



ENVIRONMENTAL NOISE AND CARDIOVASCULAR DISEASES IN BULGARIA

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ABSTRACT

Purpose: Noise has emerged as a leading environmental nuisance. Cardiovascular diseases rank first among the causes of death on a global scale and one of the possible effects of noise impact on the human organism.

The study aims to analyze the level of noise pollution in Bulgaria and to measure its association with cardiovascular diseases.

Methods: Data provided by the National Statistical Institute, Eurostat and other databases were used to analyze the noise pollution in Bulgaria. The 28 regions in Bulgaria were compared according to the proportion of surveyed points above permissible limits and the death rates due to cardiovascular diseases, /2022/. Data were statistically processed with SPSS v.26.

Results: A positive fact is the absence of high values of noise levels in the range of 78-82 dB(A) and over 82 dB(A) and the decrease in the share of surveyed points with noise levels in this range during the analyzed period - from 27.3% in 2006 to 18.56% in 2022.

The study found that almost all districts with the highest share of surveyed points above permissible limits have higher levels of death rate due to CVD. There is a positive moderate correlation between the share of surveyed points above permissible limits and the Death rate due to CVD - coefficient of Pearson is 0.423 (p=0.025).

Conclusion: Cardiovascular diseases have a multifactorial genesis, but the reduction of noise in urban areas would help prevent these diseases.

Keywords: Noise, pollution, cardiovascular, inequalities, public health,

INTRODUCTION

Social determinants of health are a set of socially controlled factors that affect individual and public health. Factors in the physical environment, such as air pollution and noise, are among the social determinants of health that greatly impact population health [1].

Sources of environmental noise [2]:

- transport - road traffic, rail traffic, air traffic;
- construction and industry;
- community and social sources - neighbours, radio, television, bars and restaurants, portable music players, fireworks, toys, rock concerts.

Environmental noise is a significant environmental risk [3]. Noise is an unpleasant, discordant sound. At very high levels, noise can cause permanent changes in a person's psyche [4]. But, even at lower levels, it can cause stress and disorders of the nervous system [5]. Road traffic noise is ranked second in the World Health Organization /WHO/ categorization of environmental factors harmful to human health. Only air pollution is listed as more harmful.

Noise affects health in different ways [6, 7]. Prolonged noise-related stress can deplete a person's physical reserves, disrupt the regulatory capacity of organ functions, and thus limit their effectiveness [8, 9]. Noise is an underestimated threat that can cause several short- and long-term health problems, such as sleep disturbance, cardiovascular effects, poorer work and school performance, hearing impairment, etc. [10].

The degree of risk of damage to human health under the influence of the "noise" factor in the environment is difficult to determine [11]. Usually, this factor does not act in isolation but participates in an extremely complex combination with other health risk factors [12]. For example, people exposed to road noise are also exposed to air pollution arising from road traffic. It is not yet clear whether the impact of noise on ischaemic heart disease is

independent, additive or synergistic to the impact of outdoor air pollution.

Noise has emerged as a leading environmental nuisance, and the public complains about excessive noise more and more often [13, 14]. Noise exposure was estimated to exceed recommended residential limits in up to 40% of people living in the EU.

Global burden of diseases studies arrange noise on the second position among the environmental risk factors, attributing 260 Disability-adjusted life years /DALYs - the sum of the potential years of life lost due to premature death/ per 100,000 for 2016. There is an increase in this indicator in comparison with 1990 – 246 DALYs per 100,000. The male population is more affected, with 4 711 557 DALYs for 2016 [15].

WHO estimates that the burden of disease from environmental noise is approximately 61,000 years for ischaemic heart disease in high-income European countries, based on the exposure data from the noise maps of EU Member States [16].

WHO defined environmental noise as “noise emitted from all sources except for noise at the industrial workplace”. According to WHO guidelines, the community noise should be less than 30 A-weighted decibels (dB(A)) in bedrooms during the night and less than 35 dB(A) in classrooms to allow good teaching and learning conditions. For the night, the recommendations are as follows: less than 40 dB(A) of annual average (L night) outside of bedrooms to prevent adverse health effects from night noise [17].

The assessment of noise in Bulgaria’s urban environment is carried out according to the requirements of Directive 2002/49/EC of the European Parliament and the Council “On the assessment and management of noise in the environment”.

The determination of the degree of noise load in the environment by measurement is carried out based on Ordinance No. 54 of 2010 of the Ministry of Health and the Ministry of Education and Culture on the activity of the National system for monitoring noise in the environment and on the requirements for conducting own monitoring and providing of information from industrial sources of noise in the environment” (SG No. 3/2011), under the requirements of the “Methodology for determining the number, location and distribution of noise monitoring points, as well as the periodicity of measurements and/ or noise level calculations”, approved by the Ministry of Health, 2007, referred to in Article 6, Paragraph 2 of the above-mentioned Ordinance No. 54/2010 [18].

The sources and factors that characterize noise affecting people are many and varied [19]. Road traffic is considered to be the main source of noise pollution, with noise levels expected to increase in both urban and rural areas over the next decade due to the development of ur-

banization and the increased need for mobility. Vehicle noise depends in part on the environment in which its distribution is investigated and, in particular, the quality of the road infrastructure. There are also other factors, such as the lack of bypass routes for transiting vehicles in many cities, the minimum distance between buildings and roadways, the lack of sufficient parking spaces, which makes it difficult for motor vehicle traffic, and the insufficient shielding of traffic noise. Added to the traffic noise is the noise from entertainment venues, construction and repairs, fireworks and other activities.

Chronic non-communicable diseases have a huge effect on the socio-economic development of countries. Their long-term course determines their importance, the frequent cause of disability, the disruption of people’s ability for daily activities and their leading place among the causes of death. They are of increasing importance worldwide and are a public health problem not only for developed countries. Among chronic non-communicable diseases, cardiovascular diseases (CVD) rank first among the causes of death on a global scale - more people die from them than from any other cause [20]. In 2019, cardiovascular disease caused 18.6 million deaths worldwide [21]. Cardiovascular disease includes ischaemic heart disease, hypertension (high blood pressure) and stroke.

CVD is the most common cause of death in European Union member countries, with Ischemic heart disease accounting for 45% of these deaths in females and 39% in males [22].

Based on the picture of mortality and morbidity in Bulgaria, the leading socially significant diseases in our country are cardiovascular diseases, malignant neoplasms and chronic diseases of the respiratory system.

Tabl. 1. Top 10 causes of deaths per 100k in 2009 and 2019, all ages combined. [23]

Cause	2009 rang	2019 rang
Ischemic heart disease	1	1
Stroke	2	2
Hypotensive heart disease	3	3
Lung cancer	4	4
Colorectal cancer	5	5
Alzheimer’s disease	8	6
COPD	6	7
Cirrhosis liver	7	8
Diabetes	9	9
Other cardiovascular	10	10

In the structure of the leading causes of death in our country, diseases of the circulatory organs have the high-

est share - over 60%. Mortality from cardiovascular diseases in Bulgaria has a strongly pronounced unfavourable dynamics and a significantly higher level than in countries with a developed market economy and many countries from Central and Eastern Europe.

Data provided by the World Heart Observatory [24] in the country profile of Bulgaria are:

- Overall number of deaths from CVD - 79,119
- Age-standardized CVD mortality (per 100,000) – 541, (global – 312)
- Age-standardized CVD incidence (per 100,000) – 840
- Prevalence of raised blood pressure (women) - 23.0%
- Prevalence of raised blood pressure (men) - 33.6%
- Probability of premature mortality from CVD - 3.6%, (global – 1.7)

CVD is of great importance for public health in Bulgaria, and it requires the analysis, control, and prevention of all possible factors related to cardiovascular diseases [25].

The study aims to analyze the level of noise pollution in Bulgaria and to measure its association with cardiovascular diseases, which are one of the possible effects of noise on human organisms.

MATERIALS AND METHODS

An ecological epidemiological study was conducted. The noise pollution in Bulgaria was analyzed using the information provided by the National Statistical Institute /NSI/, Eurostat and other databases. The 28 regions in Bulgaria were compared according to the proportion of surveyed points above permissible limits and the death

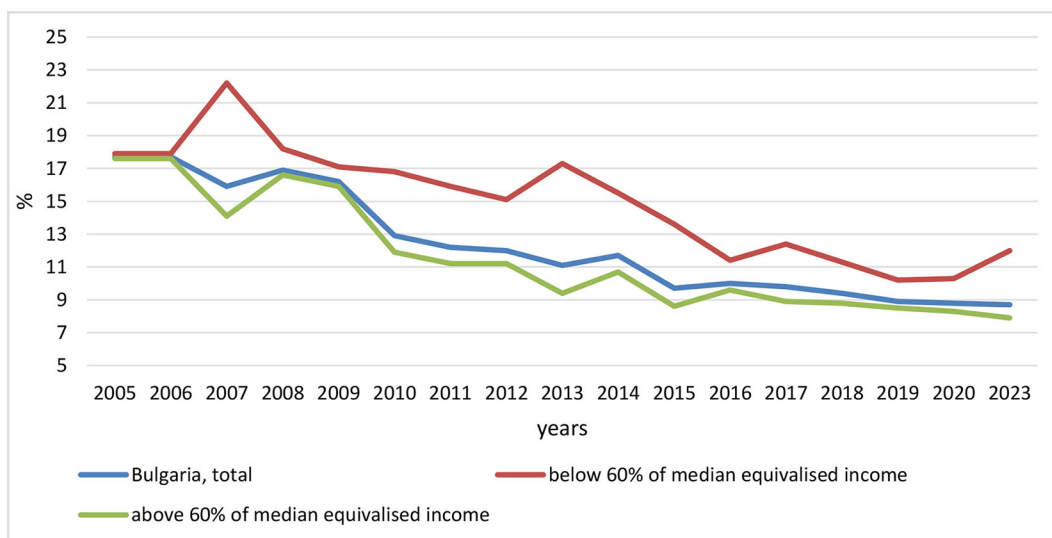
rates due to cardiovascular diseases, /2022/. According to the National Statistical Institute data, the regional indicators for the districts in the country were analyzed, the absolute numbers were regrouped, and the proportions were calculated. Analysis and calculations were performed with MS Excel 2019. Data were statistically processed with SPSS v.26. To establish the relationship between the analyzed indicators, the Pearson correlation coefficient was used.

RESULTS

Since 2002, Bulgaria has had a National System for monitoring environmental noise to prevent the adverse health-ecological effects of the spread and impact of noise pollution. Within the framework of the national system, the Regional Health Inspections (RHI) present data from measurements carried out in connection with the control of urban noise in specific points. The data reflect the noise levels created mainly by transport in 36 country cities. They include all regional cities, as well as nine more municipalities.

Data provided by Eurostat reveal that around 9% of the total population living in Bulgaria suffers from noise, but analysis of this indicator shows a very positive trend of decreasing – from 17.7% for 2005 to 8.7% for 2023 /decreasing with 49.15%/. Some noise exposures may be worse for some subgroups than for others. Issues such as the lower housing prices near noisy roads mean that the effect of noise is not uniformly distributed throughout the population. It is noteworthy that the indicator is highly sensitive to socio-economic status, and people living below 60% of median equivalised income are exposed to noise pollution much more – 12% for 2023 compared with people above 60% of median equivalised income – 7.9% [26]. (Fig. 1.)

Fig. 1. Population living in households, considering that they suffer from noise, by poverty status. Source of data: Eurostat.



The intensity of noise emissions is the main factor that determines the degree of irritation felt in response to noise, and it is for this reason that all studies investigat-

ing the impact of noise on health measure noise in terms of sound pressure.

Tabl. 2. Distribution of the registered noise levels by ranges in 36 cities of Bulgaria, 2006-2022, source: National Center of Public Health and Analyses

Year	Surveyed points	Distribution of the surveyed points according to noise level in decibels						
		under 58 dB(A)	58-62 dB(A)	63-67 dB(A)	68-72 dB(A)	73-77 dB(A)	78-82 dB(A)	over 82 dB(A)
2006	527	74	95	172	144	39	3	0
2007	710	128	116	189	216	59	2	0
2008	726	130	130	207	189	65	5	0
2009	727	140	118	227	191	51	0	0
2010	696	145	108	223	170	50	0	0
2011	727	153	117	235	175	47	0	0
2012	726	163	124	238	151	50	0	0
2013	726	170	113	242	164	37	0	0
2014	710	149	127	239	159	36	0	0
2015	727	152	127	249	166	33	2	0
2016	725	157	113	255	170	28	0	0
2017	726	155	108	270	166	27	0	0
2018	746	170	112	268	183	13	0	0
2019	744	179	116	271	163	15	0	0
2020	731	178	114	264	161	14	0	0
2021	735	182	119	268	155	11	0	0
2022	749	181	139	275	139	15	0	0

Data analysis shows that noise levels in the range of 63-67 dB(A) prevailed in the control measurements. The cases of established lowest noise levels - below 58 dB(A) have increased by 10.17% in 2022 compared to 2006. No pronounced trend was registered for the country-specific range of 63-67 dB(A). Values do not change statistically. A positive fact is the absence of high values of noise levels in the range of 78-82 dB(A) and over 82 dB(A). In the 73-77 dB(A) range, a slight decrease of 5.4% was observed compared to 2006. The continued hold of the high unfavourable noise levels in the range of 68-72 dB(A) (18.56%). However, there is a decrease in the share of surveyed points with noise levels in this range during the analyzed period - from 27.3% in 2006 to 18.56% in 2022.

The analysis of the share of surveyed points above permissible limits shows a continuing trend of maintaining a high percentage of points – 71.80% /2011/ and 68.62%/2022/.

According to the administrative organization, Bulgaria is divided into 28 regions, which differ significantly in socio-economic development, demographic and health indicators. For the purposes of the study, we will compare noise pollution levels in all districts across the country using the share of surveyed points above permissible limits in 2022.

In 2022, the daily equivalent noise levels were measured by RHI at 749 surveyed points. The comparison between the districts shows significant variations. Blagoevgrad is the district with the lowest proportion of surveyed points above permissible limits – only 17.65%. On the other side of the graph are Pleven, Vidin, Montana,

Silistra, Kyustendil and Razgrad, with shares above 80%.

To analyze the effect of noise pollution on public health in our study, we choose to measure the association with cardiovascular diseases using the death rate due to CVD per 100,000, which is an important indicator characterizing not only the health status of the Bulgarian population but gives the picture of the accessibility of health care [20]. The dynamics of this indicator in Bulgaria have a very negative trend – it is increasing, especially during the period of the COVID-19 pandemic.

At the same time, this is also the indicator that makes the inter-district health inequalities more significant. The lowest is in Sofia-capital – 786,34 ⁰/₀₀₀₀, Blagoevgrad - 977,91 ⁰/₀₀₀₀ and more than two times higher in Vidin district – 1736,16 ⁰/₀₀₀₀. The study found that almost all districts with the highest share of surveyed points above permissible limits have higher levels of death rate due to CVD:

- Vidin - 1736,16 ⁰/₀₀₀₀
- Montana - 1535,74 ⁰/₀₀₀₀
- Lovech - 1535,22 ⁰/₀₀₀₀
- Silistra - 1403,03 ⁰/₀₀₀₀
- Razgrad - 1364,60 ⁰/₀₀₀₀
- Pleven - 1272,03 ⁰/₀₀₀₀

The results of statistical data analysis show that there is a positive linear correlation between the share of surveyed points above permissible limits and the Death rate due to CVD. The correlational coefficient of Pearson is 0.423. The relationship is significant with p=0.025. The relationship between these two variables is moderate.

Fig. 2. Registered noise levels by district, 2022, Bulgaria, % of surveyed points above permissible limits

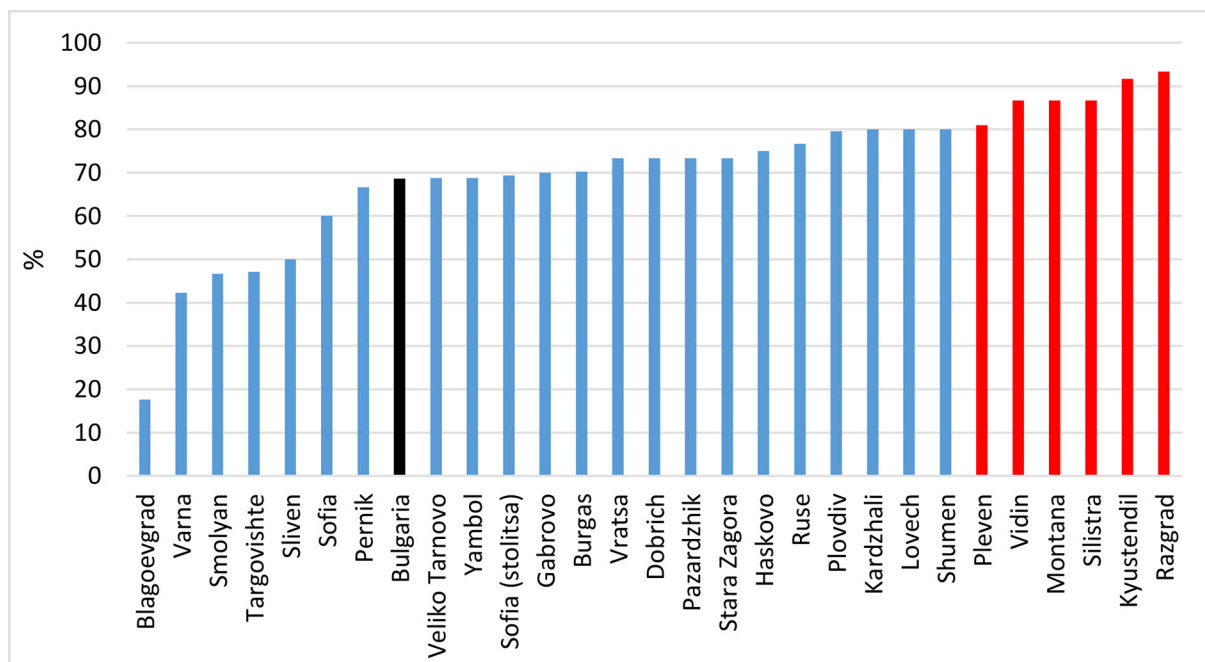
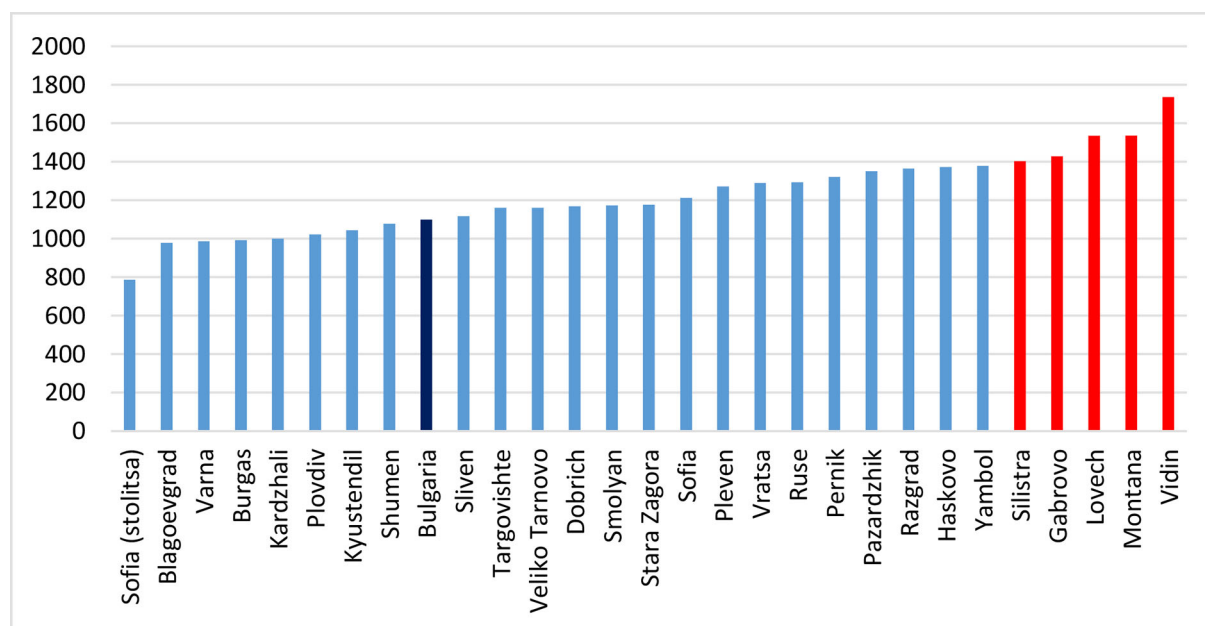


Fig. 3. Death rate due to CVD by district, 2022, Bulgaria, per 100,000.



DISCUSSION

Noise pollution creates a real problem, especially for the population living in the urban environment, where the flows of car traffic continue to increase. However, it is important to note the decrease in the relative share of the population suffering from noise pollution.

The acoustic environment in the country’s cities has not changed significantly. In the majority of control points, the measured equivalent noise levels exceed the limit values.

For the analyzed period, some positive trends are observed - throughout the observed period, the number of points falling in the range of high noise levels (73-77)

dB(A) decreases, the number of points in the range below 58 dB(A) increases, and high values of noise levels in the range of 78-82 dB(A) and over 82 dB(A) are almost missing. A positive fact is even the small decrease in the share of surveyed points above permissible limits during the analyzed period.

Established health inequalities between regions in the country are one factor contributing to Bulgaria’s deteriorating level of public health. The persistent trend of increasing mortality from CVD is a serious public health problem. The regional differences shown are also a factor exacerbating this trend.

The study found a moderate correlation between

noise pollution and the death rate due to cardiovascular disease. Like most chronic diseases, cardiovascular diseases have a multifactorial genesis, but the reduction of noise in urban areas would help prevent these diseases.

CONCLUSIONS

As a result of the performed analysis, it can be concluded that the investigated indicators determining the degree of discomfort during the daily period of the day remained high during all years of follow-up.

It is necessary to prioritize the individual measures depending on the expected improvement of the acoustic environment, reduction of the exposure of individual groups of the population, and reduction of the number of affected citizens.

Further research on environmental noise and health will help close gaps in emerging adverse health effects.

Some risk factors are potentially reversible, and this provides a huge opportunity to address the health inequalities across the country that are highlighted in this study.

There are common aspects in activities to reduce environmental noise levels, and they include requirements for proper planning of residential and industrial areas, expressways, airports, etc., assessment of compliance of the noise source (industrial enterprise, shopping centre, highway, railway line, etc.) with the current legislation.

Abbreviations

CVD - Cardiovascular diseases

EU - European Union

NSI - National Statistical Institute

RHI - Regional Health Inspections

SPSS - Statistical Package for the Social Sciences

WHO - World Health Organisation

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