

# **20th International Congress on Sound and Vibration 2013**

**(ICSV 20)**

**Bangkok, Thailand  
7-11 July 2013**

**Volume 1 of 4**

**Editors:**

**Malcolm J. Crocker  
Boonchoat Paosawatyanong**

**Marek Pawelczyk**

**ISBN: 978-1-62993-150-0  
ISSN: 2329-3675**

**Printed from e-media with permission by:**

Curran Associates, Inc.  
57 Morehouse Lane  
Red Hook, NY 12571



**Some format issues inherent in the e-media version may also appear in this print version.**

Copyright© (2013) by the International Institute of Acoustics & Vibration  
All rights reserved.

Printed by Curran Associates, Inc. (2013)

For permission requests, please contact the International Institute of Acoustics & Vibration  
at the address below.

International Institute of Acoustics & Vibration  
c/o Dr. Malcolm J. Crocker  
PO Box 13  
Auburn, Alabama 36831

Phone: (334) 844-3248  
Fax: (334) 844-3306

[www.iiav.org](http://www.iiav.org)

**Additional copies of this publication are available from:**

Curran Associates, Inc.  
57 Morehouse Lane  
Red Hook, NY 12571 USA  
Phone: 845-758-0400  
Fax: 845-758-2634  
Email: [curran@proceedings.com](mailto:curran@proceedings.com)  
Web: [www.proceedings.com](http://www.proceedings.com)

<b>241A DYNAMIC NON-LINEAR VISCOELASTIC MODEL</b> .....	2923
<i>Rajneesh Kakar, Kanwaljeet Kaur</i>	
<b>463 VIBRATION BAND GAPS IN A PERIODICALLY SUPPORTED RIB-SKIN STRUCTURE</b> .....	2934
<i>Rong Chen, Tianxing Wu</i>	
<b>507 THE EFFECT OF IMPACT NUMBER ON THE REBOUND PROPERTIES AND STRESS WAVE PROPAGATION IN THE REPEATED IMPACT OF TWO SPHERES</b> .....	2941
<i>Hirofumi Minamoto, Shingo Baba, Shozo Kawamura</i>	
<b>508 LAMB WAVE SCATTERING BY CIRCULAR BLIND HOLES IN ISOTROPIC PLATES USING MINDLIN PLATE THEORY</b> .....	2949
<i>Haiyan Zhang, Jiecong Yao, Yutian Feng, Yongling Yu</i>	
<b>515 SPLIT HOPKINSON PRESSURE BAR TEST OF CFRP LAMINATES</b> .....	2955
<i>Hirofumi Minamoto, Masakatsu Tatsutani, Shozo Kawamura, Nobuhiro Matoba</i>	
<b>525 ANALYSIS OF EIGENFREQUENCIES OF FINITE PERIODIC STRUCTURES IN VIEW OF LOCATION OF FREQUENCY PASS- AND STOP-BANDS</b> .....	2963
<i>Alexander Hyatov, Sergey Sorokin</i>	
<b>636 ACOUSTO-OPTIC INVESTIGATION OF SURFACE ACOUSTIC WAVES IN 36 DEG ROTATED YX-LITHIUM TANTALATE</b> .....	2971
<i>Daumantas Ciplys, Romualdas Rimeika</i>	
<b>788 DYNAMIC RESPONSE OF STRUCTURES DUE TO CONSTRUCTION WORKS</b> .....	2979
<i>Jan Bencat, Daniel Papan</i>	

## **COMBUSTION DYNAMICS, ACOUSTICS, VIBRATION AND FATIGUE**

<b>149 FLUID-STRUCTURE COUPLING FOR NUMERICAL SIMULATIONS OF A GAS TURBINE COMBUSTOR</b> .....	2986
<i>Simon Govert, Jim B. W. Kok</i>	
<b>171 THERMAL AND FLUID DYNAMIC ANALYSIS OF PARTIALLY PREMIXED TURBULENT COMBUSTION DRIVEN BY THERMO ACOUSTIC EFFECTS</b> .....	2994
<i>Mina Shahi, Jim B. W. Kok, Artur Pozarlik</i>	
<b>252 DYNAMICS OF A PREMIXED TURBULENT PILOTED FLAME</b> .....	3002
<i>Virginia Fratalocchi, Jim B. W. Kok</i>	
<b>316 CFD-BASED FEASIBILITY STUDY OF ACTIVE CONTROL ON A COMBUSTION INSTABILITY</b> .....	3010
<i>Roel A. J. Muller, Constanze Temmler, Robert Widhopf-Fenk, Jakob Hermann, Wolfgang Polifke, Phil Stopford</i>	
<b>581 NUMERICAL STUDIES OF UNSTEADY HEAT TRANSFER IN A MODEL COMBUSTOR WITH THERMOACOUSTICS OSCILLATIONS</b> .....	3018
<i>Antonio Filosa, Andrea Tomasello, Berthold Noll, Manfred Aigner, Mina Shahi, Jim Kok</i>	

## **ENVIRONMENTAL NOISE AND VIBRATION FROM URBAN TRANSPORTATION NETWORKS**

<b>55 COMPARISON AND ANALYSIS OF ENVIRONMENTAL RAILWAY VIBRATIONS PRODUCED BY DIFFERENT KINDS OF ROLLING STOCK</b> .....	3026
<i>Georges Kouroussis, Olivier Verlinden</i>	
<b>56 AN EXPERIMENTAL STUDY OF EMBANKMENT CONDITIONS ON HIGH-SPEED RAILWAY GROUND VIBRATIONS</b> .....	3034
<i>Georges Kouroussis, Olivier Verlinden, David Connolly, Mike Forde</i>	
<b>491 STRATEGIC NOISE MAPPING IN MID-SIZED URBAN AGGLOMERATIONS OF SOUTH EUROPE. THE CASE OF VOLOS-GREECE</b> .....	3042
<i>Konstantinos Vogiatzis, Vasileios Dalamagas</i>	
<b>533 FROM NOISE ABATEMENT TO SOUNDSCAPE CREATION THROUGH STRATEGIC NOISE MAPPING</b> .....	3048
<i>Konstantinos Vogiatzis, Nicolas Remy</i>	

## **SOLUTIONS TO NOISE PROBLEMS FOR SMART CITIES**

<b>145 IMPACT OF ENVIRONMENTAL NOISE ON THE HEALTH OF YOUNG PEOPLE</b> .....	3056
<i>Giulio Arcangeli, Nicola Mucci, Vincenzo Cupelli</i>	
<b>199 NOISE AWARENESS FOR SMART CITIES</b> .....	3063
<i>Sergio Luzzi, Rossella Natale, Raffaele Maricone</i>	
<b>254 EVALUATION AND CONTROL OF CRUISE SHIPS NOISE IN URBAN AREAS</b> .....	3071
<i>Antonino Di Bella, Francesca Remigi</i>	
<b>266 URBAN QUALITY ASSESSMENT BY MEANS OF INDICATORS AND INDEXES: APPLICATION OF AN ACOUSTIC QUALITY INDEX AND ANALYSIS OF OTHER SIGNIFICANT INDEXES FOR SMART CITIES EVALUATIONS</b> .....	3078
<i>Anna Magrini, Sergio Luzzi, Andrea Falchi, Francesco Borch</i>	

## IMPACT OF ENVIRONMENTAL NOISE ON THE HEALTH OF YOUNG PEOPLE

Arcangeli Giulio, Mucci Nicola *and* Cupelli Vincenzo

*Chair of Occupational Health, Section Health Research Services, Department of Experimental and Clinical Medicine, University of Florence, Italy*

*e-mail: giulio.arcangeli@unifi.it*

Living in big cities exposes the population to upper noise levels than just a few years ago. The study of the tonal hearing threshold – both subjective and objective (through evoked potentials) – is considered a basic requirement for the evaluation of hearing function. Regarding the occupational exposure to noise, we underline that TLVs couldn't protect all workers from the harmful effects of noise because of individual susceptibility; so TLVs cannot be considered as an absolute cut-off between safety and danger levels. This issue is even more complex in apprentices and youngest workers; in addition, there are no reference values for these kinds of population in Italy. There is also the need to find methods capable both to predict the earlier noise damage and to allow a sort of detection of most susceptible people. We remember, in this regard, the availability of new methods such as the registration of otoacoustic emissions (OAEs). The aims of our research are: evaluation in a large population of young apprentices the incidence of early changes in the hearing function, preliminary evaluation of the usefulness of OAEs as a screening test in young persons who have just started working. In this study were included 288 patients, of which 180 males and 108 females. A smaller group of young people was investigated by evaluation of OAEs. The analysis of audiometric examinations allows us to highlight the influence of some factors (gender, age, and education) on the hearing function. In detail, we observed a higher threshold among males, younger and less educated; this result may seem at least paradoxical but we cannot forget some factors (concerning cognition and attention) which may justify it. Our preliminary data regarding OAEs confirm the interest of the methodology.

### 1. Introduction

Living in big cities exposes the population to upper noise levels than just a few years ago; this may be due to several factors including, in particular, the increase of urban traffic and the habit – especially for young people – of visiting places with high sound pressure levels, such as discos.<sup>1</sup>

The study of the tonal hearing threshold – both subjective and objective (through evoked potentials) – is considered a basic requirement for the evaluation of hearing function. Experimental studies showed that cochlear structures may be damaged even without any modification of the tonal hearing threshold.<sup>2-4</sup> Probably, when the audiometric examination shows a deficit limited to high frequencies, there is already an advanced cochlear deterioration, which also covers the anatomic sites corresponding to mid and/or low frequencies. So the anatomical damage is quantitatively

greater than it may appear at the audiometric examination: the presence of abnormalities (even if limited) is, therefore, always suggestive of a cochlear injury.

It was also proved that a destruction of hair cells in a restricted cochlear area produces functional abnormalities in the surrounding areas also, where the reactions to sound stimuli become abnormal. In this regard, we note that in subjects with noise-related hearing loss, the verbal perception threshold is not only altered by the loss of some high-pitched sounds present in the human voice, but also because some high-pitched background sounds present in the environment greatly interfere on the right understanding of words. In fact, there is no correlation between the verbal perception threshold in the silence and with the presence of noise; this confirms that the noise-related hearing loss is mainly evident in the presence of background noise. This is also confirmed by investigations carried out by psychosocial questionnaires, administered to subjects with normal hearing and with noise-related hearing loss. Social life takes rarely place in silent environments, so the determination of the threshold for 2 kHz is of utmost importance to estimate the ability to understand the voice in the actual, prevailing, living conditions.

In general, to define in a quantitative way a noise-related hearing loss is essential to assess whether the values observed exceed the expected values of a reference population professionally not exposed to noise.

In fact, although the function of perceiving the formulation of a certain vocabulary – in optimal conditions of expression and reception (which are artificially created in all the audiometric tests, whether subjective or objective) – constitutes the activity for which the hearing is mainly dedicated, it doesn't exhaust their sensory capacities, which are also ordinarily used for the uptake of any sound, noise, or any extra vocal signal otherwise modulated.

As concerns the potential ototoxicity of ordinary life and social activities (except of particular places as discos, motor sports, hunting, shooting, etc.), a clear agreement in considering the obtained values as significantly ototoxic doesn't exist.

With regard to occupational exposure to noise, all defined TLVs are referred to sound pressure levels and to exposure times that represent conditions under which it can be assumed that nearly all workers may be continuously exposed without adverse effects on their hearing function and may understand a normal conversation. Nevertheless, the application of the TLVs themselves couldn't protect all workers from the harmful effects of noise because of individual susceptibility; so TLVs cannot be considered as an absolute cut-off between safety and danger levels.

The evaluation of hearing function and the of impact of noise in apprentices and youngest workers is even more complex. In fact, this issue presents many peculiarities regarding the special care needed for the younger workforces. To date, in the Italian legislation, there aren't any reference values regarding noise for the youngest working population<sup>5-6</sup>.

There is also the need to find methods capable both to predict the earlier noise damage and to allow a sort of detection of most susceptible people. We remember, in this regard, the availability of new methods such as the registration of simultaneous evoked otoacoustic emissions (OAEs), generated within the cochlea.<sup>7</sup>

Probably, the most promising application of OAEs lies in the "subclinical" cochlear lesions; these are characterized by subjective complaints such as tinnitus, full ear feeling and/or distortion, without any significant change of the threshold tone. In fact, in cases of tinnitus with a still normal tonal threshold, the transient-evoked otoacoustic emissions often lack.

OAEs are now considered an important audiological test and are embedded in the clinical practice along with all other audiometric tests; in fact, these represent a powerful and valuable tool of investigation for the dynamic of the cochlea.

## 2. Objectives

The aims of our research were the identification of reference levels for hearing function in the youth ages and the evaluation of the usefulness of screening tests for hearing function in young persons who have just started working. To pursue these objectives, we have investigated the hearing function, through an audiometric examination, in a large population of young apprentices. In addition, we performed, in a smaller population, a preliminary evaluation of the usefulness of OAEs.

## 3. Methods

In this study we enrolled 288 young apprentices, of which 180 males and 108 females, engaged in work activities involving exposure to noise. We excluded from the study, *a priori*, subjects older than 24 years and those with the finding of an occlusive plug of earwax at the otoscopic examination. We also excluded, *a posteriori* (during data analysis), subjects with a history of significant occupational exposures to noise and people with otological diseases or with major abnormalities found at the audiometric examination.

All subjects underwent the same study protocol, including audiometric examination and a medical history questionnaire, administered by expert interviewers.

## 4. Study of the OAEs

To obtain the evoked OAEs is necessary to send a series of impulsive stimuli (*clicks*) through a special probe, placed in the external auditory meatus; the evoked OAEs are picked up by a microphone, placed inside of the probe, and sent to a computerized apparatus which separates the OAEs from the artefact of the stimulus and from the resonance of the auditory meatus. Both of these last phenomena have characteristics of linearity and are completely deleted; so, the only non-linear components – namely the OAEs and noise – remain.

We have applied the international protocols of the University of Utah which classify the results as are described below:

- PASS = presence of OAEs;
- PARZIALITY PASS = dubious presence of OAEs
- FAIL = absence of OAEs.

For this specific study, we examined 7 subjects (14 ears), of which 5 males and 2 females, including 2 females and 5 males, with an age range between 17 and 23 years (mean age 20.46 years). For all subjects, we performed the following investigations:

- ENT history, to verify the absence of any hereditary disorders;
- ENT examination, to verify the absence of earwax in the external auditory meatus and the integrity of the tympanic membrane;
- Audiometric examination, to assess the hearing threshold;
- Impedance analysis, to investigate any problems in the middle ear (especially dysfunctions of the Eustachian tube and of the ossicles) and any problems in the inner ear, through the study of the stapedial reflex.

Subsequently, OAEs were detected in both ears.

## 5. Results

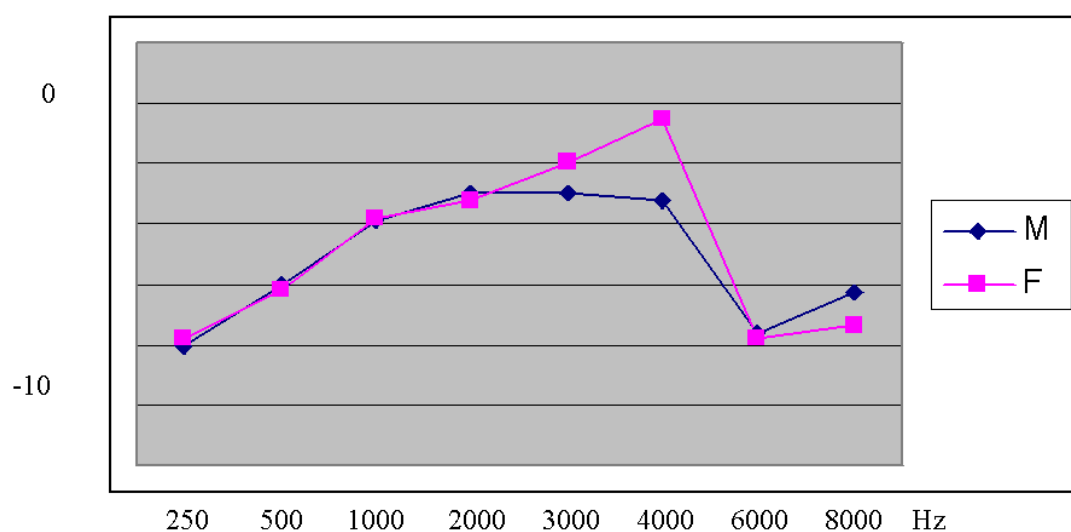
### 5.1 Study population

In this study were included 288 young apprentices, of which 180 males and 108 females, with a mean age of  $19.1 \text{ years} \pm 2.5 \text{ years}$ , a mode of 20 years and a median of 19 years. Seven subjects (0.024% of the study population) hadn't completed the Italian compulsory school. More than 50% of young people referred the use of a scooter to get to the workplace; this may be considered as one of the main non-occupational risk factors – perhaps the most important – for hearing loss in young people. As regards the frequentation of discos, 33% of the subjects reported that they had never go to discos, 34% only occasionally, the remaining 33% reported the habit to go to discos with a frequency of at least once per week. Fifty-six percent of the subjects reported that they regularly used headphones for listening to music. Nine percent of the subjects reported that they played musical instruments (7 guitar, 5 piano, 4 battery and 9 other instruments). So, the music – both listening in the discos and in the headphones – represents a major non-occupational risk factor for hearing loss in young people. Only a young man (0.0006% of the male population) reported to was an hunter; this fact confirms that hunting was almost abandoned in young people and, consequently, it is no longer a risk factor for hearing loss.

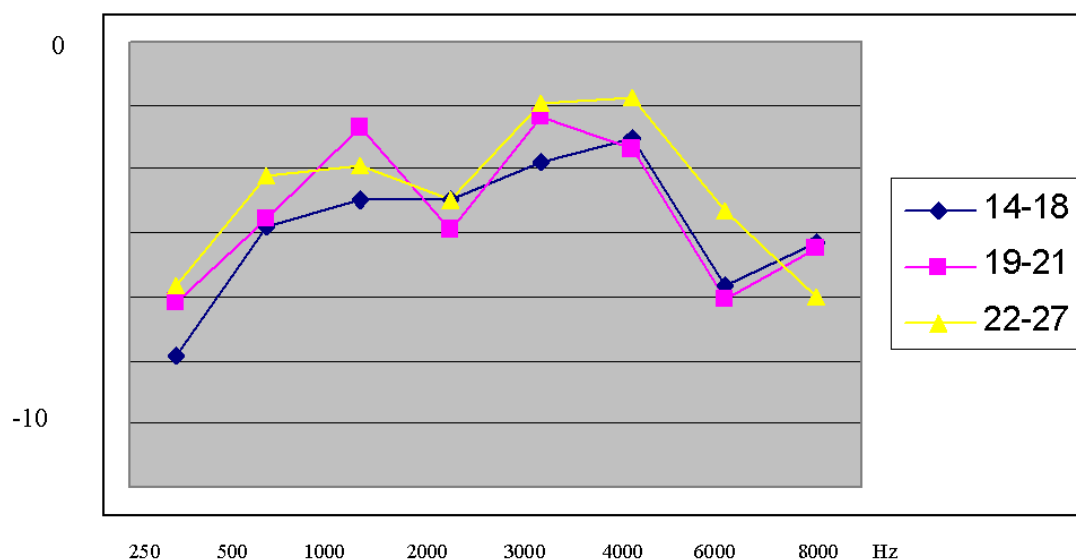
Nineteen percent of the subjects reported childhood ear disease (such as otitis media) and 3% reported acute ear traumas (in 70% of cases by bursting of firecrackers). No subject reported a previous malaria or anti-tubercular drugs assumption. Four percent of subjects said they had at least a relative with a congenital deafness and 8% with an acquired deafness. Two hundred eighty-one subjects (98%) reported a subjective feeling of a good hearing function, 4 a reduced hearing function on the right, 2 a reduced hearing function on the left, and one bilaterally; six percent reported tinnitus.

### 5.2 Analysis of audiometric examinations

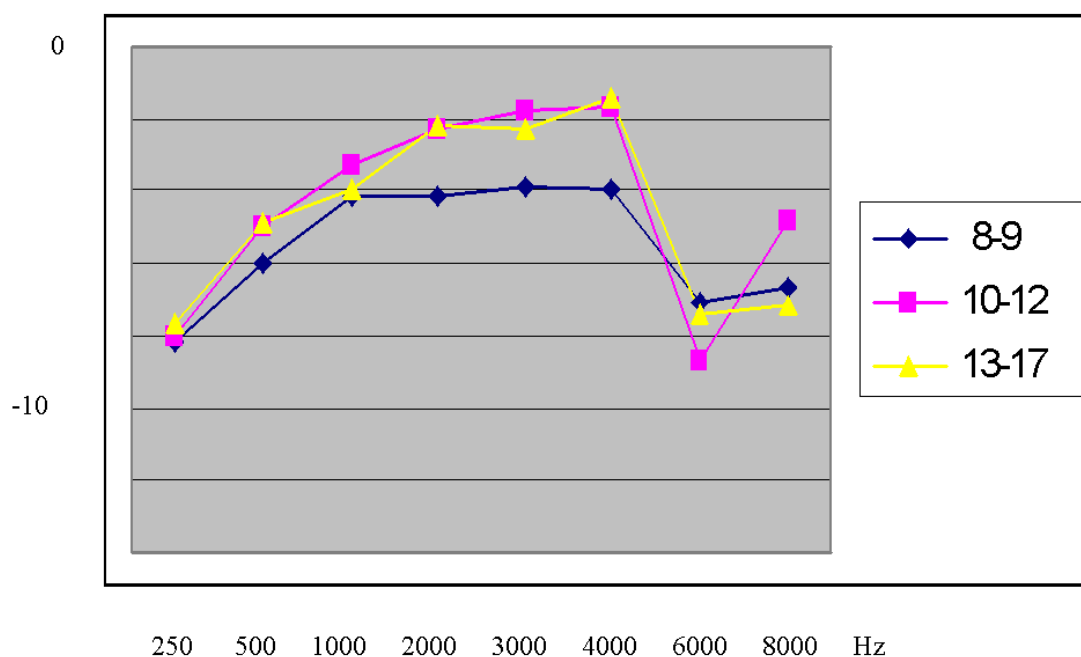
The audiometric examinations of the 288 subjects enrolled in this study were analyzed, as well as a total population, according to the influences of the following variables: gender, age, education. For illustrative purposes, we have shown in the Figs. 1, 2 and 3 the data relating to the right ear. Similar tracks can be made for the left ear.



**Figure 1.** Influence of gender on audiometric threshold (right ear, average values).



**Figure 2.** Influence of age on audiometric threshold (right ear, average values).



**Figure 3.** Influence of education on audiometric threshold (right ear, average values).

The average value of hearing thresholds appears bilaterally lower in females (Fig. 1). This is particularly evident for the 2000-4000 Hz frequencies and for the left ear. An certain explanation of this phenomenon cannot be found, but we could propose some assumptions:

- The young girls were more focused in performing the test and, therefore, carried out it in a more right way;
- Some males had a low occupational exposure, though often not reported:
- Among the males there was a greater prevalence in moving on a scooter and in frequenting discos.



Regarding the age, we observed that the average value of the audiometric threshold was bilaterally lowest in the group of less young subjects (Fig. 2). We observed this phenomenon for all tested frequencies and it was particularly evident for the left ear. Once again, the explanation of this phenomenon is difficult. We could assume that the older (and more psychologically mature) subjects have better carried out the test. Regarding the education, the average value of the audiometric threshold appears bilaterally lowest in the group of subjects who had a higher education. In particular, the difference is clear for subjects with an education less than 9 years. We could assume that this low level of education is related to cognitive difficulties, with a significant influence on both comprehensive and collaborative skills of the young people.

### 5.3 Preliminary analysis of OAEs evaluations

Considering the small number of cases that could be collected, our evaluations are very preliminary. Moreover, the method of OAEs is currently considered to be in progress for a possible use as a screening test. We noticed that the only subject showing a reduction of the response – at the frequency of 4000 Hz – presented also a moderate audiometric deep at the same frequency. Our data – although very preliminary – are an incentive to implement the number of the dedicated study population, with the aim to evaluate the usefulness of the method (with a more accurate data processing) as a screening test for young people who have just started working.

## 6. Conclusions

The analysis of audiometric examinations of 288 young apprentices, almost equally divided between the two sexes (180 males and 108 females), allows us to highlight the influence of some factors (gender, age, and education) on the hearing function. In detail, we observed a higher threshold among males, younger and less educated; this result may seem, at least, paradoxical but we cannot forget some factors (concerning cognition and attention) which may justify it.

We believe that will be necessary to carefully consider these aspects in future audiometric investigations performed (mainly with epidemiological purposes) on groups of young subjects.

Our preliminary data regarding OAEs confirm the validity of the methodology and the interest in the evaluation of their usefulness as a screening test for young people who have just started working.

## REFERENCES

- <sup>1</sup> World Health Organization – JRC European Commission (2011). *Burden of disease from environmental noise – Quantification of healthy life years lost in Europe*. [Online.] available: [http://www.euro.who.int/\\_data/assets/pdf\\_file/0008/136466/e94888.pdf](http://www.euro.who.int/_data/assets/pdf_file/0008/136466/e94888.pdf)
- <sup>2</sup> Engström, B. and Borg, E. Cochlear morphology in relation to loss of behavioural, electrophysiological, and middle ear reflex thresholds after exposure to noise, *Acta Otolaryngol Suppl*, **402**, 5–23, (1983).
- <sup>3</sup> Lonsbury-Martin, B. L., Martin, G. K. and Bohne, B. A. Repeated TTS exposures in monkeys: filterations in hearing, cochlear structure, and single unit thresholds, *J Acoust Soc Am*, **81**, 1507–1507, (1978).
- <sup>4</sup> Sinex D. G., Clark, W. W. and Bohne, B. A. Effects of periodic rest on physiological measures of auditory sensitivity following exposure to noise, *J Acoust Soc Am*, **82**, 1265–1265, (1987).
- <sup>5</sup> Baldasseroni, A. and Carnevale, F. Vigilanza e sorveglianza sanitaria tra minori ed apprendisti. *Arch Scienze Lav*, **10**, 129–129 (1994).

- <sup>6</sup> Arcangeli, G. and Mucci, N. Health problems in the working occupation of young people in handicraft factories, *G Ital Med Lav Ergon*, 31, 303–306 (2009).
- <sup>7</sup> El-Bez, M., Avan, P., Erminy, M., Francois, M. and Bonfils, P. Role of the basal cochlea in the genesis of evoked acoustic oto-emissions in the subject with normal hearing, *Ann Otolaryngol Chir Cervicofac*, **111**, 443–449 (1994).