

## Original articles

# Noise level measurement and its effects on hospital employees based on complaint reports

## *Medida do nível de ruído hospitalar e seus efeitos em funcionários a partir do relato de queixas*

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This study's data collection was conducted at the Governador Valadares City Hospital.

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## ABSTRACT

**Purpose:** to assess the noise level in different environments of a public hospital and to analyze its effects on employees from reporting complaints.

**Methods:** a quantitative, descriptive and cross-sectioned study. To survey data, we used a Minipa® decibelimeter adjusted in the range 40-130 decibels positioned in different hospital departments in different shifts for a week to evaluate noise levels and an adapted questionnaire that was applied to employees.

**Results:** the level of noise introduced minimum of 52.5 decibels in the Intensive Care Unit (NICU) and a maximum of 85 decibels in the women's ward with a significant difference between the different days of the week during the same turn. The same occurred in the emergency room, but did not show significance in other sectors. Employees feel discomfort to loud sounds, 74.4%, and 35.5% feel sick after hours due to stress caused by noise that is produced by multiple devices combined with the sounds of alarms, works, visits and schedules conversation between the hospital staff.

**Conclusion:** noise levels are above the recommended levels in different sectors and professionals manifest discomfort and tinnitus before and after their exposure.

**Keywords:** Noise; Public Hospital; Occupational Risks

## RESUMO

**Objetivos:** avaliar o nível de ruído em diversos ambientes de um Hospital Público e analisar seus efeitos em funcionários a partir do relato de queixas.

**Métodos:** estudo quantitativo, descritivo e transversal. Utilizou-se para levantamento dos dados um decibelímetro Minipa® ajustado na escala de 40 a 130 decibels posicionado em diferentes setores do hospital em turnos diferentes, durante uma semana, e um questionário adaptado que foi aplicado aos funcionários.

**Resultados:** o nível de ruídos apresentou valor mínimo de 52,5 decibels na Unidade de Terapia Intensiva (UTI) Neonatal e máximo de 85 decibels na Enfermaria Feminina com diferença significativa entre os diferentes dias da semana durante o mesmo turno. O mesmo ocorreu no Pronto Socorro, mas não apresentou significância nos demais setores. Os funcionários sentem desconforto a sons fortes, 74,4%, e 35,5 % sentem mal estar e cansaço devido ao estresse provocado pelo ruído que é produzido por vários dispositivos combinados com os sons de alarmes, obras, horários de visitas e conversação entre os funcionários do hospital.

**Conclusão:** os níveis de ruído estão acima do recomendado nos diferentes setores e os profissionais manifestam desconforto e queixa de zumbido antes e após à sua exposição.

**Descritores:** Ruídos; Hospital Público; Riscos Ocupacionais

## INTRODUCTION

Noise pollution is the emission of continuous undesirable noises disrespecting legal levels which, within a specific period of time, pose a threat to human health and collective well-being. Noise may be described as aperiodic acoustic signals originated from the overlap of several vibration movements with different, unrelated frequencies<sup>1</sup>.

Noise has been increasing over the years, specifically in large metropolitan areas. This increase is also perceived inside hospitals. Different noises originated from distinct sources, such as the operation of different devices and conversation among professional cause noise pollution in the hospital environment and this may affect the individual's physical and emotional health<sup>2</sup>. According to the World Health Organization (WHO), noise may influence individuals' professional performance and quality of life, as it interferes with sleep, communication, and causes physiological and psychological reactions that are, most times, considered health problems<sup>3</sup>.

The body perceives the exposure to noise as a stressful situation, responding to it with an increase in seric levels of adrenaline and cortisol, which may interfere with the recovery of a hospitalized patient. On the other hand, an environment with adequate sound levels provides the patient with lower levels of psychological stress and physiological damage, leading to a speedier recovery<sup>4</sup>.

A study has identified that 34.0% of hospital sources of noise are completely avoidable and 28.0% are partially avoidable. The authors also state that physical solutions may reduce 48.0% of the sources of noise, and team training may reduce 14.0% of these sources<sup>5</sup>.

According to the *United States Environmental Protection Agency*<sup>6</sup>, noise levels in hospital environments should not exceed 45 dB during the day and 35 dB during the night. The WHO recommends 30 to 40 dB for internal hospital environments. The NBR 10151<sup>7</sup> and 10152<sup>8</sup> by the Brazilian Association of Technical Norms (ABNT) have set noise levels that are compatible with acoustic comfort in hospital areas, aiming at the comfort of the community. The NBR 10151 establishes the following measurements for several hospital environments: rooms, infirmary, maternity and surgical wards 35 to 45 dB; laboratories and public use areas 40 to 50 dB; services 45 to 55 dB.

There are several recommendations for reducing hospital noise levels, and education towards noise control and noise monitoring were the most mentioned

in Brazilian studies. This emphasizes the importance of team training, good work practices, and the need for management and hospital equipment maintenance, in order to reduce noise levels<sup>9</sup>.

The concern with excessive noise in hospital environments has been motivating researches in the study of the perception of health professional regarding noise, with the purpose of developing strategies for its reduction, since hospital noise comes from within the hospital itself. Thus, the following study is justified as it constitutes a preliminary step in subsidizing the implementation of a participative program for noise reduction.

Therefore, the purposes were to measure the noise level in several environments of a Public Hospital in Governador Valadares and to analyze its effects on the employees based on their complaints.

## METHODS

This is a quantitative, descriptive, cross-sectional study, approved by the Ethics Committee of the Federal University of Juiz de Fora – Biological Science Institute, under number 771.745. Research took place in a public hospital in the city of Governador Valadares that is a reference institution for tertiary treatment in the region of Governador Valadares, in the east of the state of Minas Gerais. This is the only completely public hospital in the region and cares for about 900 people each day in a population of 1.5 million inhabitants from over 80 cities<sup>10</sup>. Two instruments were used in data survey: questionnaire responses and hospital noise measurements. All of the professionals involved in the study had their questions about the research answered, and signed a free informed consent term.

In order to analyze hospital environment noise a MSL-1325A, Minipa® decibel meter was used, set for slow response time (*slow*) in order to verify the fluctuating mean noise level. The A-weighting was analyzed and this is the most widely used to measure sound intensity in a given environment, simulating the human ear's response curve, indicated for apprehension of continuous noise (Leq). Measurement band was adjusted on the 40 to 130 dB scale. The equipment was positioned at 1.5m from the ground, in the measurement sectors, without previous knowledge of the professionals.

## Data survey

Noise level measurements were collected during one week (Monday through Sunday) in all shifts (morning, afternoon and night). The criteria for choosing the time of observations were the proportion of number of weekdays and weekends. Six random measurements were taken in a single time per shift, alternating the time among each day's shifts, based on the variation of the caregiving routine in the different hospital sectors where the measurements were taken. The sectors where measurements were held were: Maternity ward, Neonatal Intensive Care Unit (NICU), Male Infirmary, Female Infirmary, Emergency Room and Pediatrics Ward. The hospital has three floors and the largest sectors on the third floor are the Maternity ward and the NICU, the largest on the second floor are the Male and Female Infirmaries and on the first floor, the Emergency Room and Pediatrics ward. These places hold the largest number of patients and employees.

The observation was held in a non-structured way and the records were made on a log where the hour and minute of noise occurrence, as well as the factors that caused it were recorded. Continuous and impact noises were registered. At the end of the data survey, the data were transferred to a Microsoft Office Excel® spreadsheet for analyses.

During the period of data survey the hospital employees answered a questionnaire adapted from Fernandes and Morata 2002<sup>11</sup> and Siqueira 2012<sup>12</sup>(Appendix). The involved workers compose a group characterized as a multidisciplinary team as it involves health professionals and public service aids. The questionnaire was composed of 30 questions, aiming to identify the professional's profile, possible hearing disorders and the existence of health problems. Furthermore, there was a space for open-ended writing so that the employer would mention the causes of stress in his/her work routine. The sample was calculated using a proportion estimate, with confidence level

of 95,0% (critical value: 1.96), estimate error of 1,0% and 50% prevalence. The adjustment for finite populations was used, according to the number of employees working in the hospital provided by the institution's statistics department. There was a 10% addition in order to compensate for eventual losses. The final sample was composed of 235 workers, randomly selected during their work routine.

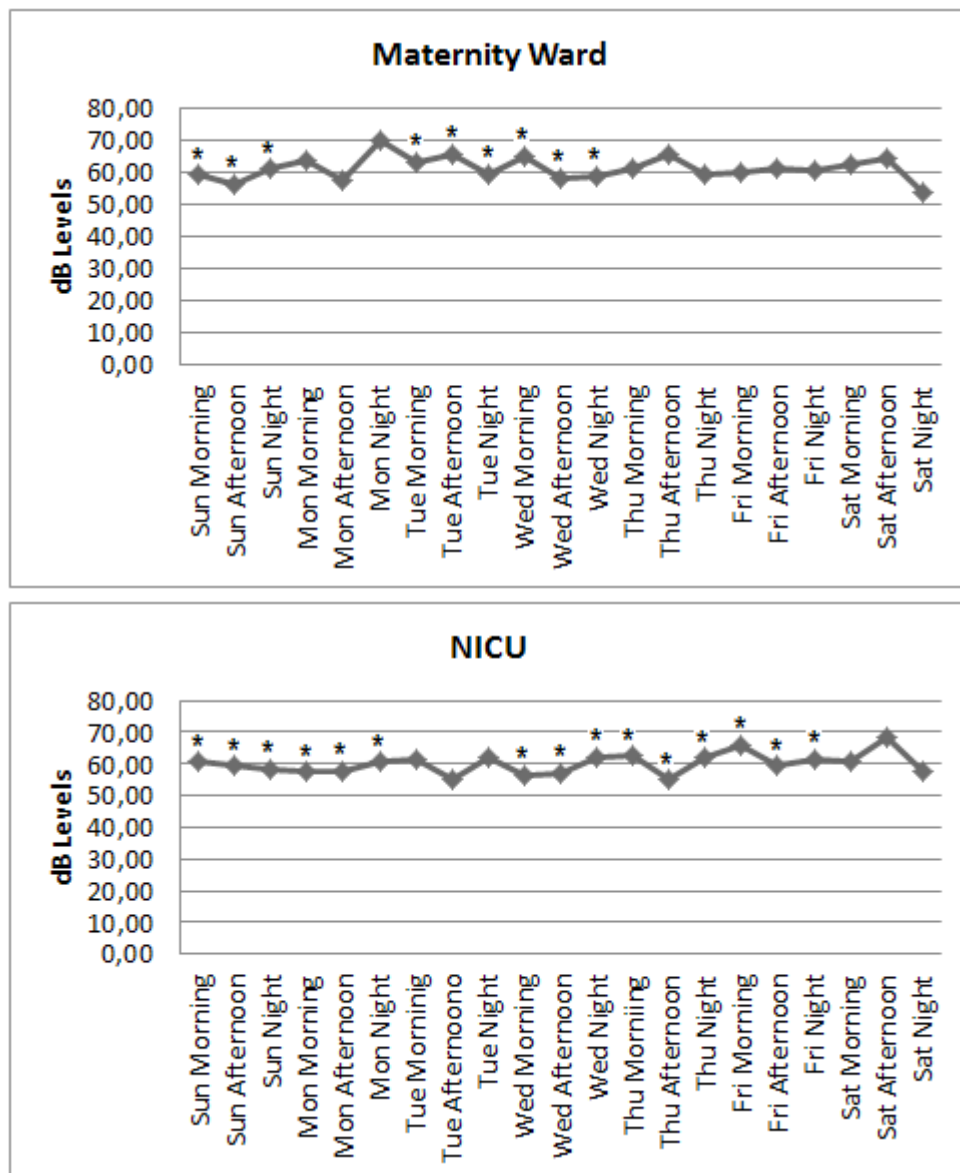
## Statistical Analysis

The following software were used for data analysis: IBM® SPSS Statistics 20.0 (software License IBM SPSS Statistics v.22.0, Series: 10101151004, 15 Authorized Users, Module: Basis)for Windows® and Microsoft Office Excel 2010®. In order to analyze noise levels, Microsoft Office Excel® was used for single-factor variance analysis for the same shift of different days of the week and different shifts within the same day. In order to analyze the answers to the questionnaires, descriptive analysis in percent distribution was used to characterize the variables. The significance value was set at  $P \leq 0.05\%$ .

## RESULTS

Noise levels in the hospital had minimum value of 52.5 dB in the NICU on Tuesday and Thursday during the afternoon, and maximum of 85 dB in the female infirmary on Sunday, during the morning shift.

In the Maternity Ward, the minimum registered level was on Saturday, 53.75 dB, and the maximum was 69.50 dB on Monday, both during the night. On Sunday, Tuesday and Wednesday there was a significant difference in noise level among the three shifts, with p value = 0.00056; 0.03 and 0.0002 respectively. On the remaining days of the week there was no significant difference among the shifts (Figure 1).The noise generating source in this sector was conversation of patients and professionals.

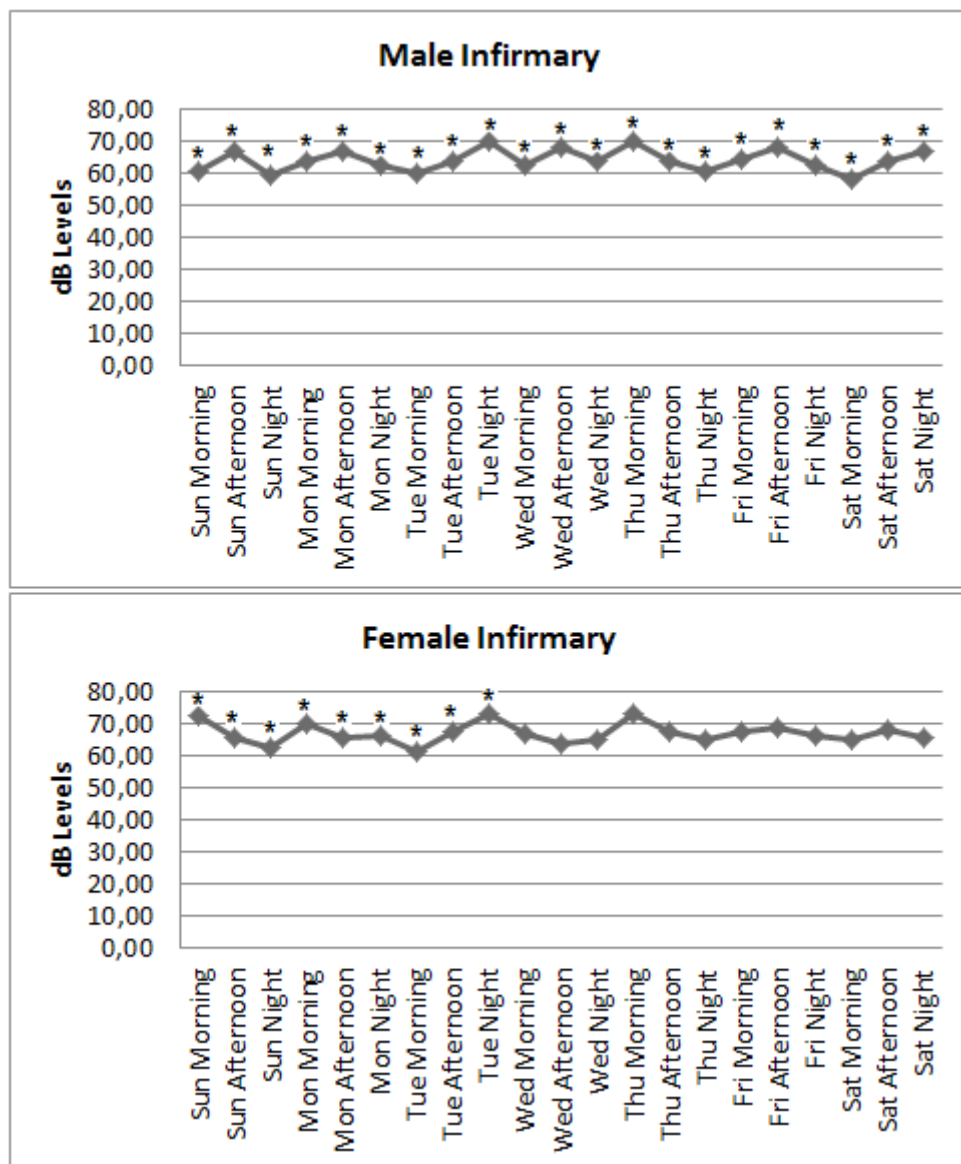


\* P ≤ 0.05, Sun = Sunday; Mon = Monday; Tue = Tuesday; Wed = Wednesday; Thu = Thursday; Fri = Friday; Sat = Saturday.

**Figure 1.** Noise levels at the Maternity Ward and NICU during the week over all three shifts.

In the NICU, the noise levels varied from 52.5 dB to 72 dB. There was a statistically significant variation among the shifts on Sunday, Monday, Tuesday, Thursday and Friday (Figure 1). The noise generating sources in this sector were the loudspeaker and the machines next to the incubators.

In the Male Infirmary there were statistically significant oscillations among the shifts with p value ≤ 0.05 on Monday and p ≤ 0.02 on the remaining days of the week. Noise levels varied from 58 to 82.5 dB (Figure 2).



\*  $P < 0,05$  and  $P < 0,02$  respectively, among the shifts of a same day of the week. Single-factor variance analysis for the same shift in different days of the week and different shifts of a same day.

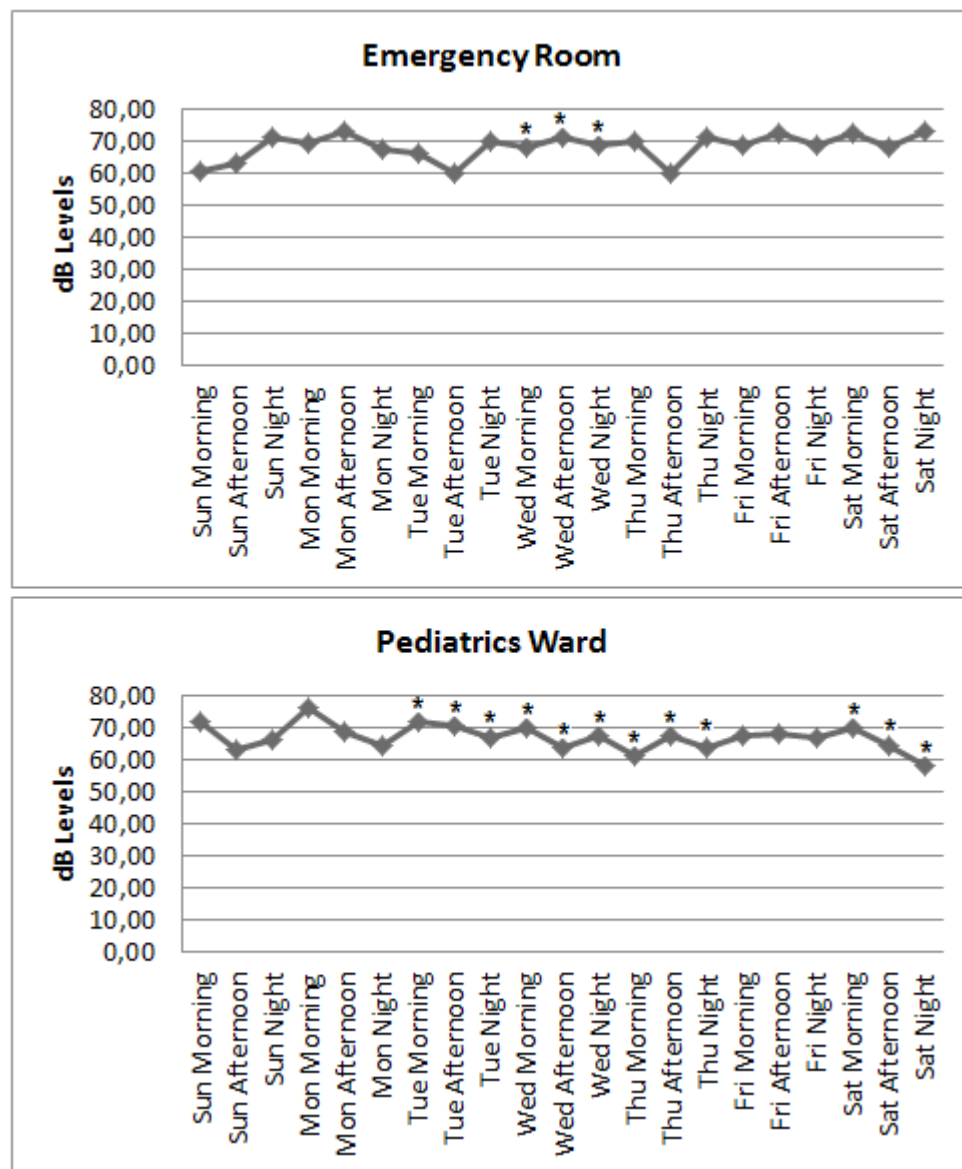
Sun = Sunday; Mon = Monday; Tue = Tuesday; Wed = Wednesday; Thu = Thursday; Fri = Friday; Sat = Saturday.

**Figure 2.** Noise levels in the male and female infirmaries during the week, on all three shifts.

In the Female Infirmary there were also noise level oscillations, where the minimum value was 60 dB and maximum was 85 dB with a statistically significant difference among the three shifts on Sunday, Monday and Tuesday,  $p$  value  $\leq 0,02$ , (Figure 2). In both the Female and Male Infirmaries, the noise generating sources were the loudspeaker conversation of

employees, patients and the machinery for monitoring vital signs.

In the Emergency Room, there was a significant difference in noise levels among the three shifts only on Wednesday, with  $p$  value  $\leq 0,05$ . Noise levels varied from 60.5 dB to 85 dB (Figure 3).



\*  $P \leq 0,05$  and  $P \leq 0,03$  respectively, among the shifts of a same day of the week. Single-factor variance analysis for the same shift in different days of the week and different shifts of a same day. Sun = Sunday; Mon = Monday; Tue = Tuesday; Wed = Wednesday; Thu = Thursday; Fri = Friday; Sat = Saturday.

**Figure 3.** Noise levels in the emergency room and pediatrics Ward during the week, on all three shifts.

The Pediatrics Ward had noise oscillations during the three shifts on Tuesday, Wednesday, Thursday and Saturday, with  $p$  value  $p$  valor  $\leq 0.03$ . The minimum and maximum recorded values were 60 and 81.5 dB, respectively (Figure 3). Noise generating sources in Pediatrics and in the Emergency Room were the loudspeaker and conversation of employees and patients.

There was a significant difference in noise levels among the different days of the week during the same shift in three sectors of the hospital (Female Infirmary, NICU and Emergency Room). In the Female Infirmary, the noise levels on different days of the week were

statistically significant, with  $p$  value = 0.006 in the morning, 0.016 (afternoon) and 0.003 (night). In the NICU,  $P = 0.0004$  in the morning shift and  $P = 0.006$  on the night shift. At the Emergency Room, there was a significant difference among the different days of the week only on the morning shift ( $P = 0.0001$ ). For the other sectors, there was no significant difference in noise levels among the days of the week during the same shifts.

The questionnaire was answered by 235 professionals who were employees or interns at the hospital. The information according to participant occupation is shown in Table 1.



**Table 1.** Professionals of the Public Hospital in Governador Valadares who answered the questionnaire (n=235)

Variable	n	%
Occupation		
Public service assistant	96	40.9
Nursing aids	73	31.1
Nurses	26	11.1
Doctors	13	5.5
Interns	6	2.6
Laboratory Technicians	7	3.0
Radiology Technicians	4	1.7
Social Service Professionals	6	2.6
Psychology	3	1.3
Physical Therapists	1	0.4

Table 2 shows the frequency distribution of habits and symptoms caused by noise as reported by hospital professionals. Regarding the habits, 46.8% feel the need to adjust radio or television volumes when they are in the presence of someone else, 26.4% often go to noise places and only 4.3% use hearing protection. The vast majority, 88.1%, has good hearing, but 35.3% feel

sick at the end of the work day, 75.7% report discomfort related to loud noise and 20.9% have tinnitus. Tinnitus complaint was not correlated to occupational exposure since the question referred only to its presence or absence. Other factors in the hospital were referred to as stressful. Among these, noise and tumult were the most frequently reported.

**Table 2.** Habits and Symptoms caused by noise

Questions	Yes (%)	No (%)
Feeling sick at the end of the workday	35.3	64.7
Difficulty hearing what people say	29.8	70.2
Need to adjust volume	46.8	53.2
Goes to noisy places	26.4	73.6
Feels uncomfortable about loud noises	75.7	24.3
Uses hearing protection	4.3	95.7
Hears well	88.1	11.9
Ear ache	8.5	91.5
Tinnitus	20.9	79.1

## DISCUSSION

This study measured the noise levels in places with greater number of people, and analyzed its effects based on the reports of employees so that actions may be planned and conducted in order to reduce them. These actions are needed since noise levels found in all moments of measurement were excessively above ABNT and WHO recommendations for hospital environments.

Sound levels obtained in the maternity ward varied between 53 and 69 dB and studies have shown that the noise in maternity wards is considered a risk factor for privacy and success in breast feeding<sup>13</sup>, newborn development, health of pregnant women and recuperation of puerperal women<sup>14</sup>. Interruption of sleep and rest, caused many times by noise, may negatively influence the child's health recovery process<sup>15,16</sup>. For a newborn, staying in a noisy environment for over 48 hours is considered a risk factor for hearing disorders<sup>17</sup>.

Pivatto and Gonçalves (2013)<sup>18</sup> have also found high sound levels in a public maternity hospital in Curitiba, where values varied from 45.6 dB to 67.5 dB in the pediatrics room and nursing post, respectively during the morning shift and 65.3 dB in the visitation room during the afternoon.

A study conducted by Kakehashi *et al.*<sup>19</sup> in a NICU recorded Leq between 61.3 and 66.6 dBA, larger on weekend days with peak values varying between 90.8 and 123.4 dBC, louder during the night shift. The main sources were alarms coming from ventilators and oximeters, conversation between professionals and parents. These results may be compared to those found in the NICU of the hospital in this study where the noise levels varied between 52.5 dB to 72 dB, higher than those recommended by the ABNT, that sets sound pressure levels at between 35 to 45 dB in these wards.

Carvalho *et al.*<sup>20</sup> found, in a pediatric intensive care unit with 10 beds at a university hospital in the city of São Paulo, a basal noise level between 60 and 70 dB with 120 dB peaks. The higher levels happened during the day, due to professional activity and communication. These values are similar to those recorded in the Pediatrics ward that varied between 60 and 81.5 dB. These levels are above those recommended by the ABNT, WHO and the *American Academy of Pediatrics*.

In the Male and Female Infirmaries, as well as in the Emergency Room, values exceeding those set by the ABNT and the WHO were found (Figures 2 and 3). Values above those that are recommended may cause physiological and psychological effects on the medical care team, such as tinnitus, stress, higher risk of work accidents (either for not hearing orders correctly, or for the fact that noise may be distracting)<sup>21</sup>, abnormal social behavior, muscle tension, higher blood pressure and insomnia<sup>22</sup>. All of these effects may be worsened if individuals are exposed continuously to noise levels of 85 dB for over eight hours, according to Oliva (2008)<sup>23</sup>.

Regarding the participant professional, there were more public service aids, represented by doormen, receptionists, kitchen, laundry and cleaning workers, administration team (40.9%), followed by nursing technicians (31.1%), nurses (11.1%) and doctors (5.5%) (Table 1). Regarding the perception of the professionals about the noise in the hospital context, they consider their work environment noisy and are bothered by noise.

A study shows the negative effects of noise on the quality of life of the health professional in hospital

environments<sup>24</sup>, and their most frequent complaint is tinnitus. Even though the noise levels in different hospital sectors may not be associated to the professionals' complaints, literature shows that sound pressure levels above recommendation cause unhealthy physiological and psychological disorders to the employees<sup>4</sup> which may affect both their work routines and the patients' rest and recovery<sup>2</sup>.

The results in this study show the need for developing actions that will change management and maintenance of noise generating equipment, as well as provide information to health professionals and those of related fields about the harmful effects of occupational exposure to noise. These effects may be diminished with the development of educational programs and preventive measures in monitoring noise levels in different hospital sectors during the three shifts in different days of the week.

## CONCLUSION

Noise levels are elevated in the Maternity Ward, NICU, male and female infirmaries, pediatrics Ward and emergency room and professional report discomfort and tinnitus complaints before and after exposure.

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## Appendix

### Assessment Questionnaire for the Workers Exposed to Noise in a Public Hospital in Governador Valadares

The following questionnaire aims to collect data for the study named "Quantification and perception of noise in the hospital environment". Read the questions below and answer them objectively. If you have any questions, ask the interviewer.

1. What is your occupation? \_\_\_\_\_
2. Do you feel any sickness at the end of the work day? ( ) Yes ( ) No
3. Do you experience any difficulties hearing what people say? ( ) Yes ( ) No
4. Do you feel the need to adjust the volume of the radio or television set when you are in someone else's presence? ( ) Yes ( ) No
5. Do you live in or go to noisy places where you need to speak loudly in order to talk? ( ) Yes ( ) No
6. Are you uncomfortable around loud noises? ( ) Yes ( ) No
7. Do you use hearing protection? ( ) Yes ( ) No
8. Is your hearing good? ( ) Yes ( ) No
9. Do you experience ear aches? ( ) Yes ( ) No
10. Do you experience tinnitus? ( ) Yes ( ) No
11. Do you have headaches? ( ) Yes ( ) No
12. Do you feel dizzy? ( ) Yes ( ) No
13. Do you have stomach problems? ( ) Yes ( ) No
14. Do you experience difficulty sleeping? ( ) Yes ( ) No
15. Do you have diabetes? ( ) Yes ( ) No
16. Do you feel your heart pounding? ( ) Yes ( ) No
17. Do you have insomnia? ( ) Yes ( ) No
18. Do you experience memory problems? ( ) Yes ( ) No
19. Do you have difficulties paying attention? ( ) Yes ( ) No
20. Are you irritable? ( ) Yes ( ) No
21. Do you experience anxiety? ( ) Yes ( ) No
22. Are you depressive? ( ) Yes ( ) No
23. Do you feel lonely? ( ) Yes ( ) No
24. Do you feel fatigue? ( ) Yes ( ) No
25. Do you lose your appetite? ( ) Yes ( ) No
26. Do you have blood pressure problems? ( ) None ( ) Low ( ) High ( ) Low and High - unregulated
27. Do you easily become ill? ( ) Yes ( ) No
28. Have you noticed any changes in your hearing after a serious illness? ( ) Yes ( ) No
29. Is there anything stressful in your work routine? ( ) Yes ( ) No
30. If so, what is the cause of stress?