OVIDIUS UNIVERSITY CONSTANTA
DOCTORAL SCHOOL OF THE FACULTY OF MEDICINE

NOISE EFFECTS STUDY ON HUMAN BODY

-THESIS ABSTRACT-

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Constanta
2013

Content

Keywords

Cortisol, triglycerides, hearing loss, acoustic trauma, glucose, audiometer, noise, sound, body

Introduction

Along with the picture, sound is one of the most important carrier of information not only for us but for a lot of other creatures that inhabit the earth. Furthermore, we use sound to calculate distances for communication or control the masses. We went flying speed of, with our equipment, we have composed symphonies to harmonize with the universe and we sent it into space for other civilizations to communicate them our message of peace.

The sounds are probably the oldest memories of people. Without them there would be no communication and no music. We produce them from ancient times, and the first complex devices and artificial reproduction of sounds are musical instruments.

Archaeologists have discovered wind instruments from animal bones that date back more than 50,000 years.

In today's world we are constantly bombarded by sound. Many of the sounds are pleasant, but unfortunately there are times when sounds become noises.

The reason that there are differences in the perception of noise is that some people are more sensitive than others.

But we all agree that noise is an unwanted sound; in specific terms, a loud noise is a sound that can cause hearing loss.

For people who have a hearing loss, noise is a particular problem because of their ability to understand the speech in noisy environments is very limited.

In addition, there is a problem that some hearing aids amplify not only the speech, but also noise, making the speech difficult in noisy environments.

To reduce the number of people with hearing loss caused by exposure to noise at work, most countries have adopted a set of rules limiting the daily noise exposure of workers in the working environment at 85 dB.

It is based on noise intensity and time of exposure to noise. The noise intensity is higher the shorter is the time that enabled workers to work in that environment.

Applying the same criteria to other sources of noise that would expose a person to a concert at 110 dB, the risk of permanent hearing loss occurs only after a few minutes.

The best thing we can do for our hearing is, of course, to avoid excess noise. Perhaps it is hard but there are some important steps that we must follow.

In general, we should know the potential sources of noise and move towards to a healthy sound environment. We can also listen our ears.

If loud sounds are annoying or troublesome, our ears tell us that these sounds could

cause damages. Such acts the warning system of the body.

Unfortunately, our ears ability to warn us at high and dangerous levels may be reduced, for example when we drink alcohol.

To use hearing protection equipment is a great solution when we are in noisy environments.

There are a wide variety of products that are used to stop the sound. At music festivals, concerts or clubs where the sound is uncomfortably loud is a good idea to wear earplugs because they can provide significant protection.

If one's hearing ability starts to weak, measure should be taken as soon as possible to optimize the communication and quality of life.

While some of the symptoms of hearing loss can be treated medically or surgically, hearing loss caused by noise exposure can be treated with hearing aids.

This study is structured in two parts, one special and general part.

The first study contains the variations of the biochemical parameters commonly used in medical practice, when a biological organism is subjected to sound stress.

The second study is the degree of hearing impaired population, and the third study is a practical correlation between the first two studies, which is sounding the alarm over damages to the body by exposure to noise.

Each one of the three studies, and the entire research was subdivided into: introduction, working hypothesis, materials and methods, results, discussion, conclusions, and selective bibliography.

The results of research were used by publishing in journals from the country and abroad, but also by presenting them at the national congress of otolaryngology with international participation, held in Oradea, this summer.

I wish to thank to the management and staff of companies SC. Clarfon. S.A., SC. IOWEMED S.A. and Provita 2000 from Constanta for their professionalism, understanding and support that they have showed for this scientifically study.

However, I wish to thank my colleagues from the University Ovidius Constanta for the advice and help in solving encountered problems during the implementation of the thesis.

Finally, I wish to thank Prof. Dr. Gheorghe Ionel Comsa, scientific leader of the thesis for the permanent, competent and valuable guidance that I received during the four years that I realized this thesis.

RESULTS

In this large study, we started from the idea that in addition to affecting the acoustic-vestibular apparatus, voluntary or involuntary subjection to stress sound source, produces an impairment of the whole body.

There are literature articles that noise is producing pathological changes in the cardiovascular, renal, endocrine, nervous, but there are little data's about how and why these changes occur.

However, there are small information about the digestive system damages in people who work under pressure noise.

This broad and complex research aims to be "an intermediate path" between previous research and future research that will follow, and also to open up new ideas and discussion of the danger to which we are exposed every day without recognizing.

Being a complex research, we divided it into 3 themes:

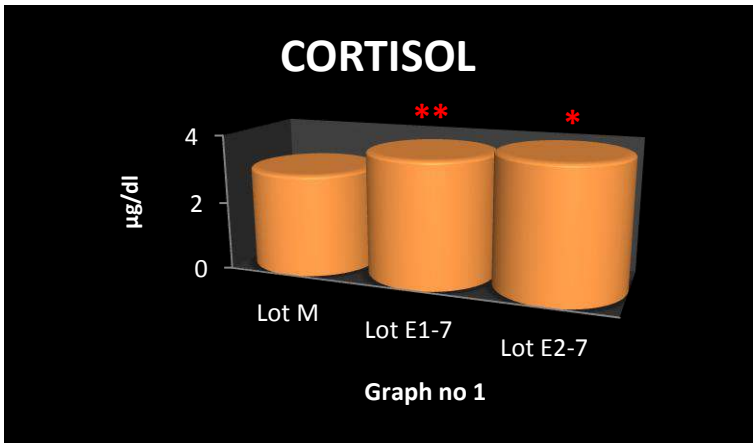
1. A controlled study on experimental animals which have been stressed to sound in an isolated environment with no other factors that could affect the research
2. A blinded study that was conducted as statistical study to see the percentage of impaired hearing among population, study that has spanned for a period of 12 months
3. A final study, designed to combine the first two studies that provide an insight into the degree of professional involvement of people working in sound polluted environment

Sounds surround us from ancient times, and thus subjecting to noise is present since the beginning of civilized life.

But, moving into urban and technological development, overlook serious damage to the body caused by urban noise (and not only), noise can cause or precipitate a pathological condition.

In the first study, test animals were subjected to sound one hour and two hours for a week. There were two groups that were subjected to a single exposure, for one hour, and a single exposure for 2 hours. Exposures were made of 3 in 3 minutes, to avoid biological organisms to adapt to the auditory source stress.

The effects of exposure to sound stress, hormone level is observed by affecting the hypothalamic-pituitary axis port, which by prolonged stimulation, produce negative effects on the body.

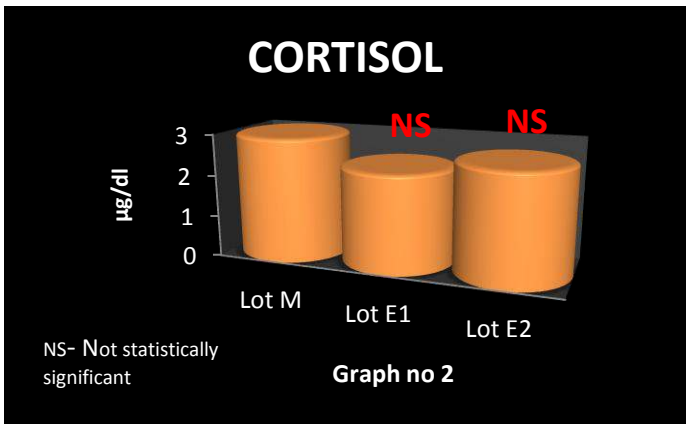


Graph no 1. Statistical variation in serum cortisol levels after one hour of exposure to noise daily for 7 days, compared with the values obtained after 2 hours of exposure to noise per day for 7 days

Such an effect is illustrated by modified serum cortisol secretion in subjects who were subjected to stimulation, to long term sound stress. This is shown in the chart no. 1. This graph represents the change in serum cortisol, because of the action of an acoustic stimulus driven for one hour over 7 days ($p \leq 0.01$).

Exposure to the stress sound, act for 2 hours for 7 days producing the same changes in the level of serum cortisol ($p \leq 0.05$)

Compared to these two changes in values, changes statistically significant, shows that the subjects were subjected to a harmful factor, factor by maintaining prolonged chronic exceeds the body's ability to adapt to stress, and can cause pathological events .



Graph no 2. Statistical variation in serum cortisol levels after a single exposure to noise for one hour, as compared with the values obtained by a single exposure to noise for 2 h

Chart no. 2 shows the results of serum cortisol levels after a single exposure to auditory stimulus to a group of subjects for one hour, and for the second batch, for 2 hours. By this, I tried to highlight changes in the acute phase serum cortisol, at the sound stress action.

The results are statistically insignificant, because of the acute changes that occur, produced by sympathetic-adrenergic stimulation (changes that are characteristic of the acute stress) and adrenal system involvement, as evidenced by elevated serum cortisol (chart. 1), is characteristic of the chronic phase of stimulation ..

Stimulation of the hypothalamic-pituitary axis port, stimulating both acute and chronic, is producing changes throughout the body.

Impaired hypothalamic-pituitary axis port can cause changes on liver enzymes. Changed enzyme produced by the liver tissue, are both produced by the action of short duration of the stimulus (a single exposure period of one hour to two hours), and long term, by the action of the stimulus (for 7 days).

Liver parenchyma start, in the acute phase to show signs of damage, signs evidenced by increases in serum transaminases, increases statistically significant ($p \leq 0.001$), as revealed in the chart no 3.

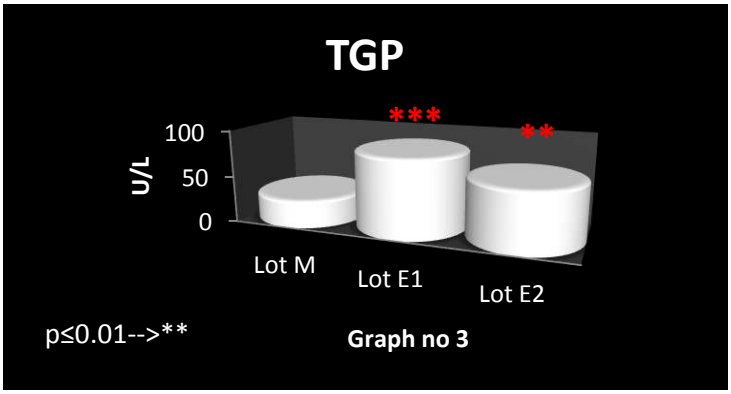


Chart no 3 TGP statistical variation values after a single exposure to noise for one hour, as compared with the values obtained by a single exposure to noise, for 2 h

Under conditions of chronic stimulation in the study for a period of 7 days, changes in transaminases secretion remains present. This can be seen in the chart no 4. Changes are statistically representative ($p \leq 0.01$).

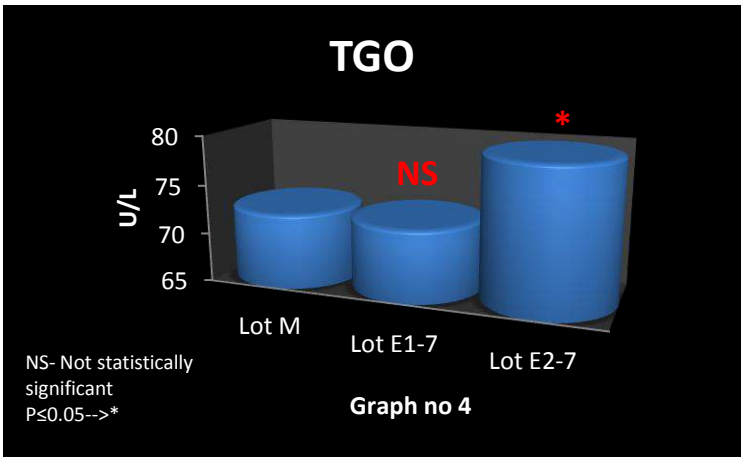


Chart no 4. GOT statistical variation after one hour of exposure to noise daily for 7 days, compared with the values obtained after 2 hours of exposure to noise per day for 7 days

All these data, together, summarizes that, from the beginning, in terms of exposure to a sound stimulus, changes occur in the liver, and are maintained throughout the stimulus actions.

This suffering that occurs in the liver, is met in the study number 3 where we considered after analyzing safety sheets, 82 people who met the selection criteria.

In terms of the variation of serum transaminases, in the case of employees with mild hearing loss, it is observed that 27% of those employed, transaminases average values remains in the normal range, and 73% of employees averages of serum transaminases appears slightly modified (chart number 5).

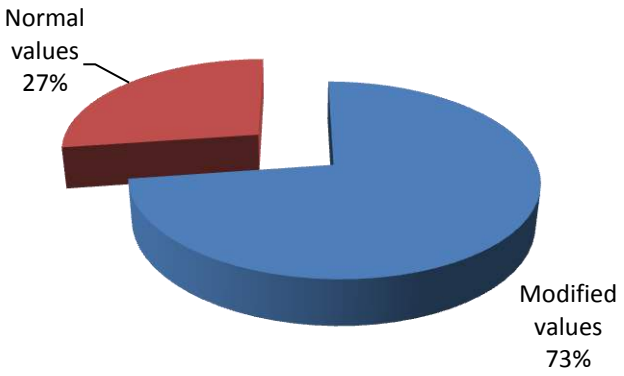


Chart no 5 Graphical representation of the ratio changes of serum transaminases in patients with mild hearing loss

This slight increase in mean serum transaminases, finds out at the employees who are no longer worker in the sound environment.

Mild hearing loss was found in a proportion of 25% of the patients analyzed, and the remaining patients analyzed had other hearing loss, 300 patients had an average hearing loss (45%), 132 the severe hearing loss (10%) and 67 patient the profound hearing loss (30%). (chart. 6)

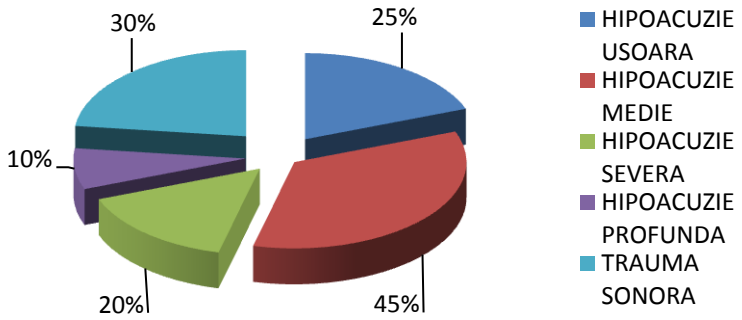


Chart 6 Distribution in percentage of patients tested for hearing problems

Cardiovascular impairment begins to be observed in people with mild hearing loss, where eight people show a slight increase in heart rate, and only 3 people show normal levels of it.

From the point of view of the average values of blood pressure, 7 persons showed a slight increase compared with 4 people who have normal blood pressure.

Graph number 7 shows that this slight modification of cardiovascular activity is found in people who do not work in sound polluted environment, but still has slight hearing loss, audiometric highlighted.

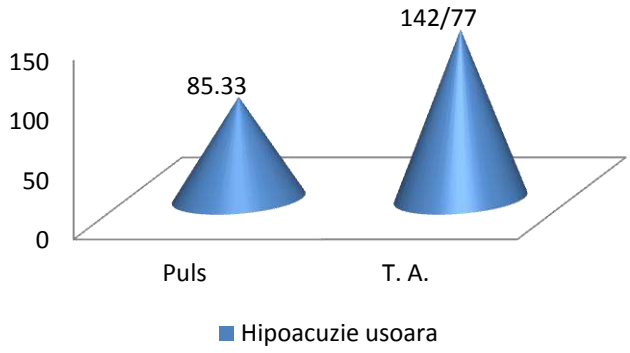


Chart no 7 Graphical representation of the average values of blood pressure and pulse fired employees diagnosed with mild hearing loss

If the average hearing loss, occurring in 45% of patients tested at 12 months, the change in serum transaminase level is about 80% compared with 20% of the workers, who have normal levels of serum transaminases.

Heart rate values are changed to 7 people, and from 3 individuals are normal in the case of individuals with hearing loss medium, and the blood pressure is increased to 8 people, 2 people compared to blood pressure values are present in the range of normal values. (chart no. 8)

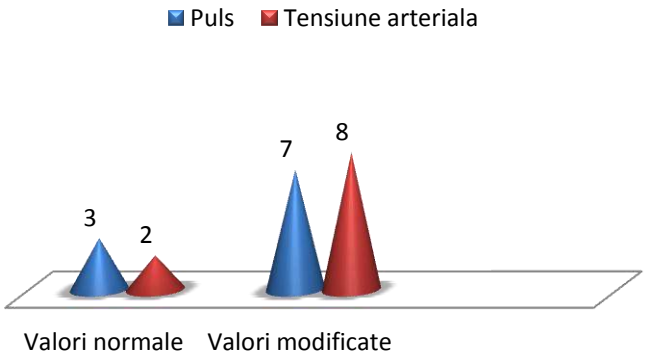


Chart no 8 Graphical representation of the ratio changes in blood pressure and pulse rate in patients with average hearing loss

Blood pressure and pulse has a 2% increase in people who have worked in sound polluted environment, and at the last audiometric testing was found to have a mean hearing loss.

Conversely, people who are still working in sound polluted environment, has the altered serum transaminases in 93% of cases, and in case of blood pressure 14 people in 15 shows elevated.

Profound hearing loss (chart. 9) was discovered in a 30% of the audiometric test

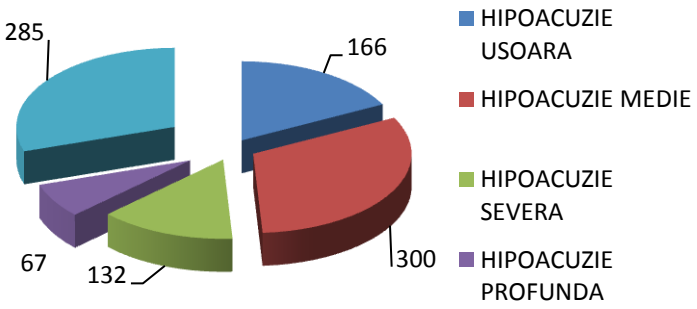


Chart no 9. The numerical values of patients tested with hearing problems

Profound hearing loss meet in employees working in noisy environment, cause changes in mean values of serum transaminases in 89% of cases and for persons no longer working in sound polluted environment, produced an increase in mean serum transaminases close double to the maximum allowed (Chart No. 10).

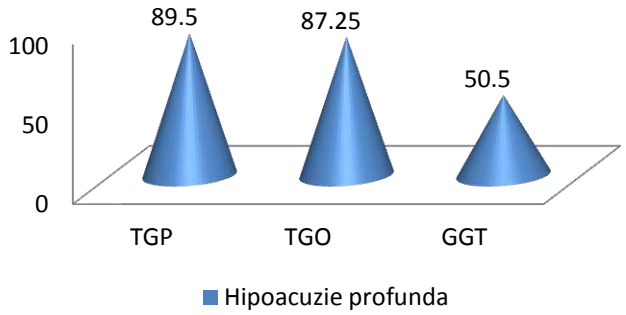


Chart no 10 Graphical presentation of the average values of transaminases redundant employees diagnosed with profound hearing loss

Blood pressure and heart rate, maintained elevated at 8 to 9 people for blood pressure and increased heart rate remains above the maximum limits for 6 of 9.

It was also observed in people who are not occupationally exposed to noise increase in mean blood pressure by 30%, and an increase in mean heart rate by approximately 50%.

Trauma noise found in persons employed, produced a change in mean transaminase, pulse and blood pressure in 50% of cases (Chart no. 11).

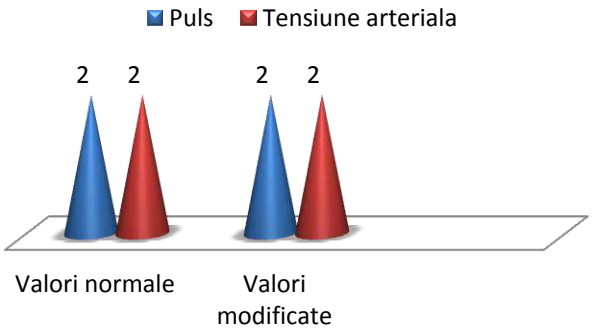


Chart no 11 Graphical representation of the ratio changes in blood pressure and pulse rate in patients with acoustic trauma

However, the people who have left the polluted environment sound, produced an increase of about 2 and a half times the average values of transaminases, an increase of almost double the average values of heart rate, and an increase of approximately 50% in mean blood pressure.

Alkaline phosphatase is a parameter suggesting an hepatobiliary damage.

The variation of this parameter in the context of the first study, with changes of serum transaminases, suggests a suffering liver tissue.

Variation of alkaline phosphatase in relation to the exposure to stressors aid is represented in chart no 12.

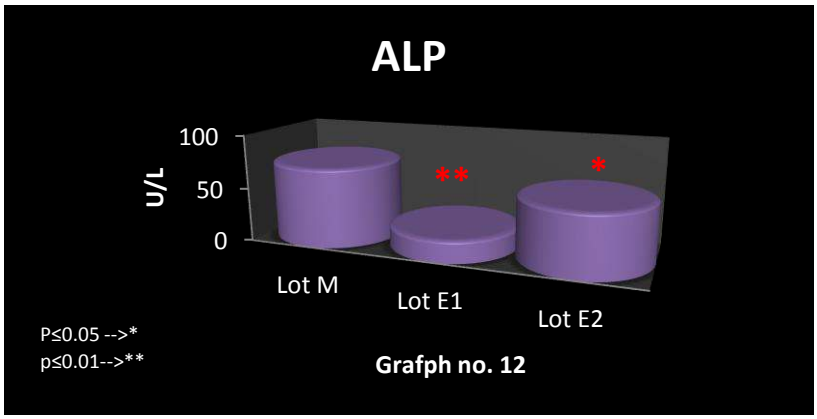


chart no 12 ALP statistical variation values after a single exposure to noise for one hour, as compared with the values obtained by a single exposure to noise, for 2 h

If is a single exposure to stress, there is a change statistically significant ($p \leq 0.05$), similar to changes seen with the serum transaminases, changes exemplified by chart no 12. And if is prolonged exposure over a period of seven days, there are significant changes ($p \leq 0.03$).

Exposure, both short and long term, of a biological system to a noise source with constant intensity can produce physiological changes in the body, changes that can lead to disease, acute and chronic.

The effect is due to stimulation of the hypothalamic-pituitary-adrenal (HHS), which is a dynamic system adapted to answer the constantly changing to body interrelation with the environment.

Stimulation of a single shaft HHS noise exposure produces significant changes ($p \leq 0.001$) of triglycerides (chart. 13), with a significant percentage difference between the group concerned and the control group (119.49 compared to 196 26).

This can be explained by the fact that HHS axis stimulation produces a discharge of increased amounts of adrenaline, as an effect of stimulation of the autonomic nervous system.

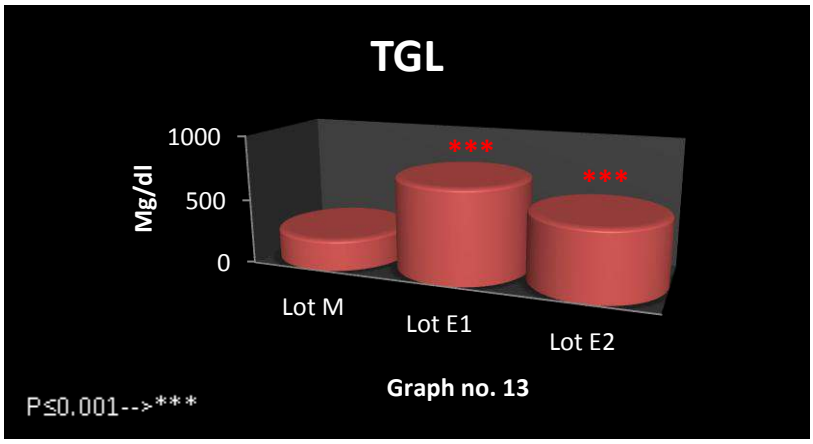


Chart no 13 TGL statistical variation values after a single exposure to noise for one hour, as compared with the values obtained by a single exposure to noise, for 2 h

Due to increased secretion of adrenaline, the pituitary gland generates HGH (human growth hormone) which favors the transformation of fats (lipids) in carbohydrates causing hyperglycemia even if the subject has not consumed food.

Cortisol stimulates the activity of glycogen syntethase, stimulates amino acid uptake and synthesis of regulatory enzymes of gluconeogenesis, and also potentiates the action of glucagon and epinephrine in the liver.

The adipose tissue lipolysis increase cortisol, both directly and indirectly by potentiating other lipotropic hormones like adrenaline and somatotropic hormone, and decreases glucose uptake at this level.

Cardiovascular protection is ensured, among other things, by the level of HDL-cholesterol.

If the auditory stimulus act only once on the body, it causes a significant increase ($p \leq 0.002$ and $p \leq 0.02$) HDL cholesterol level with a percentage difference between the batch in question and control group +25.08 <29, 80 (between group E1 and group E2) (chart. 14).

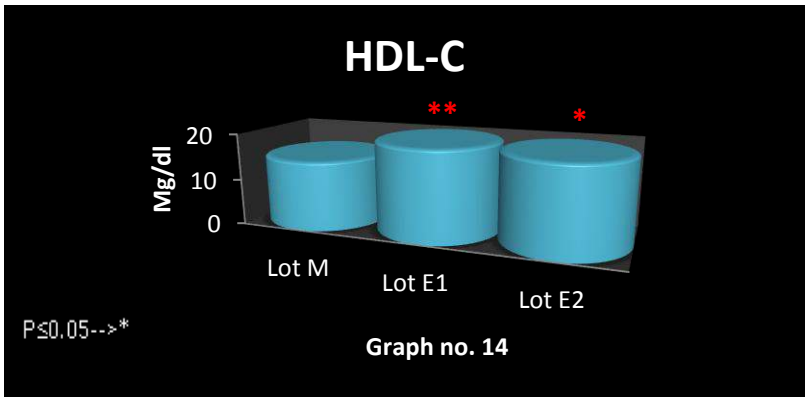


Chart no 14 Statistical variation of HDL-C by a single exposure to noise for one hour, as compared with the values obtained by a single exposure to noise, for 2 h

This highlights vascular protection provided by HDL-cholesterol in action of auditory stimulus.

If the exposure lasts longer (7 days), is maintaining vascular protection, ensured by statistically significant levels of HDL-cholesterol ($p \leq 0.05$), and with the percentage difference between the batch in question and the control group 13.70 <+ 47,43 (between group 7 and group E1-E2-7).

This can be explained by the fact that, in the liver, increases the rate of metabolism of cholesterol.

Fat reserves stored in the body muscles begin to be put into circulation by growth hormone, secreted by the pituitary gland, and are carried by lipoproteins to the liver, where conversion into carbohydrates occurs, producing hyperglycemia.

This increase in fat metabolism is leading to increased HDL cholesterol maintenance, to ensure effective cardiovascular protection.

These changes are just the beginning of a long series of pathophysiological events that may occur as long as the determining factor is maintained.

To remove these effects, or at least to delay their appearance is essential to reduce exposure to noise, if we cannot fully remove it.

And also in financial terms, it is more advantageous to prevent damage occurs due to exposure to noise than treating pathology encountered.

CONCLUSIONS

1. Noise is one of the major health problems that we face every day.
2. Sound stress is an important factor for the development of diseases in different cellular and anatomical levels.
3. There is evidence of organ system damage in people suffering from hearing loss due to changes in noise exposure.
4. While we are daily subjected to sound stress, fewer people are protected against the harmful effects of it.
5. Acute exposure to a sound stimulus may produce changes in the liver.
6. Chronic stimulation of auditory stimulus can cause both, changes at the cellular and behavioral changes in vegetative state, with the substrate modification in serum cortisol secretion.
7. In terms of overexposure to noise may occur an increase in blood glucose due to continuing high levels of cortisol, which can ultimately lead to the development of diabetes.
8. Effects of noise exposure of laboratory animals are similar to the effects of noise exposure of humans.
9. Pathophysiological effects of exposure to auditory stress is based on a complex mechanism that includes, among other things, a change in triglycerides
10. 80% of employees working in sound polluted environment shows the changes in hearing of varying degrees.
11. Of these, 26% have lost their job, from personal point of view or from a medical standpoint.
12. It is present a strong correlation between cardiovascular impairment and noise exposure.
13. Aids for the occurrence of changes in prevailing age is around 65-75 years
14. Due to sound stress, which is subject to human body, the degree of hearing loss increase gradually moving from mild hearing loss, average hearing loss, and severe hearing loss until the final stage, profound hearing loss.
15. However, installing hearing loss may be due to noise trauma.
16. Although the degree of hearing impairment is higher in men than in women, it appears that there is a genetic predisposition and hereditary transmission of the disease aids that may precipitate hearing loss installation.
17. We need national health programs that people should be informed about the risk of hearing loss installation, and also free treatment to people already affected.
18. Exposure to noise can cause an inability to work, thus leading to the emergence of a social class issues.

ABBREVIATIONS USED IN THE TEXT

- ✓ dB - decibel
- ✓ Fig. -figure
- ✓ mm-milimeters
- ✓ Pa- pascals
- ✓ Hz-hertz
- ✓ mp- square meter
- ✓ CA-air driving
- ✓ CO-bone leading
- ✓ CC-cartilaginous driving
- ✓ Ms-miliseconds
- ✓ kHz-kilohertz
- ✓ g-grams
- ✓ OMS- World Health Organization
- ✓ CRH- corticotropin-releasing hormone
- ✓ ACTH- adenocorticotrop hormone
- ✓ MSH- melanocyte-stimulating hormone
- ✓ HHT-hypothalamus-pituitary-thyroid
- ✓ HHG-hypothalamic-pituitary-gonadal
- ✓ LH-luteinizing hormone
- ✓ CBG- corticosteroid binding globulin
- ✓ CRH- corticotrophin releasing hormone
- ✓ LDL-low density lipoprotein
- ✓ HDL- high density lipoproteine
- ✓ VLDL- very low density lipoproteine
- ✓ ALP alkaline phosphatase
- ✓ TGO-glutamic oxaloacetic transaminase
- ✓ TGP-glutamate pyruvate transaminase
- ✓ GGT-glutamyl transferase
- ✓ TGL-triglycerides
- ✓ HDL-C- HDL-Cholesterol
- ✓ MDH- malate dehydrogenase
- ✓ LDH- lactate dehydrogenase
- ✓ AST-aspartate aminotransferase
- ✓ ALT-alanine aminotransferase
- ✓ GK-glycerol kinase
- ✓ POD-peroxidase

- ✓ LPL-lipoprotein lipase
- ✓ GPO-glycerol-3-phosphate-lipase
- ✓ ° C-degrees Celsius
- ✓ GOD-glucose oxidase
- ✓ NS, not statistically significant
- ✓ *- $p \leq 0.05$
- ✓ ** - $p \leq 0.01$
- ✓ *** - $p \leq 0.001$
- ✓ HHS-hypothalamic-pituitary-adrenal axis
- ✓ IL- interleukin
- ✓ TNF- tumor necrosis factor
- ✓ AVC- stroke
- ✓ PTK- protein-tyrosine kinase
- ✓ T.A. - blood pressure
- ✓ mmHg- millimeters of mercury
- ✓ CNS-central nervous system

SELECTED REFERENCES

1. Benito J.I., Gil-Carcedo L.M., Gayoso M.J.- Morphological evaluation of the organ of Corti in the guinea pig subjects to acoustic trauma I. Surface preparation study. *Acta Otorinolaringologica Espanola* 1991 Sep.-Oct.
2. Darabont A., Iorga I., Ciodaru M. – Măsurarea zgomotului şi vibraţiilor în tehnică, Ed. Tehnică, Bucureşti 1983
3. Horwitz A.R., Turner C.W., Fabry D.A.- Effects of different frequency response strategies upon recognition and preference for audible speech stimuli. *J-Speech-Hear-Ref.* 1991, Oct.
4. Mihailescu V. – Psihoterapie şi psihosomatică. Ed. Polirom Iaşi 1996
5. Teodorescu C. – Cercetări privind incidenţa hipertensiunii arteriale la muncitorii expusi la zgomot industrial şi rolul dietei în apariţia şi tratamentul hipertensiunii, al XI-lea Congres de Farmacie, Iaşi, 1998
6. Thorsteinsson R., Johannesson A., Jonsson H. et al – Effects of dietary intervention on scrum lipids in factory workers. *Scand J Primary Health Care*. 12(2): 1994 Jun.
7. Vasile R V – Sistemul international de unitati in medicina, Ed. Medicala, Bucuresti 1986
8. Wyngarden B. J., Smith H L. – Occupational and Environmental Medicine, *Cecil Text Book of Medicine*, volume 2, 19Th edition, 1992
9. Yvert, B., Fischer C., Bertrand O., and Pernier J. – Localization of human supratemporal auditory areas from intracerebral auditory evoked potentials using distributed sources models. *Neuroimage* 28:140-423, 2001
10. Zahang J., Cai W.W., Lee D.J.- Occupational hazards and pregnancy outcomes. *Am J. Ind. Med* 1992, 21(3)
11. Zeana C.- Magneziul , biologie- clinică- tratament, Ed. Enciclopedică Bucureşti, 1994
12. Zhan C., Lu Y., Li C., Wu Z.- A study of textile noise influence on maternal function and embryo-groth, *J West China Univ Med Sci*, 1991 Sep. 22 (4)
13. Zhou B., Green D.M- Reliability of pure-tone thresholds at highs frequencies. *J Acoust Soc Am*, 1995, Aug. 98 (2)
14. Encyclopaedia Britannica. 2006. Encyclopaedia Britannica Online. 25 Oct. 2006 http://www.britannica.com/eb/article-65058
15. Regulamentul serviciului la bordul navelor fluviale civile- M.T.Tc., ediţia 1989.
16. Ataman T, Mădălina Georgescu- Proba pneumatic. O.R.L., 19, pag 3-4, 91-93, 1998
17. Costinescu N., Garbea St- Otorinolaringologie, editura Medicală, pag 97-99, 1964
18. Pascu A.- Audiometrie, editura Universitară ,,C Davila", Bucureşti, 2000
19. Ataman T.-Otologie, editura Tehnică, Bucureşti, 2002, 213-291
20. http://www.9am.ro/stiri-revista-presei/Social/77368/Zgomotul-otrava-care-ne-ucide-lent.html

21. Bardac I, Stoia M. Elemente de medicina muncii şi boli profesionale, Editura Mira Design Sibiu 2004.
22. Toma I. Medicina Muncii, Editura Sitech Craiova, 2004.
23. Cocarlă A. Medicină Ocupaţională, Editura Medicală Universitară Iuliu Haţieganu, Cluj Napoca, vol.1, 2009.
24. Frances Fischbach. Chemistry Studies. In A Manual of Laboratory and Diagnostic Tests. Lippincott Williams & Wilkins, USA, 8 Ed., 2009, 390-391.
25. Frances Fischbach. Effects of the Most Commonly Used Drugs on Frequently Ordered Laboratory Tests. In A Manual of Laboratory and Diagnostic Tests. Lippincott Williams & Wilkins, USA, 8 Ed., 2009, 1234.
26. Henry John Bernard. Evaluation of endocrine function. In Clinical Diagnosis and Management by Laboratory Methods. ASM Press, USA, 20 Ed., 1998, 99-346.
27. Ion Teodorescu Exarcu. Corticosuprarenala. In Fiziologia si fiziopatologia sistemului endocrin. Editura Medicala, Romania, Ed. 1989, 680-699.
28. Ion Teodorescu Exarcu. Fiziopatologia corticosuprarenalei. În Fiziologia şi fiziopatologia sistemului endocrin. Editura Medicală, România, Ed. 1989, 699-727.
29. Jacques Wallach. Afecţiuni endocrine. În Interpretarea testelor de diagnostic. Editura Ştiinţelor Medicale, România, Ed. 7, 2001, 866-868.
30. Jacques Wallach. Afecţiuni endocrine. În Interpretarea testelor de diagnostic. Editura Ştiinţelor Medicale, România, ed. 7, 2001, 835-837.
31. Laborator Synevo. Referinţele specifice tehnologiei de lucru utilizate 2010. Ref Type: Catalog.
32. Laboratory Corporation of America. Directory of Services and Interpretive Guide. Cortisol. www.labcorp.com 2010. Ref Type: Internet Communication.
33. Ciudin Elena, Marinescu D. Animale de laborator, vol. I, *Ed. All, Bucureşti.* 1996, 99 - 136.
34. Senedecor G.W, Cochran WG. Statistical methods.7th ed. *Ames, Iowa, Iowa State University Press.* 1980, 334-364.
35. Bhattacharya S.K., Pradhan C.K., Tripathi S.R.: *Human performance capacity in psychomotor tasks at variable difficulty levels and physological reactions under noise and heat conditions*, Ind Health, 1991; 4:16.
36. Dakak N., Arshed A., Quyyumi M., Eisenhofer G.: *Sympathetically mediated effects of mental stress on cardiac microcircullation of patients coronary artery disease*, Am J Cardiology, 1995 July 15; 76:97-100.
37. Dias A., Cordeiro R., Goncalves C.G..: *Occupational noise exposure and work accidents,* Cad Saude Publica. 2006 Oct; 22(10):2125-30.
38. Gitanjali B, Dhamotharan R.: *Effect of occupational noise on the nocturn*al *sleep architecture of healthy subjects*, Indian J Physiol Pharmacol. 2003 Oct;47(4):415-22, Erratum in: Indian J Physiol Pharmacol. 2004 Apr;48(2):136.

39. Goupil G., Hans Selye: Inţelepciunea stresului, Editura Coressi, Bucureşti 1991.
40. Horner KC: *The emotional ear in stress*, Neurosci Biobehav Rev. 2003 Aug;27(5):437-460.
41. Iamandescu I.B.: Stresul psihic din perspectivă psihologică şi psihosomatică, Editura Infomedica, Bucureşti 2002, pg. 5-166.
42. Keiichi Miki, Kouki KawamoritA, Yutaka Araga, Toshimitsu Musha, Sudo A.: *Urinary and Salivary Stress Hormone Levels While Performing Arithmetic Calculation in a Noisy Environment*, Industrial health 1998;36(1):66-9.
43. Lees R.E.M., Smith-Romeril C, Wetherall LD.: *A study of stress indicators in workers exposed to industrial noise*. Can J Public Health 1980; 71:261-265 .
44. Ozguner M.F., Delibaş N., Tahan V., Koyu A., Koylu H : *Effects of industrial noise on the blood levels of superoxide dismutase, glutathione peroxidase and malondialdehyde,* Eastern Journal of Medicine 1999; 4 (1): 13-15.
45. Rădulescu N., Ion I., Ceamitru N.,Adumitresi C., Farcaş C., Ciufu C., Hanzu-Pazara L.: *The correlation between noise exposure and urinary vanillylmandelic acid elimination on seamen*, Ars Medica Tomitana; 2008, vol XIV, nr.1 (52)
46. Sudo A, Miki K.: *Dissociation of catecholamine and corticosterone responses to different types of stress in rats*, Ind Health. 1993;31(3):101-11.
47. Asist. Univ. Drd. Rădulescu Ninela-STUDIUL STRESULUI PROFESIONAL AUDIOGEN LA PERSONALUL NAVIGANT MARITIM, teză de doctorat, Constanţa 2008
48. Thomas L. Alanine aminotransferase (ALT), Aspartate aminotransferase (AST). In: Thomas L, editor. Clinical Laboratory Diagnostics. 1st ed. Frankfurt: TH-Books Verlagsgesellschaft; 1998. p. 55-65.
49. Moss DW, Henderson AR. Clinical enzymology. In: Burtis CA, Ashwood ER, editors. Tietz Textbook of Clinical Chemistry. 3rd ed. Philadelphia: W.B Saunders Company; 1999. p. 617-721.
50. Schumann G, Bonora R, Ceriotti F, Ferard G et al. IFCC primary reference procedure for the measurement of catalytic activity concentrations of enzymes at 37 °C. Part 5: Reference procedure for the measurement of catalytic concentration of alanine aminotransferase. Clin Chem Lab Med 2002;40:718-24.