Short Communication

HEALTH ASSESSMENT OF POPULATIONS LIVING CLOSE TO THE AIRPORT OF BOURGAS, BULGARIA

Tanya TURNOVSKA[1], Jeni STAYKOVA[2], and Tonko PETKOV[3]

Medical University, Plovdiv[1], Inspectorate of Hygiene and Epidemiology, Kardjali[2], Air Transport Institute, Sofia[3], Bulgaria

Received September 2003

The aim of this follow-up performed in a period of three years (1997-1999) was to assess the morbidity rate among children (0-17 years) and adults (18 years and above) from housing estates Sarafovo, Izgrev, Zornitsa and partly Slaveykov, located close to the airport of Bourgas and compare it to population living at more distance from the airport (town centre). It was found that the prevalence of all diseases in children and the incidence in adults were higher in populations living close to the airport than in matching population living in the town centre. Specific groups of diseases which may be considered more closely associated with the adverse health effects of noise included diseases of the nervous system and of the sense organs, mental disorders, cardiovascular diseases, particularly arterial hypertension, and diseases of the digestive system. It is worth noting, however, that some diseases whose relationship with the effects of aircraft noise was not expected to be that of cause and effect were also found in higher prevalence or incidence rate in exposed populations. This indicates that other factors, which were not sufficiently analysed in this study, deserve full consideration in the evaluation of the results obtained.

KEY WORDS: *aircraft noise, morbidity incidence, morbidity prevalence*

A large number of studies emphasize negative health effects of air traffic on populations living in the vicinity of airports. They point out that long-term exposure to noise caused by aircrafts disturbs everyday life and leads to increased irritability and impaired quality of life (1-4), reduction in working capacity, disturbance in the learning process, impairment of memory abilities (5-8), and serious difficulties in communication, especially when using a foreign language (9). Literature reports cardio-vascular disturbances (8, 10) and the risk of mental disorders and other diseases (2, 10, 11). Loss of hearing has been reported in places with high levels of noise intensity, such as military airports (12). An extensive study of children attending schools near Heathrow Airport in London showed that the children were running a greater risk of cognitive impairment due to exposure to aircraft noise (13). The effect of noise on sick children is definitely unfavourable, even in short-term exposure. It was found that the noise of emergency helicopters transporting sick babies was a strong stress-producing factor (14). When taking off and landing, airplanes are a source of an infrasound (15) which, besides direct adverse health effect, may cause window panes to rattle, which in turn may cause irritation and anxiety among people exposed who live close to airfields (16). We believe that this latter effect is important and that house glazing is generally insufficient in reducing noise of this kind.

The town of Bourgas is a Black Sea resort in Bulgaria (211,234 inhabitants) with a very intensive air traffic, especially in the summer. This paper is mostly focused on possible effects of aircraft noise on the health on population living near operating airports.

STUDIED POPULATION AND METHODS

The exposed populations included in this study live in the following districts located in the vicinity of the

Bourgas airport: Sarafovo district (located about 700 m off the end of the runway and in its direction), Izgrev housing estate (located about 4 km off the end of the runway and in its direction), Zornitsa housing estate (located about 5 km in the direction of the runway and 1.5 km aside form it), and partly the Slaveykov housing estate (located about 5 km off the end of the runway and in its direction). Sarafovo district, Izgrev and Zornitsa housing estates total 36,349 inhabitants, and Slaveykov housing estate counts 35,530 inhabitants. The health status of the population living in these areas was analysed using one of the most commonly applied methods in practice, that is, morbidity rate based on the number of cases registered at the primary health care level (in Bulgaria this means in polyclinics). Data on diseases registered among children (0-17 years old) and adults (over 18 years) were obtained from the Bourgas Healthcare Centre. Morbidity rates were determined on the basis of main classes of diseases for the period 1997-1999 and were estimated according to occurrence per 1,000 inhabitants.

We also analysed the morbidity rates of a population living in the centre of Bourgas (43,940 people) located at a greater distance from the airport, which was taken as control somewhat arbitrarily, because greater distance from the airport is not the only characteristic which distinguishes the town centre from the exposed areas on the outskirts. It is worth mentioning that motor transport noise monitoring at the different stations in different parts of Bourgas (performed by the Inspectorate of Hygiene and Epidemiology) recorded values between 63 and 85 dB(A).

The analysis of children included all recorded morbidity cases, i.e. the prevalence of diseases, whereas in adults annual incidence data represent newly diagnosed diseases per 1000 inhabitants.

The statistics is based on non-parametric analysis (Chi square test - χ^2) and the value of $P<0.05$ was taken as statistically significant.

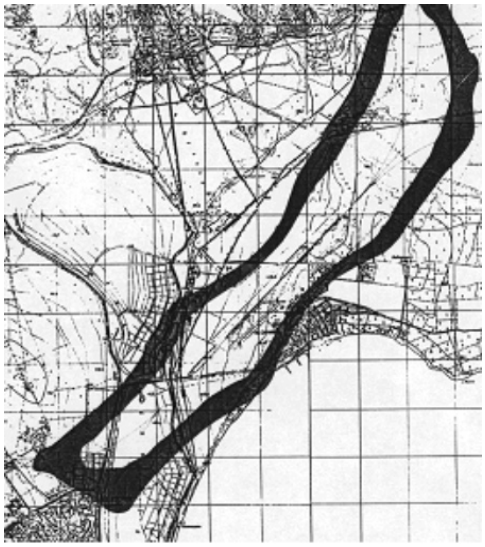

Figure 1 *Noise outlines near the Bourgas airport in LAeq (energy equivalent sound pressure level), dB(A), 16 hours (06.00-22.00 h), for a busy summer day (outside line correspond to LAeq = 60 dB(A))*

Figure 2 *Noise outlines near to Airport Bourgas in LAeq, dB(A), 8 hours (22.00-06.00 h), for an busy summer night (outside line correspond to LAeq = 50 dB(A))*

RESULTS AND DISCUSSION

So far, airport noise levels have not been monitored regularly. Using a simulation model we outlined the areas directly affected by aircraft noise created during takeoffs and landings on Bourgas airport (17) to estimate aircraft noise in studied areas in the daytime (Figure 1) and at night (Figure 2). According to that model, approximately 29 % and 38 % of the population living in the districts close to the airport were exposed to the aircraft noise above the Bulgarian Leq (energy equivalent noise level) limits [daytime - Leq<60 dB(A); night - Leq<50 dB(A)] in the summer and winter, respectively. Sonic discomfort affects relatively more people at night than during the day. An investigation of basic vegetative functions under exposure to noise during sleep has shown significant deviations in the pulse, blood pressure, and electroencephalography (18, 19).

The prevalence and the incidence of diseases in respective age groups were higher in populations

from the areas exposed to aircraft noise than in the town centre. The total morbidity level in areas closest to the airport was more than twice as high as in the town centre and apparently the less noisy Slaveykov housing estate area.

The results for the basic classes of diseases are presented in Table 1. Naturally, diseases in populations living close to airports which, according to literature, might have an aetiology in aircraft noise, are of paramount interest. Psychic disorders, neuroses,

Table 1 *Diseases recorded in children and adults living close to the Bourgas airport in comparison to the "control" population in the town centre (1997-1999)*

Diseases	Number of ICD*	Average per 1,000 people			
		0-17	P**	18+	P**
Total	**001-999**				
Sarafovo, Izgrev, Zornitsa		3613.00	<0,001	1376.56	<0.001
Slaveykov		1437.57	0.007	637.90	<0.001
Centre		1327.52		569.49	
Infectious and Parasitic Diseases	**011-139**				
Sarafovo, Izgrev, Zornitsa		750.00	<0.001	62.44	<0.001
Slaveykov		233.96	<0.001	20.87	<0.05
Centre		59.41		8.21	
Neoplasms	**140-239**				
Sarafovo, Izgrev, Zornitsa		0.76	0.75263	3.69	0.2395
Slaveykov		0.26	0.63235	1.76	0.2623
Centre		0.52		2.65	
Diseases of the Endocrine Glands, Nutrition, Metabolism, etc.	**240-279**				
Sarafovo, Izgrev, Zornitsa		6.82	<0.001	62.82	<0.05
Slaveykov		0.77	0.96864	20.77	<0.05
Centre		0.63		15.66	
Blood and Blood Organs' Diseases	**280-289**				
Sarafovo, Izgrev, Zornitsa		4.17	0.14	3.09	0.133
Slaveykov		1.03	0.0788	3.81	<0.05
Centre		1.15		1.80	
Mental Disorders	**290-319**				
Sarafovo, Izgrev, Zornitsa		11.11	<0.05	31.76	<0.05
Slaveykov		1.55	0.52115	19.94	0.4061
Centre		2.09		22.41	
Neuroses and Personality Disorders	**300-301**				
Sarafovo, Izgrev, Zornitsa		31.94	<0.001	90.12	<0.05
Slaveykov		1.55	0.48143	19.65	0.4684
Centre		2.09		22.03	
Diseases of the Nervous System and the Sense Organs	**320-389**				
Sarafovo, Izgrev, Zornitsa		169.04	<0.05	21.261	<0.05
Slaveykov		57.79	<0.05	79.65	<0.05
Centre		96.78		154.94	
Diseases of the Blood Circulatory Organs	**390-450**				
Sarafovo, Izgrev, Zornitsa		9.97	0.13	103.45	<0.05
Slaveykov		2.71	0.3025	91.63	<0.05
Centre		4.90		65.45	

Diseases	Number of ICD*	Average per 1,000 people			
		0-17	P**	18+	P**
Myocardial Infarction	**401-405**				
Sarafovo, Izgrev, Zornitsa		2.40	0.60375	71.72	<0.05
Slaveykov		1.55	0.08729	62.88	<0.05
Centre		2.91		45.66	
Cerebro-vascular Disease	**437**				
Sarafovo, Izgrev, Zornitsa		0.63	0.31220	4.96	0.15
Slaveykov		0.26	0.77175	4.68	0.10011
Centre		0.21		3.03	
Diseases of the Respiratory System	**460-519**				
Sarafovo, Izgrev, Zornitsa		1677.2	<0.05	219.54	<0.05
Slaveykov		962.04	<0.05	219.00	<0.05
Centre		1064.21		137.65	
Diseases of the Digestive System	**520-579**				
Sarafovo, Izgrev, Zornitsa		159.95	<0.001	68.52	<0.005
Slaveykov		61.85	<0.005	62.95	<0.005
Centre		29.86		24.03	
Gastric and Duodenal Ulcer	**531-533**				
Sarafovo, Izgrev, Zornitsa		5.18	<0.001	7.32	<0.005
Slaveykov		0.39	0.77823	3.81	0.13948
Centre		0.42		3.08	
Diseases of Genitourinary System	**580-629**				
Sarafovo, Izgrev, Zornitsa		38.76	<0.005	62.93	<0.005
Slaveykov		11.75	0.3208	34.15	0.16
Centre		15.76		39.17	
Complications of Pregnancy, Childbirth and after Childbirth Period	680-709				
Sarafovo, Izgrev, Zornitsa		0.63	0.31220	4.04	0.60515
Slaveykov		0.13	0.85370	5.65	0.68
Centre		0.21		3.75	
Diseases of the Skin and Hypodermic Tissue	**680-709**				
Sarafovo, Izgrev, Zornitsa		154.40	<0.001	61.66	<0.001
Slaveykov		68.95	<0.005	19.97	<0.005
Centre		36.33		9.78	
Diseases of Bone-Muscular System	**740-759**				
Sarafovo, Izgrev, Zornitsa		17.93	<0.001	63.60	<0.001
Slaveykov		1.94	0.1250	25.73	0.2931
Centre		0.52		3.61	
Inborn Anomalies	**740-759**				
Sarafovo, Izgrev, Zornitsa		4.80	<0.005	0.35	0.4405
Slaveykov		0.13	0.33169	0.07	0.81188
Centre		0.52		0.08	
Diseases	**Number of ICD***	**Average per 1,000 people**			
		0-17	**P****	**18+**	**P****
Traumata and Intoxications	**800-999**				
Sarafovo, Izgrev, Zornitsa		593.61	<0.001	413.50	<0.001
Slaveykov		29.18	<0.005	31.49	<0.005
Centre		11.80		52.53	

**ICD – International Classification of Diseases (Revision IX)*
***P value is calculated toward "Centre"*

diseases of the nervous system and sense organs have been reported to be in positive dependence with the stress-producing influence of aircraft noise. and the degree of involvement correlates with the intensity and the duration of exposure (2, 3, 10, 11). The results given in the Table 1 show that the morbidity rates in populations from the district of Sarafovo and housing estates of Izgrev and Zornitsa were significantly higher than in the population from the town centre. This finding is also true for adults from the Slaveykov housing estate. The latter could be explained with a combination of aggravating effects of different factors such as occupational environment in working population or concomitant diseases in retired population.

In some classes of diseases such as "traumas and intoxications", "diseases of the skin and subcutaneous tissue" or "diseases of the genitourinary system" a direct connection between higher morbidity rate and aircraft noise can hardly be established. Most results are likely to reflect a combined influence of different adverse factors from the natural and social environment and may partly be connected with differences in the level and quality of health services provided to people from different districts included in this study. However, this does not undermine the implications of higher morbidity in populations living in the closest vicinity of the airport. On the other hand, it is well known that noise and infrasound as a non-specific biological stressor can influence the entire body via both the autonomic nervous system and the neuroendocrine system (15, 20). Higher morbidity of "diseases of the endocrine glands, nutrition, metabolism", "diseases of the respiratory system", "diseases of the digestive system" may therefore be partly connected with the adverse health effects of exposure to noise.

In conclusion, we think that our observations indicate that higher morbidity rates in populations from areas located in the closest vicinity to the Bourgas airport (Sarafovo, Izgrev, Zornitsa and partly Slaveykov) may partly be associated with the exposure to aircraft noise. However, the evaluation of the obtained results should take into consideration other factors which could not be sufficiently controlled in our study. We think that it is necessary to apply a combination of preventive measures to improve the acoustic environment of people living near the airport and to organise continued health monitoring of exposed populations using more selective methods.

REFERENCES

1. Fidell S, Silvati L, Haboly E. Social survey of community response to a step change in aircraft noise exposure. J Acoust Soc Am 2002;111:200-9.
2. Haines MM, Stansfeld SA, Brentnall S, Head J, Berry B, Jiggins M, Hygge S. The West London Schools Study: the effects of chronic aircraft noise exposure on child health. Psychol Med 2001;31:1385-96.
3. Kressin J. Aviation medicine problems in otorhinolaryngology. Z Arztl Fortbild Qualitatssich 1999;93:509-12.
4. Smith A, Holmsen E. Public health work in connection with a new international airport. Tidsskr Nor Laegeforen 1998;118:3656-8.
5. Hatfield J, Job RF, Hede AJ, Carter NL, Peploe P, Taylor R, Morrell S. Human response to environmental noise: the role of perceived control. Int J Behav Med 2002;9: 341-59.
6. Hygge S, Evans GW, Bullinger M. A prospective study of some effects of aircraft noise on cognitive performance in schoolchildren. Psychol Sci 2002;13:469-74.
7. Haines MM, Stansfeld SA, Head J, Job RF. Multilevel modelling of aircraft noise on performance tests in schools around Heathrow Airport London. J Epidemiol Community Health 2002;56:139-44.
8. Rosenlund M, Berglind N, Pershagen G, Jarup L, Bluhm G. Increased prevalence of hypertension in a population exposed to aircraft noise. Occup Environ Med 2001;58:769-73.
9. Shimizu T, Makishima K, Yoshida M, Yamagishi H. Effect of background noise on perception of English speech for Japanese listeners. Auris Nasus Larynx. 2002;29:121-5.
10. Stansfeld S, Haines M, Brown B. Noise and health in the urban environment. Rev Environ Health 2000;15: 43-82.
11. Hattori M. A field study of health effects of aircraft noise in adults around Komatsu Air Base (1998). Nippon Koshu Eisei Zasshi 2000;47:20-31.
12. Miyakita T, Yoza T, Matsui T, Ito A, Hiramatsu K, Osada Y, Yamamoto T. An epidemiological study regarding the hearing acuity of residents in the area with high level of aircraft noise: results of hearing tests conducted in the vicinity of Kadena Air Base. Nippon Eiseigaku Zasshi 2001;56:577-87.
13. Haines MM, Stansfeld SA, Job RF, Berglund B, Head J. A follow-up study of effects of chronic aircraft noise exposure on child stress responses and cognition. Int J Epidemiol 2001;30:839-45.
14. Buckland E. Transport noise stresses sick babies. Australian Nursing Journal, 2001;9:41.
15. Nikolaeva D, Paunov I. Infrazvuk. V: Infrazvuk, ultrazvuk, shum i vibrasii. Infrasound. In: Tzvetkov D, Angelova M, editors. Infrasound, ultrasound, noise and vibations. [in Bulgarian]. Sofia: Medicina i Fizkultura Publisher; 1995. p. 11-43.

16. Fidell S, Pearsons K, Silvati L, Sneddon M. Relationship between low-frequency aircraft noise and annoyance due to rattle. J Acoust Soc Am 2002;111:1743-50.
17. Velev V, Geogieva R, Dimitrova, R, Dimitrov D, Naidenova V, Nehrizov G, Petkov T, Petrov M, Staykovaistova R. Airport of Bourgas. Ecological analysis (Report for Barents Group) in Bulgarian; 2002.
18. Carter N, Henderson R, Lal S, Hart M, Booth S, Hunyor S. Cardiovascular and autonomic response to environmental noise during sleep in night shift workers. Sleep 2002;25:457-64.
19. Raschke F. Arousal caused by aircraft noise - environmentally-induced adverse sleep and health effects from the sleep medicine viewpoint. Schriftenr Ver Wasser Boden Lufthyg 2001;111:56-69.
20. Morell S, Taylor R, Lyle D. A review of health effects of aircraft noise. Aust N Z J Publ Health 1997;21:221-36.

Sažetak

OCJENA ZDRAVSTVENOG STANJA STANOVNIKA U NEPOSREDNOJ BLIZINI AERODROMA BOURGAS U BUGARSKOJ

U razdoblju od 3 godine (1997 – 1999) analiziran je morbiditet u djece (0 - 17 godina) i u odraslih (18 god. i više) u naseljima Sarafovo, Izgrev, Zornica koja se nalaze u blizini zračne luke Bourgas. Grad Bourgas važan je turistički centar Bugarske. U ispitivanje su uključeni i stanovnici naselja Slaveykov koje je udaljeno oko 5 km od završetka aerodromske piste ili se nalazi u smjeru slijetanja – uzlijetanja aviona. Morbiditet je u tim dijelovima grada Bourgasa uspoređen s morbiditetom centra grada koji je izvan dometa buke proizvedene avionskim prometom.
Podaci o morbiditetu dobiveni su iz rutinske zdravstvene statistike koja se temelji na evidencijama u poliklinikama u kojima se provodi izvanbolnička zdravstvena zaštita pučanstva. Za djecu su podaci prikazani kao ukupni zbroj bolesti registriranih u navedenome trogodišnjem razdoblju, a za odrasle kao godišnja incidencija bolesti. Rezultati su pokazali da je i u djece i u odraslih prevalencija odnosno incidencija bolesti bila veća u naseljima blizu zračne luke u usporedbi s onima koji žive u centru grada Bourgasa. Evidentirane razlike u pojedinim skupinama bolesti, poput bolesti živčanog sustava, bolesti osjetnih organa, mentalnih poremećaja, bolesti cirkulacije – posebno arterijske hipertenzije te bolesti probavnih organa mogle bi se dijelom povezati sa štetnim učincima buke uzrokovane avionskim prometom. Ali i u vezi s tim bolestima, kao i nekim drugim koje su bile češće u stanovnika naselja u blizini zračne luke, a u učestalosti kojih se ne može pretpostaviti uloga izloženosti buci, upozorava se na to da su očito u igri i drugi čimbenici koji u provedenom ispitivanju nisu dovoljno uzeti u obzir odnosno nisu bili kontrolirani.
U zaključku se ističe da, uza sva ograničenja koja se moraju uzeti u obzir pri interpretiranju prikazanih podataka i razlika u morbiditetu uspoređenih skupina stanovnika u Bourgasu, ne treba podcijeniti štetne učinke buke na zdravlje. Uz mjere usmjerene na učinkovitiju kontrolu aerodromske buke potrebno je provoditi zdravstveni nadzor potencijalno ugroženih stanovnika, ali uz korištenje selektivnijih metoda.

KLJUČNE RIJEČI: *aerodromska buka, incidencija bolesti, prevalencija bolesti*

REQUESTS FOR REPRINTS:

Tanya Turnovska, MD, PhD
Lozengrad str 24, 4000 Plovdiv
Bulgaria
E-mail: *turnovt@yahoo.com*