Scope of Air Quality Monitoring Within the Network of Public Health Institutes in Republic of Serbia

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Coal burning power plants, household solid fuel combustion, industrial contamination, traffic, and topography of urban settings are key reasons for labelling air pollution as a serious public health threat for urban population in Republic of Serbia, where air quality (AQ) is monitored by both National and Local network of measuring stations. The research tool in this cross-sectional study is a database formed by the Institute of Public Health of Serbia (IPHS) as a part of continuous AQ monitoring process for the Ministry of Health, through regular reporting of local IPHS, from the Network of Public Health Institutes (Network). Depending on the Local AQ monitoring Program, sources of continuous air pollution and pollutants' chemical nature, local IPHS monitor among the following: SO₂, black carbon (BC), NO₂, total atmospheric deposited matter, BeToXy, PM₁₀ and PM_{2.5}. SO₂ and BC are measured daily. In 2018, 18 out of 25 Network IPHS monitored AQ for any of the given parameters: SO₂ at 76 measuring points in 33 urban settlements; both BC and NO₂ at 70 measuring points in 31 settlements. The pollutants most needed to be monitored are PM₁₀ and PM_{2.5} particles, but are still monitored with the least frequency within the Network. Only 8 out of 25 IPHS monitors PM₁₀ in 15 settlements at 28 measuring points. Local programs of AQ monitoring in Serbia, conducted with the participation of the IPHS Network, give an incomplete coverage of potential public health threats for quantifying the burden of disease originating from urban air pollution.

Key words: air quality, Public Health Network, Serbia

1. INTRODUCTION

Air pollution, from both outdoor and indoor sources, represents the single largest environmental risk to health globally. WHO estimated that air pollution was responsible for more than 550 000 premature deaths in the WHO European Region in 2016, almost 6.600 of which were attributed to air pollution in Serbia. This disease burden is preventable, if air quality improves [1]. Coal burning power plants, household solid fuel combustion, industrial contamination, traffic, and topographic position of urban settings are key reason for labeling air pollution as a serious public health threat for urban population in Republic of Serbia [2].

AQ is monitored by both National and Local network of measuring stations. National network of automatic measuring stations (AMSSs) consists of 40 stations, being distributed and maintained by the Serbian Environment Protection Agency (SEPA) [3].

Figure 1 - SEPA network of AMSSs

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Besides the broad terrestrial distribution of SE-PA's AMSs (Figure 1), their number is still accounted as insufficient. In order to increase the density of AQ monitoring, local self-government administration is contracting with other stakeholders able to carry out this task, which, in most of the cases is a local IPH, belonging jointly to the Network of IPHs, a constitutive part of the health sector of the Republic of Serbia [4, 5, 6]. Official administrator for the Local Network is local self-government [7]. In total, 25 institutions comprise the Network of Public Health Institutes (PHIs) in Serbia (Figure 2), lead by the National PHI (1+24), of which AQ laboratories are operational in 20 of them [6].

Figure 2 - IPHs Network

Our aim was to present the scope of urban AQ quality monitoring undertaken by the above-mentioned laboratories, as part of a mix of stations belonging to both the State Network of AMS and the network of local measuring stations. Also, we aimed to present a decreasing trend in monitoring, in general, when these legal entities are the case.

2. METHODS AND DATA COLLECTION

The research tool used in this cross-sectional study is a data base formed by the Institute of Public Health of Serbia (IPHS), as a segment of a continuous AQ monitoring process implemented for the Ministry of Health, through regular reporting of local IPHs from the Network. Sampling, measuring and analyzing level of defined indicators are done by environmental health departments of local/regional IPHs. Data collation, processing and analysis are undertaken by the IPHS, whose assignment is to forward its remarks on possible public health risks to decision-makers. Due to the clear market conditions established in the field of operation of accredited laboratories, the data collected at the IPHS may vary from year to year [4].

Indicators that are monitored are grouped according to the nature of pollution sources, population

coverage, traffic density and potential public health risks: SO₂, black carbon (BC), NO₂ and other specific pollutants, such as NH₃, PM₁₀, heavy metals, and traffic-originated organic chemicals. Together with the key stakeholders at the local level (local self-government, local IPH), each municipality/town produces a Local Action Plan for AQ monitoring, defining the time schedule of monitoring activities and spatial distribution of sampling points, sources of air pollution and choice of pollutants in need of monitoring. Sulfur dioxide and BC are measured daily due to the strong correlation among their ambient air concentrations and fossil fuel combustion, as Serbia's key energy source is lignite coal [8]. NO₂ is the most frequently measured specific pollutant, on daily basis.

Presence of particulate pollution in ambient air is monitored through sampling of coarse particles of total atmospheric deposition (mg/m²/day), PM₁₀ and PM_{2.5}, with different measurement frequency, according to local AQ monitoring plans and specific indication, depending on pollution sources and financial resources of the local administration and the polluter, *per se* [9].

3. RESULTS

SO₂ and BC are measured on daily basis. In 2018, 18 out of 25 IPHs from the Network has monitored AQ for any of the given parameters, with the following distribution: SO₂ measurements covered 76 measuring points in 33 urban settlements; BC 70 measuring points in 31 urban settlements; as traffic-induced pollutant NO₂, measured also in 31 urban environments at 70 measuring points. Table 1 presents the overall picture of monitoring dynamics for the period 2009 - 2018, performed for SO₂, BS and specific pollutants (SPs) by the local IPHs. (Table 1).

Table 1. AQ monitoring dynamics by the IPH Network

Year	Townns			Samplng sites		
	SO ₂	BC	SPs	SO ₂	BC	SPs
2009.	32	32	23	91	91	62
2010.	32	32	29	95	95	78
2011.	31	31	27	75	75	63
2012.	34	34	34	93	93	85
2013.	32	32	33	83	83	81
2014.	27	27	26	60	60	45
2015.	32	32	29	61	62	61
2016.	27	26	27	52	56	47
2017.	32	30	29	62	59	60
2018.	33	31	31	76	70	71

If we analyze the data trend line, we clearly note that a decrease in the dynamics occurred steadily, throughout the last decade, for both general pollutants (SO₂, BC), and the heterogeneous group of „specific

pollutants“, strictly speaking of the IPHs Network activities (Figure 3 - 4).

Figure 3 - Trend line of SO₂, BC measuring dynamics

Figure 4 - Trend line of SPs measuring dynamics

Further on, in analyzing the frequency of NO₂ measuring, together with other specific indicators of urban ambient air pollution in 2018, the distribution of frequencies for 31 urban settings is as follows: pollutants are sampled at 1 sampling site in 18 urban settings/towns; at 2 sites in 6 towns; at 3 sites in 2 towns; at 4 sites in 3 towns; at 6 sites in 1 town, and at 17 sites in only 1 urban setting (capital city of Belgrade).

Among all of the SPs, the pollutants most needed to be monitored are PM₁₀ and PM_{2.5} particles, but are still monitored with the least frequency within the Network of IPHs. Only 8 out of 25 IPHs monitors PM₁₀, in 15 urban settlements at 20 measuring points (Table 2). The other public health mischief is that among them, only in 5 settlements (Veliki Crljeni, Obrenovac, Kraljevo, Sremska Mitrovica, Užice), the parameter is measured continuously, while in other 10 it is performed only once in a week, which is insufficient for any serious EHIA analysis. Regular air sampling for the PM₁₀ contents is of essential importance, as those two municipalities are hosting two lignit-burning power plants, of which, the one in Obrenovac is the

largest in the Western Balkans Region, marking it as a source of substantial public health concern [12].

Table 2. Scope of PM₁₀ monitoring in 2018

Town	sampling sites	sampling episodes	Above ALV	%
Bor	3	315	141	44.76
V. Crljeni	1	365	126	34.52
Elemir	1	35	0	0
Zrenjanin	2	147	5	3.40
Ivanjica	1	55	15	27.27
Kraljevo	1	356	105	29.49
Lazarevac	1	365	67	18.36
Niš	1	47	16	34.0
Obrenovac	1	365	46	12.6
Pančevo	2	380	176	46.3
S.Mitrovica	1	354	58	16.38
Čuprija	1	48	33	68.75
Užice	1	328	95	29.14
Čačak	1	56	25	44.64
Šabac	2	204	0	0
	20			27.31

The same disproportion is met in the capital city of Belgrade (agglomeration), having only 2 sampling sites with continuous PM₁₀ monitoring, while the other 7 are engaged only once in a week.

Table 3. Scope of PM₁₀ monitoring in Belgrade City (2018)

Measuring points		Days	Above ALV	%
AMS Ovča	daily	365	70	19,18
Zemun, J.Kopitara		365	118	32,33
KBC "Dr D.Mišović"	1/week	52	14	26,92
BAS, Železnička 4		52	14	26,92
Rakovica, O.Š.		52	6	11,54
Krnjača 1		52	14	26,92
Krnjača 2		52	12	23,08
B.Oslobođenja 18		52	13	25,0
Zemun		52	15	28,85
	9			24,53

4. DISCUSSION

Besides pure technical AQ measuring practice, local IPHs pursue their expertise with the local administrative bodies established for the cause of environmental pollution prevention, which is, also, a legally-defined activity [6, 10]. One of the most substantial improvements in local ambient AQ was implemented in the

town of Užice (West Serbia), known for its historical high levels of BC, generating from household fossil fuel combustion, in combination with its specific terrain topography. These long-lasting mix of environmental conditions was recognized by the expert community as a cause of different, mostly respiratory, health problems [11]. Due to locally adopted by-laws and financial subsidies for switching to other energy sources and pollution sustainable heating modes, Užice is experiencing a steep drop in the BC pollution trend line (Figure 5).

Figure 5 - Užice – decrease of BC annual mean values

The measures applied in Užice local self-government are in line with suggestions given by the European Environment Agency on the issue of local authorities as legal entities responsible for giving examples on air pollution mitigation measures [12]. As given in this EEA publication, local measures include expanding district heating, using cleaner fuels for heating, introducing lowemission transport zones, switching to cleaner buses or trams, promoting cycling, lowering speed limits and issuing congestion charges. Because of the variety of these measures and the different types of city, there is not one specific solution that fits all cities. What is remarkable about these measures is that they both reduce local air pollution and improve the quality of life in those cities. Furthermore, they cut greenhouse gas emissions and, in many cases, save money.

Last but not least, local IPHs are filling-in the data to the IPHS database for admissions to primary health care units on cases of exacerbation of asthma bronchiale and COPD (chronic obstructive pulmonary disease), which is, then, used to distribute them spatially using GIS in comparison to high mean annual concentration of PM₁₀ and BC [13].

5. CONCLUSIONS

Local programs of AQ monitoring in Serbia, conducted by the Network of IPHs give an incomplete coverage of potential public health threats for quantifying the burden of disease originating from urban air pollution. One of the main reasons for such a

situation is the constant non-compliance with the provisions of the legislation of those stakeholders (any accredited laboratory, be it private or public) who are obliged to forward all data on pollution monitoring in any environmental medium to the public health authority in charge of a specific territory, as well as to the IPHS, responsible for the country level [14].

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REZIME

OBIM MONITORINGA KVALITETA VAZDUHA U MREŽI INSTITUCIJA JAVNOG ZDRAVLJA U REPUBLICI SRBIJI

Termoelektrane na ugalj, sagorevanje čvrstog goriva u domaćinstvu, industrijska kontaminacija, saobraćaj i topografija urbanih sredina su ključni razlozi za markiranje zagađenja vazduha kao ozbiljne javno-zdravstvene pretnje izloženog gradskog stanovništva. Kvalitet vazduha (KV) prate kako nacionalna tako i lokalna mreža mernih stanica. Cilj ovog rada je da prikaže srazmere udela institucija javnog zdravlja u monitoring KV u Srbiji. Instrument istraživanja u ovoj studiji preseka je baza podataka formirana od strane Instituta za javno zdravlje Srbije (IJZS) kao komponenta kontinuiranog procesa praćenja KV za Ministarstva zdravlja, kroz redovno izveštavanje lokalnih ZJZ, iz Mreže zavoda za javno zdravlje (Mreža). U zavisnosti od lokalnog programa praćenja KV, izvora kontinuiranog zagađenja vazduha i hemijske prirode zagađivača, lokalni ZJZ prate sledeće parametre: SO₂, čađ, NO₂, ukupne taložne materije, BeToXy, PM₁₀ i PM_{2.5}. SO₂ i čađ se mere dnevno. U 2018. godini 18 od 25 lokalnih ZJZ pratilo je KV za bilo koji od zadatih parametara: SO₂ na 76 mernih mesta u 33 naselja; čađ i NO₂ na 70 mernih mesta u 31-om naselju. Polutanti čiji je monitoring od prioriteta su čestice tipa PM₁₀ i PM_{2.5}, a iste se prate sa najmanjom učestalošću unutar mreže. Samo 8 od 25 ZJZ prati PM₁₀ u 15 naselja na 28 mernih mesta. Lokalni programi monitoringa AK u Srbiji, sprovedeni uz učešće MZP-a, daju nepotpuno pokrivanje potencijalnih pretnji po javno zdravlje za kvantifikaciju tereta bolesti koje potiču od zagađenja urbanog vazduha.

Ključne reči: kvalitet vazduha, mreža javnog zdravlja, Srbija