Effects of transport noise and vibration on the population

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The action of transport noise on residents leads to changes in the functional state of the central nervous and cardiovascular systems. With the combined action of noise and vibration, the changes are more pronounced.

Environmental factors (noise and vibration) produced by urbanisation are to a large extent responsible for the harmful shifts in the state of health of the urban population [2].

The main sources of the high levels of noise and vibration in residential buildings are: motor transport, shallow cut underground railways and tram systems. The action of noise and vibration from these sources affects the population throughout the day and night [4].

A study of the effect of 36 natural and anthropogenic environmental factors on the morbidity of the population has shown that the most significant factors are atmospheric pollution and transport noise and vibration. A subjective assessment by the population of the degree of effect of the principal factors on overall comfort led to a ranking of these factors in terms of their significance. Noise was put in the fifth and vibration in the sixth place among the 10 factors considered. This indicates their significant role in the formation of unfavourable living conditions in residential homes [3].

Up until now, the hygiene regulation of noise and vibration under everyday conditions has been carried out separately, although their combined effect on the population under residential living conditions is obvious.

The aim of the work described here was to study the changes in the functional state of the central nervous and cardiovascular systems of humans under the systematic effect of noise and vibration under everyday conditions.

The studies were carried out in the Belarus Scientific Research Sanitary-Hygiene Institute over a number of years so that it was possible to investigate the special features and the dynamics of the noise-vibration exposure on the residents from such sources as a shallow cut underground railway and tram system and motor transport.

Material and methods

In order to study the subjective assessment by the population of the noise and vibration produced by shallow cut underground railway and tram system, we used a questionnaire survey in 50 multi-storey residential buildings in Minsk.

In the buildings, which were situated near underground railway lines, tram lines or motor transport highways, we studied two groups of women aged 21-40 years living under different noise and vibration exposure conditions. Of these, 60 were living in the experimental region and 60 in a control region. The study of the functional state of the central nervous and cardiovascular systems of the residents was carried out throughout the day.

In the experimental region the population was subject to the action of vibration created by the underground railway and the tram system and also noise generated by motor transport. The corrected vibration acceleration level in the residential buildings was as high as 40 dB and exceeded the permissible level for daylight hours by 10 dB. The equivalent sound level reached 55dBA and exceeded the permissible level for daylight hours by 10dBA.

In the control region the residents were subject only to motor transport noise with an equivalent level of 55dBA, which exceeded the permissible level for daylight hours by- 10 dBA. The corrected level of vibration acceleration in the living accommodation was 16-18 dB and did not exceed the night-time permissible level of 20 dB.

The people included in the groups were not connected in terms of their activity with the action of industrial vibration or noise.

The study of the functional state of the central nervous system was made by recording the latent period of the simple visual-motor reaction (VMR) and acousto-motor reaction (AMR) by the chronoreflexometry method, determining the critical light flicker frequency (CLFF), and studying the attention and mental working capacity by means of modified Platonov tables.

The functional state of the cardiovascular system was assessed by measuring the arterial pressure, the heart rhythm frequency and by means of variational pulsometry. In order to reveal the compensatory possibilities of the cardiovascular system and to identify any hidden insufficiency in the working of the system we used a functional load in the form of the martin test [3]. The physiological parameters were studied at the place of residence for each person observed.

Results

The questionnaire data showed that underground railway vibration, propagating into the living rooms of the buildings causes disturbance in a large number of residents 43% compared with 32.4% for vibration generated by the tramway.

The noise created by the underground railway causes disturbance in 27% of the residents and that by the tram system in 74% of the total number of those interviewed.

A deterioration of the living conditions in apartments as a result of vibration from the railway was noted by 48.2% of those questioned; for the tram system, the figure was 36.5%.

Vibration from the railway and tram system had almost the same disturbing effect on all those questioned, irrespective of the nature of the activity.

In all the age-gender groups, women noted the disturbing effect of vibration from the given sources more than men.

The structure of complaints from the population about sleep disturbance was approximately the same in those living along the railway and those near the tram lines.

An analysis of the complaints showed that the least tolerant of the exposure to vibration and noise were people with diseases of the nervous and cardiovascular systems, the gastrointestinal tract and the organs of hearing. The number of complaints form these were a factor of 2.0 higher ($p < 0.01$) than in the group of people without these diseases.

As a function of the time of day, the vibration and noise are most disturbing in the morning (37.6% of residents), in the evening (30.9%) and at night (27.6%).

Changes can be observed during the day in a number of physiological parameters compared with the morning data, and by the evening these reach statistically significant differences after 10-12 h of exposure of the residents to vibration and noise.

In the experimental region we noted an increase in the light signal perception frequency whereas in the control this parameter changed only by an insignificant amount. The CLFF in the experimental region was significantly ($p < 0.001$) higher (by 6.4 Hz) than in the control.

During the day the latent VMR and AMR times increase and achieve statistically significant differences ($p < 0.001$) by the evening. In the experimental region the VMR time increased by 16.7 ms and the AMR by 16.3 ms; in the control group the results were 8.8 and 9.3 ms respectively.

A more significant increase in the latent VMR and AMR times was obtained in the experimental region for the 21-30 years age group by 19 and 17.4 ms respectively compared with the 31-40 age group, in which the increase in the reaction time was less significant. In the control group these shifts were less pronounced and the increase in reaction time did not exceed the 9-11 ms range.

In the experimental region the VMR and AMR times are significantly higher ($p < 0.001$), by 8.4 and 7.3 ms respectively, than in the control region.

The reduction in the activity of the central nervous system among the residents was more pronounced under the action of vibration and noise in the evening hours. The time for carrying out a correct test in the experimental region in residents of 21-30 years increased significantly ($p < 0.001$), by 25.3 s; for residents aged 31-40, the increase was 22 s. In the control region this increase in the time for carrying out the test did not exceed 12-13 s for either age group.

The differences in the time for carrying out the test as a whole over the sample among the residents of the experimental and control regions were of a significant nature ($p < 0.001$).

The number of errors made by the residents of the experimental region was a factor of 2.1 times greater ($p < 0.05$) than in the control region for residents aged 21-30 and a factor of 2.6 times greater for residents of 31-40 years although the differences were not statistically significant.

Dynamic observations in the study of the functional state of the cardiovascular system of the residents showed that the heart contraction rate (HCR) as a whole over the group increased significantly ($p < 0.001$) in the evening – in the experimental region by 6.8 per minute and in the control region by 5.1 per minute.

The HCR under exposure to vibration and noise is on the whole over the group significantly higher ($p < 0.01$) in the evening in the experimental region – by 6.6 per minute compared with the control.

The frequency of deviations of the HCR from the norm (tachycardia) in the residents was significantly higher ($p < 0.05$) in the experimental region than in the control region, both as a whole over the group (factor of 3.2) and in the 21 -30 and 31 -40 age groups (factors of 5.0 and 2.5 respectively).

In the experimental region both the maximum and the minimum arterial pressure had a tendency to increase over the day. In the control region the maximum arterial pressure decreased during the day and statistically significant differences ($p < 0.05$) were obtained only in the 31-40 year age group.

An analysis of the results showed that the maximum arterial pressure was significantly ($p < 0.001$) higher

Table 1. Variational pulsometry parameters of the population (21-40 years, n = 120) living under different conditions of noise and vibration

Parameter	Experimental region (vibration + noise)		Control region (noise)	
	Morning	Evening	Morning	Evening
		Background		
Mo, s	0.73±0.02	0.75±0.02	0.76±0.01	0.77±0.01
AMo, %	44.2±1.52	43.7±1.60	40.9±1.37	42.1±1.31
ΔX, s	0.17±0.01	0.19±0.01	0.17±0.01	0.18±0.01
SI, rel. units	230.1±20.3	196.0±18.2	170.0±9.96	167.5±10.4
		Load		
Mo, s	0.54±0.01	0.55±0.01	0.61±0.01	0.60±0.01
AMo, %	32.7±1.25	33.0±1.13	36.0±1.03	37.7±1.12
ΔX, s	0.30±0.02	0.34±0.01	0.20_0.01**	0.21±0.01
SI, rel. units	142.7±14.8	113.4±8.73	164.7±10.2	178.6±10.2
		3 min		
Mo, s	0.77±0.02	0.80±0.02	0.79±0.01	0.78±0.01
AMo, %	37.6±1.70	38.1±1.54	37.6±1.20	39.5±1.58
ΔX, s	0.24±0.0	10.26±0.01	0.20_0.01	0.22±0.01
SI, rel. units	172.7±22.8	141.5±19.2	130.3±7.96	142.2±11.8

*Differences between regions are significant (p < 0.01).

**Differences between regions are significant (p < 0.001)

in residents in the experimental region compared with the control region (7.4 mm Hg st. as a whole over the sample and 5.5 and 9.9 mm Hg st. in the 21-30 and 31-40 age groups).

The mathematical processing of the individual cardiac rhythm characteristics [I] revealed in the residents of the experimental region (especially after a load (Martin test)), a tendency for directed changes in the stress index of the vagotonic type in comparison with the control region (Table 1). This parameter was significantly lower (p < 0.001) (by 65.2 rel. units) in the experimental group as a whole and was lower by 74.7 and 57 rel. units in the 21-30 and 31-40 age groups compared with the control.

As a rule, by the third minute of the recovery period the stress index parameters over the whole group and in the 31-40 age group were approaching the background values. Only in the 21-30 year group did we note a further reduction in the stress index, so that we can talk of a stronger disturbance in the regulation of the cardiovascular system when vibration acts in combination with noise in this age group.

The significant (p < 0.05) change in the parameters of the amplitude of the mode and the variational spread suggests a moderate stress in the system for regulating the cardiac rhythm.

Conclusions

l) Vibration and noise are factors of great hygienic and social significance for the population. Data from a questionnaire of the population living in buildings with high levels of vibration (40 dB) have shown that it disturbs 64-68% of the residents. The population living near motor highways noted a disturbing effect of noise in 76-80% of cases. 2) The action of noise on the residents leads to significant changes in the physiological parameters of the central nervous and cardiovascular systems. Combined exposure of the population to noise and vibration leads to changes in the physiological parameters that are more pronounced than with noise alone. 3) Vibration significantly enhances (on average by a factor of 1.5-2.0 in terms of the changes in the physiological parameters) the harmful effect of noise on the body of the residents under normal living conditions. 4) The magnitude and direction of the physiological shifts in residents under combined exposure to vibration and noise indicate a more pronounced stress on the adaptive reactions of the body compared to exposure to noise alone.

References

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Portland international

In response to residents complaints, officials at Portland International Jetport, Maine, are to begin a study of noise levels and look at ways to reduce the impact of noise from jet engines. “We think it’s appropriate to take some measures to find out what’s going on. It may be that the perception is worse than the reality,” said Jeffrey Monroe, Portland’s transportation director. Night-time noise particularly incenses residents. Airplanes are not supposed to take off or land between midnight and 5.45am at Portland but, increasingly, they do. Airport officials say these late arrivals are beyond their control, the result of an overloaded air traffic control system and increased demand for flights at hub airports in larger cities.

Night flights

Taxpayers could have to provide up to £2 billion in compensation to residents near airports because of a European Court of Human Rights judgment against night flying. The Department of Transport estimates that up to 500,000 people could be eligible for pay-outs, following the Strasbourg decision that the loss of sleep resulting from night-time landings at Heathrow violated residents’ right to “respect for private and family life”. The eight west London householders who brought the case were each awarded £4,000. Officials calculate that if such payments were made to all residents within Heathrow’s noise “envelope”, the cost would range form £400 million to £2 billion, depending on the decibel level used for the compensation threshold. The decision is being appealled by the Government.

Variable compensation

American states vary a great deal in terms of how they compensate and handle workers’ compensation claims for occupational hearing loss, according to a survey of workers’ compensation authorities. For instance, when a worker is found to have wilfully disregarded a requirement to wear hearing protection, about 40 per cent of the states either deny the claim altogether, or reduce the payout. The level of awards also depends on the state and range from as little as $9000 to as much as $150,000 over and above replacement of lost earnings. The statute of limitations for filing claims, meanwhile, can be anything from 30 days to up to five years. Some states date the injury to “last date exposed” to the noise, while others work from when the employee became aware of hearing damage/loss.