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Comparative Evaluation of Air Pollution Impact on Severity of Multiple Sclerosis in Patients of Northern and Southern Cities of Kazakhstan: Astana, Shymkent

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Abstract: An study is considered the analysis of clinical characteristics of patients diagnosed with MS who live in Northern and Southern Regions of Kazakhstan in the context of Astana and Shymkent Cities and to perform comparative assessment of the impact of climatic characteristics and air pollution on severity of MS in these regions during the 2010-2012. There were set a goals: to investigate characteristics of the total patient population in Astana and Shymkent; to analyze climatic characteristics and the level of air pollution in these regions; to evaluate clinical characteristics of patients with MS in Northern and Southern Regions of Kazakhstan; to evaluate the impact of air pollution level on severity of the disease in MS patients of these regions.

Key words: Multiple sclerosis, air pollution, ecology, API_5, climate, epidemiology

INTRODUCTION

Multiple Sclerosis (MS) is a chronic, progressive and degenerative disorder of Central Nervous System (CNS), represented by disseminated neurological symptoms affecting several functional systems that are mainly developed in adults of 18-45 years of age (Shmidt and Yahno, 2010).

To date, lack of full understanding of etiology and pathogenesis of the disease (Henriksson *et al*., 2001; Shmidt and Yahno, 2010) difficulty of treatment, high levels of disability as well as large financial costs to help such patients, make the issue relevant for all countries.

One of the most discussed and debated issues of MS relates to its epidemiology which in turn defines the need to investigate regional, environmental and temporal characteristics. Additionally, the role of endogenous and exogenous external environmental factors and their impact on incidence of the disease, clinical implications, course and outcome of the disease should be studied on a deeper level taking into account such important factors as geographical location, climatic zone, race and age of the patients. The foregoing issues stand at the center of modern European and American epidemiological research (Rogan, 2014; Simpson *et al*., 2015) while data for Asian countries are extremely small and insufficient.

In Kazakhstan with a total population of 17,244.4 people, about 1,125 officially hospital based suffer from MS. This investigation is unprecedented epidemiological study of MS in Kazakhstan which evaluates the role of exogenous factors in development of MS, clinical features of the disease and impact of medical and social conditions on quality of life of MS patients. In this study, we will comparatively analyze the influence of external factors, including the level of air pollution on severity of the disease in patients of Northern and Southern regions of Kazakhstan (Astana and Shymkent Cities). We also plan to identify risk factors, course and prognosis of the disease. The findings of this investigation will comprise the basis of the first National Registry of MS in Kazakhstan.

MATERIALS AND METHODS

During this observational descriptive epidemiological study, we analyzed 125 patients with verified MS diagnosis who lived in Astana and Shymkent Cities during 2010-2012. Astana, the administrative center of the state is the new capital of Kazakhstan. It is represented by mainly new buildings with a population of 828,759 people including 569189 Asians (0.008%) and 157253 Caucasians (0.023%).

Astana is located in the Northern region of the country and has an extreme continental climate with average annual temperature of 3.7°C and average annual

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Table 1: Standard API_5 scale

Scale levels	Air pollution	Index	Annual assessment
I	Low, merely affects health	API5	0-4
II	Increased	API5	5-6
III	High, unhealthy	API5	7-13
IV	Very high, very unhealthy	API5	>14

air humidity of 61.6%. Shymkent is the Southern city and is one of the largest industrial centers of the country with over 60 production facilities, including lead and phosphorus plants, pharmaceutical, oil refining and gas processing plants, chemical factories and a cement factory. The total population of Shymkent is 854,500 people including 516124 Asians (0.005%) and 96798 Caucasians (0.02%). The average annual temperature in Shymkent equals to 13.5°C and the average annual air humidity is 55.3%.

The sources of information on MS patients in these regions were medical documents (outpatient medical records and archived medical records from the hospitals, health care statistics, records of clinical examination). Epidemiological factors included gender, race and patients' age during the onset of the disease.

Air pollution index for five substances (API_5-suspended solids, carbon monoxide, nitrogen dioxide, sulfur dioxide, formaldehyde) was used as an indicator of climatic and ecological condition in these regions. This standard scale (Table 1) according to Kazhydromet and Committee on statistics of Kazakhstan, represents not only the long-term-"chronic "-air pollution and concentrations but also reflects the degree to which pollutants affect health.

Statistical analysis of the study results was performed using Windows Operating System with MS Excel and Stata 13.0 Software Package.

RESULTS AND DISCUSSION

General characteristics of the population that were identified during this study are presented in Table 2. The average age of onset of the disease is 25.8±7 years. In both cities the number of women suffering from this disease is twice more than men (66.4 vs. 33.6%). In general, the number of patients belonging to Asian race turned out to be larger than the number of Caucasian patients.

Climatic and ecological characteristics of these regions had significant differences which was a prerequisite for inclusion in the study. These characteristics are presented in Table 3.

The clinical characteristics during the onset of the disease in patients of Asian race were represented by spinal disorders, whereas visual impairment was predominant at the onset of the disease in

Table 2: Baseline characteristics of the patients with MS by residency

Features	Astana (N = 80)	Shymkent (N = 45)	p-values
Age of onset	28.15±7.69	21.73 ± 2.41	<0.0001
Gender			0.458
Male	25 (31.2%)	17 (37.7%)	
Female	55 (68.7%)	28 (62.2%)	
Race			0.664
Asian	42 (52.5%)	26 (57.7%)	
Caucasian	38 (47.5%)	19 (42.2%)	

Table 3: Climatic and ecological characteristics of Astana and Shymkent

Factors	Astana	Shymkent
Annual average air temperature (°C)	3.70	13.5
Annual average relative air humidity (f%)	61.60	55.3
Air pollution index (API_5)	4.00	11.5

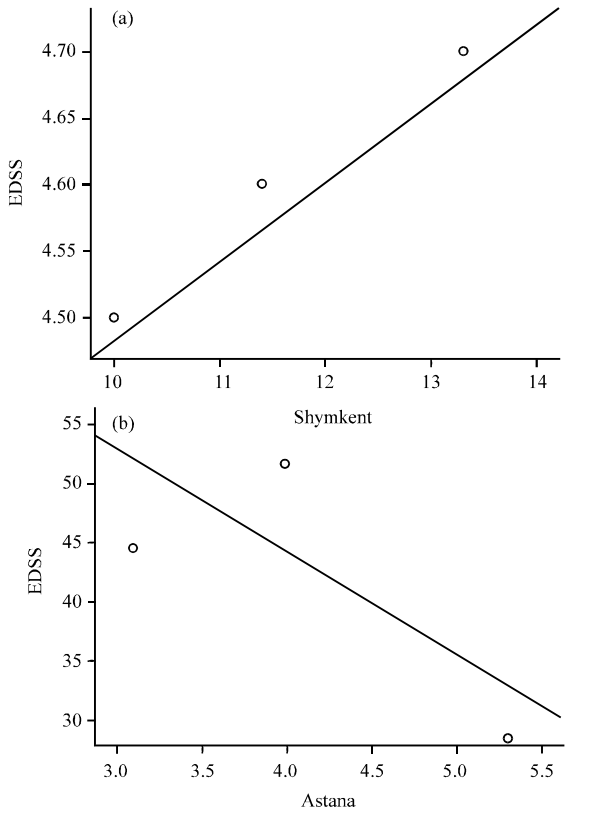

Fig. 1: Correlation between API_5 levels and severity of MS according to EDSS scale: a) Shymkent and b) Astana

Caucasian patients. No significant differences were observed for other clinical parameters (Table 4).

Analysis of the severity of MS was conducted according to EDSS scale. High scores of 5.5 and above and hence severe disability groups (I and II) are associated with patients from Southern region. However, the number of patients with lower EDDS score (3.5-4.0) was prevalent in the Northern region, implying milder form of impairment (III) (Table 5).

Table 4: Clinical characteristics of patients

	Astana			Shymkent		
Variables	Asian	Caucasian	p-values	Asian	Caucasian	p-values
Visual	9 (11.3%)	13 (16.3%)	0.156	3 (6.7%)	7 (15.6%)	0.070*
Pyramidal	14 (17.5%)	14 (17.5%)	0.622	3 (6.7%)	9 (20.0%)	0.007
Sensory	4 (5.0%)	5 (6.3%)	0.726*	0	2 (4.4%)	0.173*
Cerebellar	12 (15.0%)	5 (6.3%)	0.117	11 (24.4%)	1 (2.2%)	0.006
Spinal	2 (2.5%)	0	0.497*	10 (22.2%)	1 (2.2%)	0.014*

*Fisher's exact test; p>0.05 is significant difference

Table 5: Disability characteristics of MS patient

Indices	Astana (%)	Shymkent (%)
EDSS >1.5	20	11
EDSS >4.5	28	36
EDSS >6.5	12	18

Examination of comparative characteristics of contamination levels in the cities of interest with severity of MS according to EDSS scale identified a positive correlation of severity with high API_5 level in Shymkent, and a negative correlation with low level of API_5 in Astana (Fig. 1).

Our investigation of age characteristics of MS patients indicates that the average age of patients equals to 30 years and the average age of onset of the disease was 25.8 years which confirms the fact that multiple sclerosis affects young people of working age (Stolyarov and Boyko, 2008) and the age of the patients as in many studies accounts for 30 years (Debouverie *et al*., 2008).

It was revealed that in both cities there are more women with multiple sclerosis than men which corresponds to the data presented in literature (Kurtzke, 1993; Alonso and Hernan, 2008).

Our analysis of the race factor revealed that the number of Asian patients is greater than the number of Caucasian patients. We attribute this fact to increasing emigration of Caucasians that has been lasting for the past 10-20 years as a result of collapse of the Soviet Union. Nonetheless there is a trend indicating the dominance of representatives of European race in the northern region of the country. According to the data presented by many foreign authors, multiple sclerosis occurs more frequently in persons of Caucasian race as opposed to Asian and more frequently in Northern regions rather than Southern (Poser, 1994; Kuroiwa *et al*., 1983).

Significant differences were identified in climatic and ecological characteristics between the cities. Consequently, Astana, a colder city with low average temperature and high humidity but low air pollution index was assigned to I standard scale level.

Whereas, Shymkent has a mild and warm climate with high average temperatures and a relatively moderate humidity but with a high index of air pollution associated with level III of standard scale. It was also noted that MS has a greater prevalence in Northern regions than in Southern which corresponds to the data obtained from other sources (Marrie, 2004).

Analysis of the clinical onset of the disease between the two races showed significant differences. The onset of MS in Caucasian patients in both cities was associated with visual impairment while the onset of MS in Asian patients was represented by spinal and cerebellar pathology which does not contradict many published results (Poser, 1994). Results of the study of the severity of the disease, based on EDSS scale, showed that high scores of 5.5 or higher and severe disability (I and II) have resulted in a population of patients living in the Southern region and was 54% and mild disability (III) was 11%. However, a group of patients with severe disabilities accounted for 40% but with a lighter 3 group disability was 20% in the Northern region. We tend to associate these facts with adverse environmental background and with a high level of pollution in the Southern region which was confirmed by statistical analysis using Pearson criteria for correlation between these indicators presented in graphic images.

A positive correlation relationship was determined in Shymkent with reliability of Pearson value of 0.9962 which corresponds to the level of significance $p<0.01$**.

In the process we have encountered certaine difficulties in gathering epidemiological data related to the absence of similar studies. The first reliable statistical results were obtained after the official registration of Drugs Altering the Course of Multiple Sclerosis (DACMS) in 2010.

CONCLUSION

This research study is the first investigation of etiology and risk factors for multiple sclerosis, course and prognosis of the disease in different climatic and environmental conditions. The findings of this research do not contradict the outcomes of other European studies, however, clinical treatment revealed specific course of MS in Asian patients.

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