

# Overview of Air Quality and Health Impacts in Bulgaria

---

Dr. Angel Dzhambov  
Department of Hygiene, Faculty  
of Public Health,  
Medical University of Plovdiv








**MEDICAL UNIVERSITY – PLOVDIV**  
[www.mu-plovdiv.bg](http://www.mu-plovdiv.bg)

# Attitudes towards Air Quality in September 2019







## Bulgaria vs. the EU

**QC1** How informed do you feel about air quality problems in (OUR COUNTRY)?  
(%)

	 EU28	 BG
Answer: Total 'Informed'		
TOTAL	45	30
 <b>Gender</b>		
Man	48	30
Woman	42	30
 <b>Education (End of)</b>		
15-	34	21
16-19	43	29
20+	54	39
Still studying	43	14
 <b>Difficulties paying bills</b>		
Most of the time	34	23
From time to time	35	28
Almost never/ Never	50	37

Socio-demographic breakdown

**QC2** Do you think that, over the last 10 years, the air quality in (OUR COUNTRY) has ...?  
(%)

	 EU28	 BG
Answer: Deteriorated		
TOTAL	58	65
 <b>Gender</b>		
Man	54	62
Woman	62	68
 <b>Education (End of)</b>		
15-	61	52
16-19	57	67
20+	58	67
Still studying	59	63
 <b>Difficulties paying bills</b>		
Most of the time	63	65
From time to time	63	64
Almost never/ Never	56	68
 <b>Feel informed about air quality</b>		
Total 'Informed'	55	68
Total 'Not Informed'	61	64

Socio-demographic breakdown



# State of air quality in Bulgaria

The most problematic areas in both the national and the local emission inventories are the residential heating emissions (PM<sub>10</sub>, PM<sub>2.5</sub> and PAH) and to a lesser extent – transport emissions (NO<sub>2</sub>).

NO<sub>2</sub> is an occasional issue in one municipality, SO<sub>2</sub> is a persistent issue also in one municipality, whereas PM<sub>10</sub> (especially, due to the higher number of samplers), PM<sub>2.5</sub> and PAH continue to be problematic for most municipalities where monitoring of those pollutants is performed.

## STATE OF AIR QUALITY IN BULGARIA: OVERVIEW



### MAIN EMISSION SOURCES, 2018, NIE 2020

POLLUTANT	MAIN EMISSION SOURCE	SHARE IN NATIONAL EMISSIONS, %
NO <sub>x</sub>	Road transport: Passenger cars and heavy-duty vehicles and buses, combined	34%
SO <sub>x</sub>	Public electricity and heat production	42%
PM <sub>2.5</sub>	Residential sector	77%
PM <sub>10</sub>	Residential sector	51%

SOURCE: CENTER ON EMISSION INVENTORIES AND PROJECTIONS:  
[https://www.ceip.at/ms/ceip\\_home1/ceip\\_home/status\\_reporting/2020\\_submissions/](https://www.ceip.at/ms/ceip_home1/ceip_home/status_reporting/2020_submissions/)



# State of air quality in Bulgaria

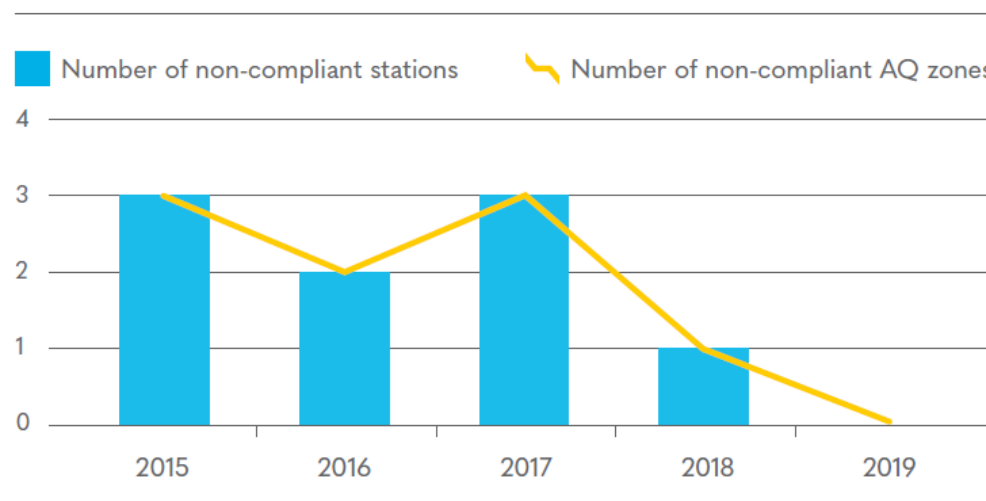
- In 2019, all AQ stations, measuring  $PM_{2.5}$  were compliant with the annual average limit value.
- However,  $PM_{2.5}$  is only monitored at 10 stations, and only 7 are in cities. Therefore, the territorial coverage of  $PM_{2.5}$  sampling is much more limited than the one for  $PM_{10}$ .
- The  $PM_{2.5}$  sampler has not been operating in the AQ station in Sofia for the last two full years, and the  $PM_{2.5}$  sampler in the AQ station in Plovdiv was not working in 2016. Hence, detailed analysis of  $PM_{2.5}$  concentration trends is highly limited.



## COMPLIANCE WITH $PM_{2.5}$ LIMIT VALUE, 2015-2019

SOURCE: ExEA

## COMPLIANCE WITH $PM_{2.5}$ ANNUAL AVERAGE, 2015-2019



Compliance with  $PM_{2.5}$  average annual limit value.



# Health-related social costs of air pollution



## Bulgaria

City	Total annual damage	Per capita damage	Damage as % of GDP
Burgas	€ 200.2 mln	€ 987	8.2%
Plovdiv	€ 354.8 mln	€ 1,033	8.6%
Ruse	€ 199.9 mln	€ 1,379	9.9%
Shumen	€ 92.9 mln	€ 1,208	8.6%
Sofia	€ 2575.3 mln	€ 2,084	7.7%
Stara Zagora	€ 153.8 mln	€ 1,124	8.0%
Varna	€ 330.6 mln	€ 986	7.0%
Vratsa	€ 59 mln	€ 1,100	7.9%



# Evidence on health impacts of air pollution from published literature (selected research since 2000)

Author (year)	Population	Observed effects of air pollution
Turnovska et al., 2001; 2007; 2009	School children	<ul style="list-style-type: none"> <li>• School children in Plovdiv exposed to higher NO<sub>2</sub> at school were found to have worse lung and cardiopulmonary functions</li> <li>• Children born since the drastic decline in air pollution levels (PM, SO<sub>2</sub>) after the political reform in Bulgaria in 1989 and exposed to considerably lower levels had better lung function compared with their counterparts</li> <li>• Exposure to a bouquet of industrial air pollutants in children's early-life was not found to yield differences in immunoglobulin levels across the cities Dimitrovgad (highly industrialized) and Nova Mahala</li> </ul>
Dobreva et al., 2013  Dzhambov et al., 2018	Adolescents	<ul style="list-style-type: none"> <li>• Altered balance between pro- and anti-inflammatory cytokines in those living in the city of Stara Zagora (one of the most polluted regions), which could indicate suppression of Th1 cell-mediated immunity and exacerbation of Th2 humoral immune response</li> <li>• Among university students in Plovdiv, higher level of NO<sub>2</sub> was associated with lower perceived restorative quality of the neighborhood, in turn with lower level of outdoor physical activity, which in turn related to more frequent symptoms of anxiety and depression</li> </ul>



# Evidence on health impacts of air pollution from published literature (selected research since 2000)

Author (year)	Population	Observed effects of air pollution
<p>Gábelová et al., 2004</p> <p>Taioli et al., 2007</p> <p>Rossner et al., 2007</p>		<ul style="list-style-type: none"> <li>In an international project, there was evidence of oxidative DNA damage and genotoxicity in subjects exposed to high levels of polycyclic aromatic hydrocarbons (PAH) and benzopyrene (BaP). Notably, PAH and BaP levels were several-fold higher in Bulgarian participants and greatest overall air pollution genotoxicity was observed in Sofia.</li> </ul>
<p>Dimitrova et al., 2010</p> <p>Platikanova et al., 2013</p> <p>Dzhambov et al., 2016</p>	<p>Adults (general population)</p>	<ul style="list-style-type: none"> <li>Daily concentrations of O<sub>3</sub> and PM<sub>10</sub> in the city of Varna were moderately-to-highly correlated with hospital admissions for acute myocardial infarction.</li> <li>In the Stara Zagora region, strong correlations were reported between several pairs of air pollution indicators (SO<sub>2</sub>, PM, NO<sub>2</sub>, Pb, H<sub>2</sub>S) and disease classes (cardiovascular, respiratory, genitourinary, digestive systems) in the period 2009-2013</li> <li>In Plovdiv, there were (non-significant) positive associations between type 2 diabetes and PM<sub>2.5</sub> and BaP</li> </ul>



# Evidence on health impacts of air pollution from published literature (selected research since 2000)

Author (year)	Population	Observed effects of air pollution
Krachunov et al., 2017	Adults (patients with pre-existing pathology)	<ul style="list-style-type: none"> <li>• Among COPD patients in the city of Pleven who were followed for a year, the daily incidence of acute exacerbations was found to correlate with average PM<sub>10</sub> in the previous six days.</li> </ul>
Doneva et al., 2019		<ul style="list-style-type: none"> <li>• A larger multi-center study in 16 Bulgarian settlements also followed COPD patients for a year and corroborated this finding of an association between higher PM<sub>10</sub> levels and the number of exacerbations and length of hospital stay.</li> </ul>
Dzhambov et al., 2017		<ul style="list-style-type: none"> <li>• Another study reported a multiplicative interaction between road traffic noise and PM<sub>2.5</sub>, where higher noise exposure at the residence was associated with lower renal function only in CVD patients exposed to lower levels of air pollution.</li> </ul>





# Promising trends in reviewed literature

- Expanding the scope beyond respiratory health outcomes of air pollution
  - ✓ Growing appreciation of impacts on cardiovascular and metabolic health
  - ✓ Several mechanistic studies looking into modification of the immune system and psycho-behavioral processes
- Investigation of both short- and long-term effects of air pollution
  - ✓ Daily/monthly dynamics in air quality linked to morbidity/mortality
  - ✓ Ingenious use of natural experiments
  - ✓ 3 studies using personal monitors and 1 using a land-use regression model
- Evidence on impacts in vulnerable populations
  - ✓ **Studies in children**
  - ✓ Studies in patients with pre-existing pathology



# Methodological caveats in reviewed literature

- Suboptimal air quality assessment techniques – exposure misclassification
  - ✓ Sparsely distributed AQ monitoring stations
  - ✓ Lack of high-quality land-use regression models
- Suboptimal research design – compromised external validity
  - ✓ Small, non-population-based samples
  - ✓ Lack of dose-response functions generalizable to the Bulgarian population
- Suboptimal analytical approaches – compromised internal validity
  - ✓ No dynamic regression modeling with time-series data
  - ✓ Binary tests of association without sufficient control for confounding
- Poor communication of knowledge and expertise between disciplines concerned with various aspects of the subject



# STATE OF AIR QUALITY IN BULGARIA: OVERVIEW



## MAIN ISSUES AND OPPORTUNITIES FOR IMPROVED AQ MANAGEMENT IN BULGARIA

TOPIC	ISSUE	OPPORTUNITY
<b>Data</b>	<ul style="list-style-type: none"> <li>• Lack of data for some pollutants (such as PM<sub>2.5</sub>)</li> <li>• No easily accessible AQ data</li> </ul>	<ul style="list-style-type: none"> <li>• Improve sampling for some pollutants, including citizen science</li> <li>• Provide a possibility for easy access to AQ data</li> </ul>
	<ul style="list-style-type: none"> <li>• Lack of detailed activity data for some sources of emissions (e.g. residential heating)</li> <li>• Lack of research and studies on AQ</li> </ul>	<ul style="list-style-type: none"> <li>• Conduct surveys to collect activity data to be used in emission inventories</li> <li>• Cooperate with academic and research institutions to improve the scientific knowledge on AQ</li> </ul>
<b>Legal</b>	<ul style="list-style-type: none"> <li>• Unclear responsibilities for AQ management</li> <li>• Inability to effectively control residential burning</li> </ul>	<ul style="list-style-type: none"> <li>• Work with local stakeholders to improve control on residential burning</li> <li>• Share international good examples</li> </ul>
<b>Funding</b>	<ul style="list-style-type: none"> <li>• No experience with AQ-related funding</li> <li>• Missed opportunities to achieve AQ benefits from other funding programmes</li> </ul>	<ul style="list-style-type: none"> <li>• Provide targeted AQ funding</li> <li>• Advise on potential funding synergies with other sectors</li> </ul>
<b>Capacity</b>	<ul style="list-style-type: none"> <li>• Lack of capacity for AQ management at national and local level</li> <li>• Lack of capacity at local level to plan and implement more complex measures such as establishing LEZ</li> </ul>	<ul style="list-style-type: none"> <li>• Improve capacity for AQ management, policy-making, securing funding for AQ measures, mainly at local level</li> <li>• Provide technical assistance to municipalities to implement measures</li> </ul>
<b>Communication</b>	<ul style="list-style-type: none"> <li>• Inadequate communication with the public</li> <li>• Lack of social attitude surveys on the topic of AQ</li> </ul>	<ul style="list-style-type: none"> <li>• Demonstrate approaches to improve communication with the public</li> <li>• Conduct social attitude surveys and share results with stakeholders.</li> </ul>



**MEDICAL UNIVERSITY – PLOVDIV**

[www.mu-plovdiv.bg](http://www.mu-plovdiv.bg)

# Thank You!

---

Angel Dzhambov

Department of Hygiene, Faculty of Public Health,

Medical University of Plovdiv

Email: [Angel.Dzhambov@mu-plovdiv.bg](mailto:Angel.Dzhambov@mu-plovdiv.bg)