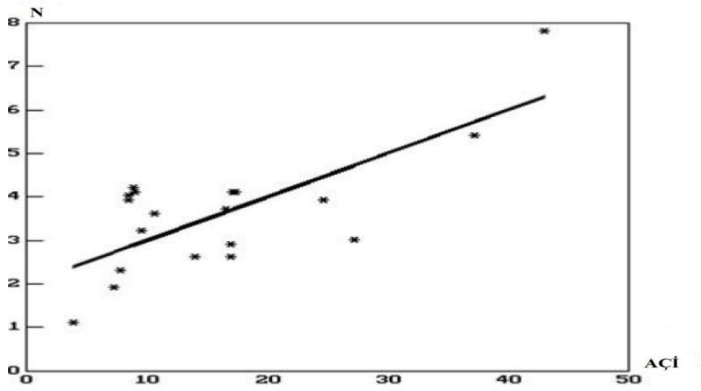

Figure 2: Dependency of Number of Deceases of Malignant Tumor from PIA (per 1000 Persons) in the Large Cities of Azerbaijan (Baku, Ganja and Sumgayit)

Results

The calculations confirm that 36-38% of deceases are directly or indirectly connected with pollution of the atmospheric air. Climatic condition, drinking water, nourishment, cigarette and other factors were also responsible for death of population. Local environmental factors are different in the cities of country. The initial indicator of (*a* coefficient of regression formula) is less variable (from 1, 47 in 2003 to 1, 94 in 2004). However, this indicator differs than that of other cities. All calculations show that *b* changes between 0, 10–0,13. Therefore, it is evident that the rise of pollution extent of the air is followed by growth of N_{AD}. The results of analysis of by definite years differs (as 10-10%) from the results of overall period. Regression formula is defined with the following formula:

$$N_{AD} = 1{,}8 + 0{,}11 \cdot PIA \qquad (2)$$

Least number of all deceases (AD) that take place due to the adverse condition of the atmosphere increases in accordance with growth of PIA. According to calculations of coefficient of correlation, R= 0,934. When other harmful effects are absent in the air, the number of deceases (N) is measured as follows:

$$N_{AD} = 0{,}14 \cdot PIA \qquad (3)$$

When PIA=10 (10 times more than the allowed limit of concentration of sulfur-dioxide), the number of revealed deceases makes up 1,4 per 1000 persons. When PIA=20 (20 times more than the allowed limit of concentration (ALC) of sulfur-dioxide), the number of revealed deceases increases 2 times as much. PIA is calculated so that the pollution of atmospheric air is expressed by ALC of SO_2. When PIA equates 2, it means that concentration of SO_2 = 100 mkg/m^3. Such growth is equivalent to 20% of malignant deceases by 0, 28 per 1000 persons. If PIA = 2, this is to be considered as significant growth because it means that deceases increases by 20% as much.

The gained results were checked on the example of 5-6 cities. Such comparison showed that error is such calculation (comparison between the results and real data) is 29%. The impact of the concentration of toxic substances on human health was widely implemented in the United States. The studies suggest that risk unit of being patient is measurable based on the pollution of the atmosphere. In particular, cancer deceases are closely depending on the condition of atmospheric air which is reflected on corresponding indicators. The assessment of relevant risk is conducted based on the suggested effect of the 20 cubic meter of polluted air within 70 years (approximate life span).

The average indicator of risk must be assessed as below:

$$N_P = \frac{R\left(X_1 N_1 + X_2 N_2\right)}{70 \cdot 230} \qquad (4)$$

where R is risk index; N_p is the medium number of patients of cancer; N_1 is the population number of the USA in million persons; N_2 is the population number of non-urban residents in million persons; X_1 is the average amount of harmful pollutants in the air of city; X_2 is the average amount of harmful pollutants in the air out of city.

The dependency of pollution of the atmospheric air and the state of health of population is studied on the example of Azerbaijan's cities as well. With this purpose, results of calculation of risk based on risk index and average concentration in the air, and also data of malignant deceases by cities were used. Total indicator of risk (including risks by each substance separately) was assessed as well. Coefficient of correlation between the real number of revealed deceases and the average indicators of risk is 0, 60. It is evident that when risk is equated to 1 in average, this indicates to the existence of 3 deceases per 1000 people.

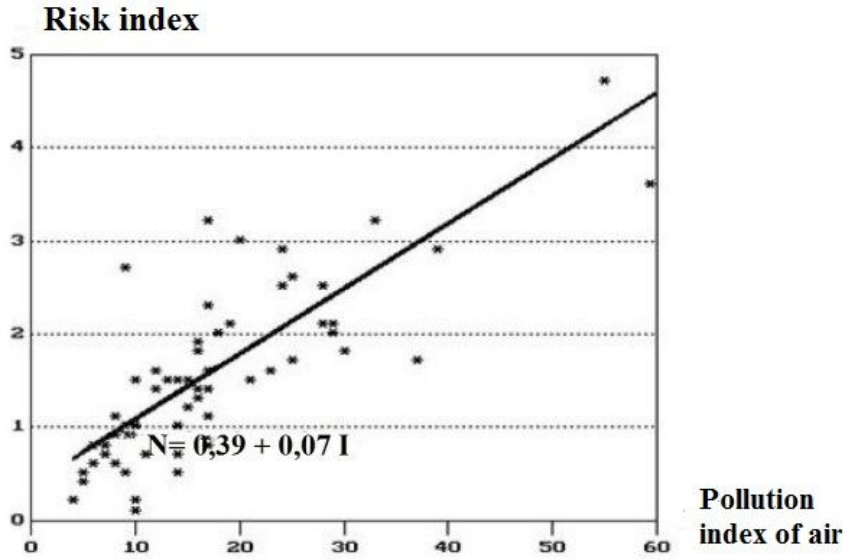

Figure 3: Correlation between PIA and Indicator of Risk

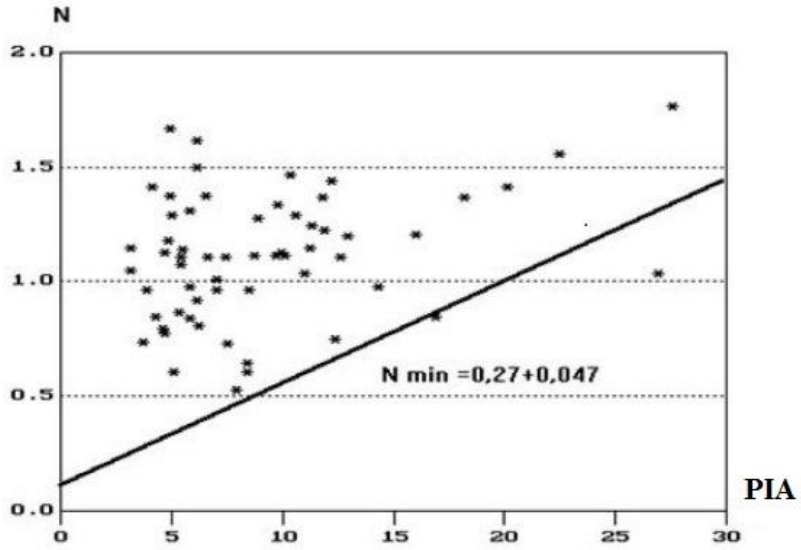

Figure 4: Correlation between Infant Respiratory Deceases among Infants and Pollution Index of Air

Dependency between PIA and indicator of risk (RQ) is determinable as below:

$$RQ = 0{,}39 + 0{,}07 \cdot IPA \qquad (5)$$

It is also mentionable that a group of researchers remark that there is not a relation between air pollution and arising of respiratory deceases among infant population of large cities. Thus, not depending on the low and high grade of air pollution, the number of these revealed deceases is the same as usual. In the large cities of Azerbaijan such as Baku, Ganja, Sumgayit, Mingachevir, coefficient of correlation between PIA and respiratory deceases among infants is weak (Table 2). Infants are exposed to the influence of many factors. Eventually, the determination of impact of air pollution can be conducted if the minimum number of facts of decease is known on different extents. Least number of facts of decease is measured for 5 years as below:

$$N_{UT\ddot{U}_{\min}} = 0.27 + 0{,}04 \cdot A\text{Ç}\dot{I} \qquad (6)$$

When PIA=10, N equates 0, 67, and when PIA=30, the corresponding indicator (N) equates 1,47.

Table 2: Coefficients of Correlation between Pollution Index of Atmospheric air and Respiratory Deceases among Infants in cities of Azerbaijan

Year	a	σ_a	b	σ_b	R	r^2	n
2002	1,02	0,35	0,01	0,01	0,28	0,08	
2003	0,88	0,31	0,02	0,01	0,29	0,08	
2004	1,17	0,37	0,01	0,008	0,11	0,012	
2005	0,92	0,27	0,02	0,01	0,30	0,09	
2006	0,85	0,23	0,01	0,004	0,36	0,13	
2002-2006 (in average)	0,96	0,26	0,016	0,006	0,32	0,10	

As the Formula 6 indicates, most facts of decease are not connected with pollution of atmospheric air. The concentration of sulfur-oxide which has harmful and even killing effect, and as a considerable factor in air pollution, it defines the pollution index of the atmospheric air. As it is shown in this study, the growth of pollution index of the atmospheric air is responsible for the growth of respiratory deceases. It was revealed that the change of pollution index as 2 units as much is equivalent to the corresponding change of 100 mkg/m^3 of concentration of sulfur-oxide. Such increase of pollution process leads to 12%-growth of facts of revealed decease.

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