



**UNIVERSITI PUTRA MALAYSIA**

**IMPACT OF NOISE AND HEARING ON TASK AND ACADEMIC  
PERFORMANCE OF PRIMARY SCHOOL CHILDREN  
IN KUALA LUMPUR**

**CHUA SWEE KIM**

**FPSK (M) 2001 4**

**IMPACT OF NOISE AND HEARING ON TASK AND ACADEMIC  
PERFORMANCE OF PRIMARY SCHOOL CHILDREN  
IN KUALA LUMPUR**

**By**

**CHUA SWEE KIM**

**Thesis Submitted in Fulfilment of the Requirement for the  
Degree of Master of Science in the Faculty of Medicine and Health Sciences  
Universiti Putra Malaysia**

**September 2001**



This work is especially dedicated to

My loving and caring grandmother, father and family members

My love

All the children

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Master of Science

**IMPACT OF NOISE AND HEARING ON TASK AND ACADEMIC  
PERFORMANCE OF PRIMARY SCHOOL CHILDREN  
IN KUALA LUMPUR**

By

**CHUA SWEE KIM**

**September 2001**

**Chairman: Associate Professor Dr. Zailina Hashim**

**Faculty: Medicine and Health Sciences**

Noise poses a serious threat to children's hearing, health, learning and behavior. This study was done to determine the effects of noise and hearing on task and academic performance of primary school children in Kuala Lumpur. A total of 110 Standard One Malay children aged from 6 ½ to 7 ½ years were recruited in this study according to stratified random sampling. Environmental noise levels and personal noise exposures were measured by using sound level meter and noise dosimeter, respectively. A personal questionnaire and audiometric tests was administered on all the respondents. Seven tests in the McCarthy Scales of Children's Abilities constituted the tests in the Task Performance. Task Performance was carried out twice on the same respondents in quiet and noise condition. The child's academic performance was determined by his latest examination result in the school.

Environmental noise measurement indicated that a mean equivalent continuous sound level (LEQ), maximum level (LMAX) and minimum level (LMIN) of at least 60 dB (A) was found inside and outside the classrooms irrespective of school days or holidays. The respondents were exposed to an average sound level of 85.6 dB (A), a

maximum level of 109.6 dB (A) and a minimum level of 51.7 dB (A). Audiometric test results showed that 45.2% respondents experienced high frequency hearing loss (HFHL) and 61.5% had low frequency hearing loss (LFHL). A typical noise dip was found at 6000 Hz.

There was a significant difference in Verbal Memory 2 ( $t = 2.236$ ,  $p = 0.027$ ). At high pure tone average (HPTA), significant differences were found in Tapping Sequence and Verbal Memory 2 for normal hearing ( $t = 3.173$ ,  $p = 0.002$ ) and hearing impaired respondents ( $t = 2.012$ ,  $p = 0.050$ ), respectively. At low pure tone average (LPTA), there was also a significant difference in total scores ( $t = 2.380$ ,  $p = 0.022$ ) and Verbal Memory 2 ( $t = 2.748$ ,  $p = 0.009$ ) for normal respondents. Respondents with LFHL performed significantly poorer than their normal hearing peers in all subjects ( $t = 2.347$ ,  $p = 0.021$ ), Malay Language ( $t = 2.042$ ,  $p = 0.044$ ) and English Language ( $t = 2.642$ ,  $p = 0.010$ ).

By using Pearson's Correlation, personal LMAX was found to have significant correlation with left ear thresholds at HPTA ( $r = 0.309$ ,  $p = 0.002$ ) and LPTA ( $r = 0.213$ ,  $p = 0.032$ ). Results from Multiple Regression showed that there were significant relationships between right ear thresholds at HPTA with house environment scores ( $\beta = 0.647$ ,  $t = 2.479$ ,  $p = 0.015$ ). As for the left ear, personal LMAX ( $\beta = 0.600$ ,  $t = 2.690$ ,  $p = 0.008$ ) was found to have significant relationship with HPTA thresholds. At LPTA, significant relationships were found between left ear thresholds with clinical history scores ( $\beta = -1.302$ ,  $t = -2.292$ ,  $p = 0.024$ ). There was a significant relationship between academic performance with personal LMAX ( $F = 5.935$ ,  $p = 0.017$ ) and hearing category at HPTA ( $F = 4.560$ ,  $p = 0.036$ ). In

conclusion, noise exerts variable effects on task performance. Exposure to LMAX of over 100 dB (A) tended to have some effects on hearing thresholds and academic performance.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Master Sains

**KESAN BUNYI BISING AND PENDENGARAN KE ATAS PRESTASI  
TUGASAN AND AKADEMIK DI KALANGAN MURID-MURID SEKOLAH  
RENDAH DI KUALA LUMPUR**

Oleh

**CHUA SWEE KIM**

**September 2001**

**Pengerusi: Profesor Madya Dr. Zailina Hashim**

**Fakulti: Perubatan dan Sains Kesihatan**

Bunyi bising merupakan satu ancaman ke atas pendengaran, kesihatan, pembelajaran dan tingkahlaku kanak-kanak. Kajian ini dilakukan untuk menentukan kesan bunyi bising dan pendengaran ke atas prestasi tugas dan akademik di kalangan murid-murid sekolah rendah di Kuala Lumpur. Sejumlah 110 orang kanak-kanak Melayu Darjah Satu yang berumur dari 6 ½ ke 7 ½ tahun telah dipilih sebagai responden berdasarkan kaedah persampelan berstrata. Alat pengukur bunyi dan dosimeter bunyi bising digunakan untuk mengukur tahap bunyi bising persekitaran dan pendedahan bunyi bising individu. Borang soal selidik dan ujian pendengaran telah dijalankan ke atas semua responden. Ujian Prestasi Tugas yang terdiri daripada tujuh ujian yang dipilih dari McCarthy Scales of Children's Abilities dijalankan sebanyak dua kali dalam situasi sunyi dan bising. Prestasi akademik kanak-kanak ditentukan oleh keputusan peperiksaan terkini.

Pengukuran bunyi bising persekitaran mendapati tahap bunyi berterusan equivalen (LEQ), tahap maksimum (LMAX) dan tahap minimum (LMIN) mencapai sekurang-kurangnya 60 dB (A) di dalam dan di luar bilik darjah pada hari bersekolah atau hari

cuti. Responden terdedah kepada 85.6 dB (A) purata tahap bunyi, tahap maksimum 109.6 dB (A) dan tahap minimum 51.7 dB (A). Ujian pendengaran menunjukkan bahawa terdapat 45.2% responden mengalami hilang pendengaran pada frekuensi tinggi (HFHL) dan 61.5% mempunyai hilang pendengaran pada frekuensi rendah (LFHL). Terdapat satu lurah bunyi bising yang tipikal pada 6000 Hz.

Terdapat perbezaan yang signifikan di Memori Verbal 2 ( $t = 2.236$ ,  $p = 0.027$ ). Pada purata frekuensi tinggi (HPTA), terdapat perbezaan yang signifikan di Urutan Ketukan dan Memori Verbal 2 di kalangan responden normal ( $t = 3.173$ ,  $p = 0.002$ ) dan responden yang hilang pendengaran ( $t = 2.012$ ,  $p = 0.050$ ) masing-masing. Perbezaan yang signifikan juga didapati di jumlah skor ( $t = 2.380$ ,  $p = 0.022$ ) dan Memori Angka 2 ( $t = 2.748$ ,  $p = 0.009$ ) bagi responden normal pada purata frekuensi rendah (LPTA). Pencapaian akademik bagi responden yang mempunyai LFHL adalah lebih teruk daripada responden normal dalam semua matapelajaran ( $t = 2.347$ ,  $p = 0.021$ ), Bahasa Melayu ( $t = 2.042$ ,  $p = 0.044$ ) dan Bahasa Inggeris ( $t = 2.642$ ,  $p = 0.010$ ).

Dengan menggunakan Korelasi Pearson, LMAX individu didapati mempunyai korelasi yang signifikan dengan ambang pendengaran telinga kiri pada HPTA ( $r = 0.309$ ,  $p = 0.002$ ) dan LPTA ( $r = 0.213$ ,  $p = 0.032$ ). Keputusan dari Multiple Regression menunjukkan bahawa terdapat hubungan yang signifikan antara ambang pendengaran telinga kanan pada HPTA dengan skor persekitaran rumah ( $\beta = 0.647$ ,  $t = 2.479$ ,  $p = 0.015$ ). Manakala untuk telinga kiri pula, LMAX individu ( $\beta = 0.600$ ,  $t = 2.690$ ,  $p = 0.008$ ) didapati mempunyai hubungan yang signifikan dengan ambang pendengaran HPTA. Pada LPTA, hubungan yang signifikan didapati antara ambang



pendengaran telinga kiri dengan skor sejarah klinikal ( $\beta = -1.302$ ,  $t = -2.292$ ,  $p = 0.024$ ). Terdapat hubungan yang signifikan antara prestasi akademik dengan LMAX individu ( $F = 5.935$ ,  $p = 0.017$ ) dan kategori pendengaran pada HPTA ( $F = 4.560$ ,  $p = 0.036$ ). Secara kesimpulan, bunyi bising mendatangkan kesan yang berlainan ke atas prestasi tugas. Pendedahan kepada LMAX yang melebihi 100 dB (A) dapat menjejaskan pendengaran dan prestasi akademik.

## ACKNOWLEDGEMENTS

Without exception, each of the illustrations was specially selected and prepared for the project paper. Whilst accepting full responsibility for the entire contents, the researcher is indebted to many individuals who have made invaluable contributions in their specialized fields.

The researcher would like to express her deepest thanks to Associate Professor Dr. Zailina Hashim of Environmental and Occupational Health Unit, Department of Community Health, Faculty of Medicine and Health Sciences, Universiti Putra Malaysia who performed the role of project supervisor and editor with seemingly limitless dedication, insights and enthusiasm. Her valuable advice, unfailing patience and encouragement helped the researcher so much in completing this project.

In addition, the researcher's heartfelt thanks to Associate Professor Dr. Siti Zamratol Mai-Sarah of Audiology and Speech Science Department, Faculty of Allied Health Sciences, Universiti Kebangsaan Malaysia who totally dedicated to teach her using the audiometer and interpreting audiogram. Besides, she was extremely grateful to Dr. Iylen Benedict of Pfizer Malaysia Pte. Ltd. for her guidance in noise measurement. Both of the committee members also gave their valuable advices and recommendations in accomplishing this project. Not to forget Dr. Rohani Abdullah of Faculty of Human Ecology, Professor Peter Pook Chuen Keat, ex-Deputy Dean of Faculty of Medicine and Health Sciences, Dr. Long Seh Chin, Head of Department of Community Health, Faculty of Medicine and Health

The researcher would like to forward her appreciation to the members of the Environmental and Occupational Health Unit, Department of Community Health, Faculty of Medicine and Health Sciences, Universiti Putra Malaysia especially Encik Shamsul Bahari and Puan Juliana Jalaludin for their co-operation and guidance. Not forgetting the supports, advices and encouragements given by the researcher's fellow colleagues and friends who have given their precious support and assistance, especially Cik Saliza Mohd. Elias and Puan Junidah Raib. Puan Junidah Raib also guided the researcher on how to perform the tests in McCarthy Scales of Children's Abilities.

Besides, the researcher would like to acknowledge the excellent cooperation given by the Ministry of Education of Malaysia, Kuala Lumpur Department of Education, and especially the authorities, staffs and primary schoolchildren in Kuala Lumpur. Not forgetting their respective parents and family members for their cooperation to the researcher.

Appreciation is also due to the researcher's friends Mr. Lee Ming Enn and Mr. Chan Chew Meng for their guidance and advices. Last but not least, the researcher dedicate this work to family members and loved ones especially the researcher's dearest father, Mr. Chua Lip Chee and Mr. Lim Kok Ann for their support and encouragement throughout the years of her studies. Also to all whom have in one way or another contributed or helped the researcher in completing this project, the researcher wish to forward her gratitude.

I certify that an Examination Committee met on 3<sup>rd</sup> September 2001 to conduct the final examination of Chua Swee Kim on her Master of Science thesis entitled “Impact of Noise and Hearing on Task and Academic Performance of Primary School Children” in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulations 1981. The committee recommends that the candidate be awarded the relevant degree. Members of the Examination Committee are as follows:

Mohd. Yunus Abdullah, Ph.D.  
Associate Professor  
Faculty of Graduate Studies  
Universiti Putra Malaysia  
(Chairman)

Zailina Hashim, Ph.D.  
Associate Professor  
Faculty of Medicine and Health Sciences  
Universiti Putra Malaysia  
(Member)

Siti Zamratol Mai-Sarah, MD, M.Sc.  
Associate Professor  
Faculty of Allied Health Sciences  
Universiti Kebangsaan Malaysia  
(Member)

Rohani Abdullah, Ph.D.  
Lecturer  
Faculty of Human Ecology  
Universiti Putra Malaysia  
(Member)

Iylen Benedict, MD, M. Occup. Health  
Product Physician  
Pfizer (Malaysia) Sdn. Bhd.  
(Member)

  
MOHD. GHAZALI MOHAYIDIN, Ph.D.  
Professor/Deputy Dean of Graduate School  
Universiti Putra Malaysia

Date: 23 NOV 2001

This thesis submitted to the Senate of Universiti Putra Malaysia has been accepted as fulfillment of the requirement for the degree of Master of Science.



---

AINI IDERIS, Ph.D.  
Professor  
Dean of Graduate School  
Universiti Putra Malaysia

Date: 10 JAN 2002

**DECLARATION**

I hereby declare that the thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at UPM or other institutions.



---

CHUA SWEE KIM

Date: 21 Nov 2001

## TABLE OF CONTENTS

	<b>Page</b>
<b>DEDICATION</b>	ii
<b>ABSTRACT</b>	iii
<b>ABSTRAK</b>	vi
<b>ACKNOWLEDGEMENTS</b>	ix
<b>APPROVAL SHEETS</b>	xi
<b>DECLARATION FORM</b>	xiii
<b>LIST OF TABLES</b>	xvii
<b>LIST OF FIGURES</b>	xix
<b>LIST OF ABBREVIATIONS/NOTATIONS</b>	xxii
<b>CHAPTER</b>	
<b>1 INTRODUCTION</b>	<b>1</b>
Introduction	1
Problem Statement	3
Study Justification	4
Terms Definition	7
Conceptual Definition	7
Operational Definition	8
Objective	8
General Objective	8
Specific Objectives	9
Study Hypotheses	9
Conceptual Framework	10
<b>2 LITERATURE REVIEW</b>	<b>12</b>
Characterization of Sound	12
Definition of Sound	12
Frequency	12
Amplitude	13
Time Pattern	14
The Human Ear and Hearing	14
The Anatomy of the Ear	14
How We Hear Sounds	16
The Outer Ear	17
The Middle Ear	17
The Inner Ear	18
The Pathway to the Brain	19
Feedback Mechanisms	20
Sources of Noise	20
Recreational Noise	21
Community Noise	24
Noise and Hearing	27
Types of Hearing Loss	28
Individual Susceptibility	31

Prevalence of Hearing Loss	33
The Significance of Hearing Impairment	35
Noise and Performance	42
Perceptual-Motor Performance	42
Selective and Sustained Attention Tasks	45
Verbal Learning and Memory	49
Intellectual Tasks	51
Effects in the Classroom	53
<b>3 METHODOLOGY</b>	<b>55</b>
Background Information of the Study	55
Location	55
Sampling	56
Data Collection and Measurement	62
Background Information	62
Environmental Noise Exposure	65
Personal Noise Dose Exposure	71
Hearing Ability	72
Task Performance	79
Academic Performance	85
Data Collection Framework	85
Data Analysis	87
Statistical Analysis	87
Study Limitations	87
<b>4 RESULTS</b>	<b>89</b>
Respondents' Background Information	89
Background Information of Respondents' Families	89
Housing Environment	93
Hobby and Activity	95
Clinical History	96
Data Quality Control	98
Standard Operating Procedure	98
Reliability Analysis for Tests in Task Performance	98
Environmental Noise Exposure	101
Outdoor Noise Level	101
Indoor Noise Level	111
Personal Noise Exposures	121
Hearing Profiles	122
Task Performance	125
Academic Performance	130
Correlation Between Hearing Thresholds and Personal Noise Exposures	132
Correlation Between Academic Performance and Personal Noise Exposures	133
Relationship Between Hearing Thresholds and Selected Variables	134



Relationship Between Academic Performance and Selected Variables	137
<b>5 DISCUSSIONS</b>	<b>138</b>
Background Information of Respondents and Families	138
Risk Factors of Hearing Loss	139
Environmental and Personal Noise Exposure	142
Hearing Profiles	143
Task Performance	146
Academic Performance	150
Correlation Between Hearing Thresholds and Personal Noise Exposures	152
Correlation Between Academic Performance and Personal Noise Exposures	154
Relationship between Hearing Thresholds and Selected Variables	155
Relationship Between Academic Performance and Selected Variables	157
<b>6 CONCLUSIONS AND RECOMMENDATIONS</b>	<b>158</b>
Conclusions	158
Recommendations	161
<b>BIBLIOGRAPHY</b>	<b>163</b>
<b>APPENDICES</b>	<b>175</b>
<b>VITA</b>	<b>204</b>

## LIST OF TABLES

<b>Table</b>	<b>Topic</b>	<b>Page</b>
3.1	Noise levels in the classrooms (noise screening)	58
3.2	Type of questions in questionnaire according to parts	62
3.3	Scoring of house environment	63
3.4	Standard of background noise in audiometric booth	76
3.5	Category of hearing	79
3.6	Type of tests in McCarthy Scales of Children's Abilities	80
4.1	Background information of respondents	90
4.2	Parents' years of education	90
4.3	Parents' occupation	91
4.4	Distribution of monthly household income	92
4.5	Characteristics of respondents' houses	93
4.6	Distance of respondents' houses from source of noise pollution	94
4.7	Respondents' hobbies	95
4.8	Positive answers to questions in Clinical History	97
4.9	Reliability analysis of each test in Task Performance in quiet condition	99
4.10	Reliability analysis of each test in Task Performance in noise condition	100
4.11	Outdoor noise level of classrooms	103
4.12	Indoor noise level of classrooms	113
4.13	Respondents' personal noise exposures	121
4.14	Hearing levels based on high pure tone average	123
4.15	Hearing levels based on low pure tone average	124

4.16	Proportion of unilaterality and bilaterality of hearing loss at each frequency range	124
4.17	Comparison of noise levels in testing condition	125
4.18	Comparison of task performance according to testing condition	126
4.19	Comparison of task performance according to testing condition among normal hearing respondents based on HPTA	127
4.20	Comparison of task performance according to testing condition among hearing impaired respondents based on HPTA	128
4.21	Comparison of task performance according to testing condition among normal hearing respondents based on LPTA	129
4.22	Comparison of task performance according to testing condition among hearing impaired respondents based on LPTA	130
4.23	Respondents' academic performance	131
4.24	Comparison of academic performance according to HPTA category	131
4.25	Comparison of academic performance according to LPTA category	132
4.26	Correlation between hearing thresholds and personal noise exposures	133
4.27	Correlation between academic performance and personal noise exposures	134
4.28	Relationship between mean hearing thresholds at high pure tone average (3000-6000 Hz) and selected variables	135
4.29	Relationship between mean hearing thresholds at low pure tone average (500-2000 Hz) and selected variables	136
4.30	Relationship between academic performance and selected variables	137

## LIST OF FIGURES

Figure	Topic	Page
1.1	Malaysia: Traffic noise levels in main cities for Year 1992 and 1998 (Adapted from Department of Environment, 1999)	5
1.2	Conceptual framework	11
2.1	Semi-diagrammatic drawing of the ear	16
2.2	Simplified version of how we hear sounds	17
2.3	Range of maximum sound levels in dBA measured from common recreational, household, hobby, and transportation noises (Adapted from Clark and Bohne, 1985)	22
3.1	School plan	59
3.2	Sampling of respondents stratified according to class and sex	60
3.3	Number of respondents according to class	61
3.4	Measurement points outside classroom	65
3.5	Measurement points inside classroom	66
3.6	Data collection framework	86
4.1	Trend of outdoor noise levels in Standard 1 Beringin classroom during school days and holidays (A) Equivalent continuous sound level (LEQ), (B) Maximum level (LMAX), (C) Minimum level (LMIN), (D) Frequency spectrum of the noise level	104
4.2	Trend of outdoor noise levels in Standard 1 Cempaka classroom during school days and holidays (A) Equivalent continuous sound level (LEQ), (B) Maximum level (LMAX), (C) Minimum level (LMIN), (D) Frequency spectrum of the noise level	105
4.3	Trend of outdoor noise levels in Standard 1 Dahlia classroom during school days and holidays (A) Equivalent continuous sound level (LEQ), (B) Maximum level (LMAX), (C) Minimum level (LMIN), (D) Frequency spectrum of the noise level	106
4.4	Trend of outdoor noise levels in Standard 1 Kenanga classroom during school days and holidays (A) Equivalent continuous sound level (LEQ), (B) Maximum level (LMAX), (C) Minimum level (LMIN), (D) Frequency spectrum of the noise level	107

- 4.5 Trend of outdoor noise levels in Standard 1 Mawar classroom during school days and holidays (A) Equivalent continuous sound level (LEQ), (B) Maximum level (LMAX), (C) Minimum level (LMIN), (D) Frequency spectrum of the noise level 108
- 4.6 Trend of outdoor noise levels in Standard 1 Seroja classroom during school days and holidays (A) Equivalent continuous sound level (LEQ), (B) Maximum level (LMAX), (C) Minimum level (LMIN), (D) Frequency spectrum of the noise level 109
- 4.7 Trend of outdoor noise levels in Standard 1 Tanjung classroom during school days and holidays (A) Equivalent continuous sound level (LEQ), (B) Maximum level (LMAX), (C) Minimum level (LMIN), (D) Frequency spectrum of the noise level 110
- 4.8 Trend of indoor noise levels in Standard 1 Beringin classroom during school days and holidays (A) Equivalent continuous sound level (LEQ), (B) Maximum level (LMAX), (C) Minimum level (LMIN), (D) Frequency spectrum of the noise level 114
- 4.9 Trend of indoor noise levels in Standard 1 Cempaka classroom during school days and holidays (A) Equivalent continuous sound level (LEQ), (B) Maximum level (LMAX), (C) Minimum level (LMIN), (D) Frequency spectrum of the noise level 115
- 4.10 Trend of indoor noise levels in Standard 1 Dahlia classroom during school days and holidays (A) Equivalent continuous sound level (LEQ), (B) Maximum level (LMAX), (C) Minimum level (LMIN), (D) Frequency spectrum of the noise level 116
- 4.11 Trend of indoor noise levels in Standard 1 Kenanga classroom during school days and holidays (A) Equivalent continuous sound level (LEQ), (B) Maximum level (LMAX), (C) Minimum level (LMIN), (D) Frequency spectrum of the noise level 117
- 4.12 Trend of indoor noise levels in Standard 1 Mawar classroom during school days and holidays (A) Equivalent continuous sound level (LEQ), (B) Maximum level (LMAX), (C) Minimum level (LMIN), (D) Frequency spectrum of the noise level 118
- 4.13 Trend of indoor noise levels in Standard 1 Seroja classroom during school days and holidays (A) Equivalent continuous sound level (LEQ), (B) Maximum level (LMAX), (C) Minimum level (LMIN), (D) Frequency spectrum of the noise level 119
- 4.14 Trend of indoor noise levels in Standard 1 Tanjung classroom during school days and holidays (A) Equivalent continuous sound level (LEQ), (B) Maximum level (LMAX), (C) Minimum level (LMIN), (D) Frequency spectrum of the noise level 120

4.15	Trend of mean hearing thresholds for left and right ear at each tested frequency	122
------	--	-----

**LIST OF ABBREVIATIONS/NOTATIONS**

EPA	Environmental Protection Agency
HPTA	High pure tone average
LPTA	Low pure tone average
HFHL	High frequency hearing loss
LFHL	Low frequency hearing loss
LEQ	Equivalent continuous sound level
LMAX	Maximum level
LMIN	Minimum level
MSCA	McCarthy Scales of Children's Abilities
WHO	World Health Organization

## CHAPTER 1

### INTRODUCTION

#### Introduction

Noise is a normal feature of life and provides one of the most effective alarm systems in man's physical environment. It is an accompaniment to most human activity and as such may constitute a hazard or stimulant. Noise is generally identified as any unwanted sound that may have adverse effects on man.

With increasing population and urbanization, exposure to high intensity traffic is becoming a critical environmental problem in recent years. High intensity traffic poses a threat to our physical and mental health. Road traffic noise is a frequent, unavoidable and continuously increasing environmental factor of modern life. The acoustic study implemented throughout a neighborhood of Valencia (Spain) revealed that traffic was the major source of noise, followed by noise from neighbors and factories (Aparicio *et al.*, 1993). Noise acts as a nonspecific stressor on the human organism. Thus, the pathways of noise processing may be different with greater emphasis on either the sympathicotonic or humoral axis.

Of the many health hazards related to noise, hearing loss is the most clearly observable and measurable by health professionals. For many of us, there may be a risk that exposure to the stress of noise increases susceptibility to disease and infection. The more susceptible person may experience noise as a complicating factor in heart



problems and other diseases. Noise that causes annoyance and irritability in healthy persons may have serious consequences for those already ill in mind or body.

More than 20 million Americans are exposed to hazardous noise on a regular basis that could finally lead to hearing loss (Consensus Conference on Noise and Hearing Loss, 1990). In United States, occupational deafness is among the 10 leading occupational diseases (Hearing Institute For Children and Adults, 1998). Live or recorded high-volume music, lawn-care equipment and some household appliances are examples of non-occupational sources of potentially hazardous noise. Noise induced hearing loss (NIHL) is preventable except for certain cases of accidental exposure.

Besides that, noise can also lead to other forms of non-auditory effects. Children attending kindergartens situated in areas with traffic noise  $> 60$  dB (A) had higher systolic blood pressure and diastolic blood pressure and lower mean heart rate than children in quiet areas (Regecova and Kellerova, 1995). Study by Nivision and Endresen (1993) showed a strong correlation between the subjective noise responses of annoyance and sensitivity and health complaints among 47 women and 35 men living beside a street with moderate to heavy traffic.

Noise affects communication, it creates a ripple of effects, with a negative impact on a person's social, vocational and emotional well-being. Therefore, children study in schools that are located near busy and noisy road are at risk of experiencing the health effects of noise, especially hearing loss. Hearing loss can result in the loss of concentration and lowering of attention. Consequently, hearing-impaired students will