

¹. Meena LAAD

THE STUDY OF THE EFFECT OF SOUNDS OF CONSTANT FREQUENCY AND VARYING INTENSITY LEVELS ON SYSTOLIC BLOOD PRESSURE, DIASTOLIC BLOOD PRESSURE AND HEART RATE OF HEALTHY INDIVIDUALS

¹. DEPARTMENT OF PHYSICS, SYMBIOSIS INSTITUTE OF TECHNOLOGY, SYMBIOSIS INTERNATIONAL UNIVERSITY, PUNE, INDIA

ABSTRACT: The word noise is defined as unwanted sound, a potential hazard to health and communication dumped into the environment with regard to the adverse effect it may have on unwilling ears. The unwanted sounds at various intensity levels can cause annoyance and aggression, hypertension, high stress levels, hearing loss, sleep disturbances, and other harmful effects. One hundred individuals were selected for present study. The subjects selected were between the age group 20 to 30 years with normal blood pressure and heart rate. The normal blood pressure in this study was considered as 100-125 mm of Hg (Systolic) and 60-90 mm of Hg (Diastolic) and normal heart rate as 60-90 beats per minute. First the sound of frequency 3500 Hz and intensity levels 30dB was produced for 15 minutes in an isolated sound proof room using a CD player. The blood pressure and heart rates were recorded before the production of sound. Then the source of sound of frequency 3500 Hz and intensity level 30 dB was switched on. The systolic blood pressure, diastolic blood pressure and the heart rate were recorded after 1, 4, 7, and 9 and 13 minutes and after 1 minute when the source of sound was switched off, and then after every 3 minute interval till it came back to normal. The procedure was repeated for the sound of frequency 3500 Hz and intensity level 50 dB and 80 dB. Out of one hundred subjects selected for the study, 53 were male and 47 were female. It was observed that the sound intensity level affects the blood pressure and heart rate at low as well as high intensity levels. When the subjects were exposed to the sound of frequency 3500 Hz and 30 dB intensity levels, systolic blood pressure was found to increase in 56 subjects and decreased in 21 subjects and there was no change in BP or heart rate for 23 subjects. The diastolic pressure was found to increase in 71 subjects, decrease in 12 subjects and there was no effect on 17 subjects. At the sound of frequency 3500 Hz at intensity level 50 dB, 85 out of 100 subjects showed no change in either systolic or diastolic blood pressure. 15 subjects showed less than 5% increase in systolic as well diastolic blood pressure. There was no significant change observed in heart rate. At intensity level 80 dB, 87 subjects out of hundred showed increase in systolic pressure, and 11 subjects showed less than 5% increase in the systolic pressure and there was no effect in case of 2 subjects. Diastolic pressure was found to be increased in 92 subjects, and there was no change observed in case of 8 subjects. Thus sounds at constant frequency but different intensity levels affect the Blood pressure and Heart rate of individuals significantly.

KEYWORDS: blood pressure, effect of sounds, healthy

❖ INTRODUCTION

The word noise is derived from the Latin term 'nausea'. It has been defined as unwanted sound, a potential hazard to health and communication dumped into the environment with regard to the adverse effect it may have on unwilling ears. This unwanted sound can damage physiological and psychological health [1]. Noise pollution can cause annoyance and aggression, hypertension, high stress levels, hearing loss, sleep disturbances, and other harmful effects. The type of noise can influence stress related hormones[2]. The human ear is capable of detecting sound waves with a wide range of frequencies, ranging between approximately 20 Hz to 20 000 Hz. The amount of energy which is transported through a given area of the medium per unit of time is known as the intensity of the sound wave. Since the range of intensities which the human ear can detect is so large, the scale which is frequently used by physicists to measure intensity is a scale based on multiples of 10. The scale used for measuring intensity is called the decibel scale. The threshold of hearing is assigned a sound level of 0 decibels (abbreviated 0 dB); this sound corresponds to an intensity of $1 \cdot 10^{-12}$ W/m². Music is something that can make you relax and enjoy the beats or rhythm, while noise is an unwanted sound that may cause annoyance, and it can disturb us. Researchers observed the process using functional MRI brain scans of human test subjects who had been stressed by an unpleasantly loud noise at different decibel levels that was combined with visual images. Not only loud or sudden noises provoked

a stress response but chronic low-level noise also negatively influenced the brain and behavior [3]. Whether from the road or in the office, the noise at various intensity levels has a subtle yet insidious effect on our health.

❖ MATERIALS AND METHODS

One hundred individuals were selected for the study. The subjects selected were between the age group 20 to 30 years with normal blood pressure and heart rate.

The normal blood pressure in this study was considered as 100-125 mm of Hg (Systolic) and 60-90 mm of Hg (Diastolic) and normal heart rate as 60-90 beats per minute. First the sound of frequency 3500 Hz and intensity levels 30dB was produced for 15 minutes in an isolated sound proof room using a CD player. The blood pressure and heart rates were recorded before the production of sound. Then the source of sound of frequency 3500 Hz and intensity level 30 dB was switched on. The systolic blood pressure, diastolic blood pressure and the heart rate were recorded after 1, 4, 7, and 9 and 13 minutes and after 1 minute when the source of sound is switched off, and then after every 3 minute interval till it came back to normal. The procedure is repeated for the sound of frequency 3500 Hz and intensity level 50 dB and 80 dB.

❖ RESULTS

Out of one hundred subjects selected for the study, 53 were male and 47 were female. It was observed that the sound intensity level affects the blood pressure and heart rate at low as well as high intensity levels. When the subjects were exposed to the sound of frequency 3500 Hz and 30 dB intensity levels, systolic blood pressure was found to increase in 56 subjects and decreased in 21 subjects and there was no change in BP or heart rate for 23 subjects. The diastolic pressure was found to increase in 71 subjects, decrease in 12 subjects and there was no effect on 17 subjects. When the sound of frequency 3500 Hz was produced at intensity level 50 dB, 85 out of 100 subjects showed no change in either systolic or diastolic blood pressure. 15 subjects showed less than 5% increase in systolic as well as diastolic blood pressure. There was no significant change observed in heart rate.

When the sound of frequency 3500 Hz was played at intensity level 80 dB, 87 subjects out of hundred showed increase in systolic pressure, and 11 subjects showed less than 5% increase in the systolic pressure and there was no effect in case of 2 subjects.

Diastolic pressure was found to be increased in 92 subjects, and there was no change observed in case of 8 subjects.

Quantitative analysis of increase in Blood Pressure and Heart Rate

Subjects	Blood Pressure						Heart rate		
	30dB		50 dB		80 dB		30 dB	50 dB	80 dB
	Systolic Blood Pressure	Diastolic Blood Pressure	Systolic Blood Pressure	Diastolic Blood Pressure	Systolic Blood Pressure	Diastolic Blood Pressure			
Maximum increase (male)	11	18	16	19	24	27	20	11	25
Maximum increase (female)	15	27	13	20	26	20	19	10	28
Maximum decrease (male)	13	9	9	12	18	19	5	2	12
Maximum decrease (female)	14	15	7	8	10	9	14	6	19
Average increase (male)	3.263	3.442	2.663	2.213	4.434	4.126	13.45	8.23	14.8
Average increase (female)	4.226	4.694	2.342	2.861	4.994	4.854	10.76	8.94	14.7
Average increase (both sexes)	3.744	4.068	2.502	2.537	4.714	4.49	12.10	8.58	14.8

❖ DISCUSSION & CONCLUSIONS

This research study shows that blood pressure and heart rate are affected by the exposure to the sounds of high intensity level of 80 dB. The heart rate and blood pressure are found to be at higher levels and this rise was observed to be continued even after 4 to 6 minutes even when the source of sound was cut off. It also shows that even at very low sound intensity level i.e. at 30 dB, the blood pressure and heart rate were found to be increased as compared to that at 50dB. The exposure to sounds for long time at very high as well as very low intensity level can cause noise related problems which are high blood pressure, peptic ulcers, cardiovascular deaths, strokes, degradation of the immune system, and impairment of learning.

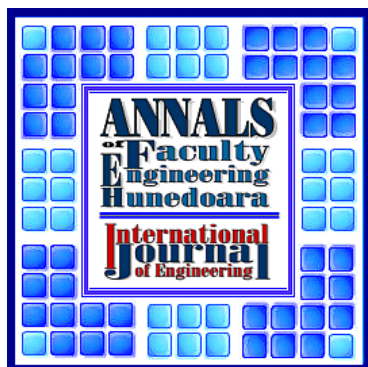
By various researches conducted so far, it is confirmed that sounds of very high frequencies and high intensity levels have both temporary and permanent effects on humans by way of the endocrine

and autonomic nervous systems. It has been postulated that these sounds act as a nonspecific biologic stressor eliciting reactions that prepare the body for a fight or flight response.[5,6,7] For this reason, high intensity sounds can trigger both endocrine and autonomic nervous system responses that affect the cardiovascular system and thus may be a risk factor for cardiovascular disease.[5,6,7,8,9-11] These effects begin to be seen with long-term daily exposure to intensity levels above 65 dB or with acute exposure to levels above 80 to 85 dB.[5,13] Acute exposure to noise activates nervous and hormonal responses, leading to temporary increases in blood pressure, heart rate, and vasoconstriction. Studies of individuals exposed to occupational or environmental noise have shown that exposure of sufficient intensity and duration increases heart rate and peripheral resistance, increases blood pressure, increases blood viscosity and levels of blood lipids, causes shifts in electrolytes, and increases levels of epinephrine, norepinephrine, and cortisol.[13] Sudden unexpected noise evokes reflex responses as well. Cardiovascular disturbances are independent of sleep disturbances; sounds that do not interfere with the sleep of subjects may still provoke autonomic responses and secretion of epinephrine, norepinephrine, and cortisol. [14] These responses suggest that one can never completely get used to night-time high intensity level sounds.

Temporary high intensity sound exposure produces readily reversible physiologic changes. However, noise exposure of sufficient intensity, duration, and unpredictability provokes changes that may not be so readily reversible. The studies that have been done on the effects of environmental noise have shown an association between high intensity sound exposure and subsequent cardiovascular disease.[5,6,7,9-12] Even though the increased risk for noise-induced cardiovascular disease may be small, it assumes public health importance because both the number of people at risk and the noise to which they are exposed continue to increase.[5,6] Children are at risk as well. Children who live in noisy environments have been shown to have elevated blood pressures and elevated levels of stress-induced hormones [6, 15,16].

❖ REFERENCES

- [1.] Darner CL. Sound pulses and the heart. *J Acoust Soc Am.* 1966;39:414–416.
- [2.] De Jung MS, Van Mourik KR, Schellekens HM. A physiological approach to aesthetic preference-music. *Psychotherapy and Psychosomatics.* 1973;22:46–51.
- [3.] Yanagihashi R, Ohira M, Kimura T, Fujiwara T. Physiological and psychological assessment of sound. *Int J Biometeorol.* 1997;40:157–161.
- [4.] Fucci D, Petrosino L, Hallowell B, Andra L, Wilcox C. Magnitude estimation scaling of annoyance in response to rock music: effects of sex and listener's preference. *Percept Mot Skills.* 1997;84:663–670.
- [5.] Berglund B, Lindvall T. (eds.) *Community Noise.* Archives of the Center for Sensory Research. 1995;2:1-195. This document is an updated version of the document published by the World Health Organization in 1995.
- [6.] Babisch W. Noise and Health. *Environ Health Perspect* 2005;113: A14-15.
- [7.] Ising H, Kruppa B. Health effects caused by noise: evidence from the literature from the past 25 years. *Noise Health* 2004;6:5-13.
- [8.] Carlos D. A different route to health: implications of transport policies. *Br Med J* 1999;318:1686-1689.
- [9.] Willich SN, Wegscheider K, Stallmann M, et al. Noise burden and the risk of myocardial infarction. *Eur Heart J* 2006;27:276-282.
- [10.] Van Kempen EEMM, Kruize H, Boshuizen HC, et al. The association between noise exposure and blood pressure and ischemic heart disease: a meta analysis. *Environ Health Perspect* 2002;110:307-317.
- [11.] Bronzaft AL. It takes a silent village to harm a child. Available at: <http://www.lfh.org/hrq/24-1/village.htm> . Accessed October 10, 2006.
- [12.] Konenci VJ. The mediation of aggressive behavior. Arousal level versus anger and cognitive labeling. *J Person Soc Psychol* 1975;32:706-712.
- [13.] American Academy of Pediatrics, Committee on Environmental Health. *Handbook of Pediatric Environmental Health*, 2nd ed. Washington, DC, American Academy of Pediatrics, 2003, pp 311-321.
- [14.] Axelsson A, Jerson T. Noisy toys: A possible source of sensorineural hearing loss. *Pediatrics* 1985;76: 574-578.
- [15.] Carlos D. A different route to health: implications of transport policies. *Br Med J* 1999;318:1686-1689.
- [16.] *Healthy People 2000: National Health Promotion and Disease Prevention Objectives.* U.S. Department of Health and Human Services. Public Health Service. Washington, DC, 1990.



ANNALS OF FACULTY ENGINEERING HUNEDOARA
 – INTERNATIONAL JOURNAL OF ENGINEERING
 copyright © University Politehnica Timisoara,
 Faculty of Engineering Hunedoara,
 5, Revolutiei, 331128, Hunedoara,
 ROMANIA
<http://annals.fih.upt.ro>