Revista Nacional de
Gerenciamento de Cidades
ISSN eletrônico 2318-8472, volume 09, número 69, 2021

Influence of the COVID-19 pandemic on the external environmental noise of a public hospital in Sorocaba, Brazil

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Revista Nacional de
Gerenciamento de Cidades
ISSN eletrônico 2318-8472, volume 09, número 69, 2021

ABSTRACT

This study aimed to evaluate environmental noise around a public hospital in the city of Sorocaba, Brazil, before and during the COVID-19 pandemic. The measurements were performed in triplicate, on weekdays, at three points around the hospital during the night, and followed the guidelines of the NBR 10151/2019 standard. At the same measurement points, the manual counting of light vehicles, heavy goods, and motorcycles was performed. The equipment used was the BK 2260 analyzer and the BK 4231 calibrator. For statistical analysis, data normality was verified through the Shapiro-Wilk test and, later, the differences in sound levels before and during the pandemic through the paired t-test. The correlation between sound levels and the number of vehicles was verified by Spearman's correlation. The level of significance adopted was α=0.05. There was a significant reduction in the movement of light and heavy vehicles during the pandemic and less reduction for motorcycles. It was found that P1 was the noisiest point and the one with the lowest variation in dB(A) during the pandemic, associated with higher speed and greater circulation of vehicles. Although there is a strong correlation between the number of vehicles and sound levels, statistically there was no significant difference. It is concluded with this work that there was a reduction in environmental noise around the hospital during the pandemic and that other factors should be taken into account, such as the speed of vehicles.

KEYWORDS: Noise pollution. Sars-CoV-2. Social isolation.

1. INTRODUCTION

Reality around the world, in developed and underdeveloped countries, noise pollution or noise is not only restricted to industrial environments but also affects small, medium and large cities (ZANNIN and BUNN, 2014). According to the World Health Organization (WHO), noise pollution is already considered as the third leading cause of global pollution, behind only air and water pollution (WHO, 2011).

Among the problems that noise causes in human health and comfort, depending on duration and volume, they can be divided into four categories: physical effects such as noise-induced hearing loss (NIHL) (SILVA et al., 2011; ZAW et al., 2020); physiological effects such as cardiovascular diseases (SORENSEN et al., 2017; VAN KEMPEN et al., 2018; HÉRITIER et al., 2018); psychological effects such as sleep disorders (BASNER and McGUIRE, 2018), anger, fatigue and stress (GUSKI et al., 2017; PAIVA et al., 2019); effects on work performance such as reduced productivity and increased chance of errors (LOUPA et al., 2019).

Hospital areas, which are considered environments even more sensitive to noise pollution, are mainly affected by noise generated by vehicle traffic (MONTEZ-GONZÁLEZ et al., 2019). Noise significantly disrupts patients' sleep, delaying their rest and recovery (LOUPA, 2020), also, increase the chance of medical errors, bothering visitors, and the hospital as a whole (MONTEZ-GONZÁLEZ et al., 2019; ZANNIN et al., 2019). According to the U.S. Environmental Protection Agency, the maximum permissible amount of noise in areas around hospitals is 55 dB(A) during the day and night (EPA, 1974). In Brazil, according to NBR 10151/2019, sound pressure levels around hospitals should not exceed 50 dB(A) during the day and 45 dB(A) at night (ABNT, 2019).

Several studies have evaluated noise levels around hospitals (ZANNIN and FERRAZ, 2016; RAVINDRA et al., 2016; 2019; ZANNIN et al., 2019), however, these studies are shown in the form of diagnosis. Noise mitigation measures and comparison before versus after, are complex due to several factors, such as the number of vehicles in circulation, the number of heavy vehicles in circulation, the dynamics of the area, and others. Sound level comparations with mitigating measures are usually restricted to simulations in acoustic software, in addition to modeling hypothetical scenarios. In the study by Fiedler and Zannin (2015), the authors

performed acoustic simulations applying a reduction of 50% of the total number of vehicles and 50% of heavy vehicles that transit the roads around two hospitals. In the study by Rossi et al. (2020), the authors estimated the benefits in quality of life in residents of the city of Lausanne with the implementation of reduction in vehicle speed to 30 km/h.

With the COVID-19 pandemic, quarantine, and social isolation measures, studies report a significant reduction in environmental noise (ASENSIO et al., 2020a; ZAMBRANO-MONSERRATE et al., 2020). On the other hand, the scientific community in the area of acoustics is mobilized, taking advantage of this rare opportunity to perform acoustic measurements in different locations, to understand the changes in environmental noise due to restrictive measures in urban mobility, that is, to compare existing measurements before COVID-19 and during it, where there was a restriction on the movement of people and vehicles (ZAMBRANO-MONSERRATE et al., 2020).

In this context, this study aimed to evaluate the nocturnal environmental noise around a public hospital located in the city of Sorocaba-SP, before and during the COVID-19 pandemic, to verify whether there was a reduction in the circulation of vehicles.

2. METHODOLOGY

2.1 STUDY AREA

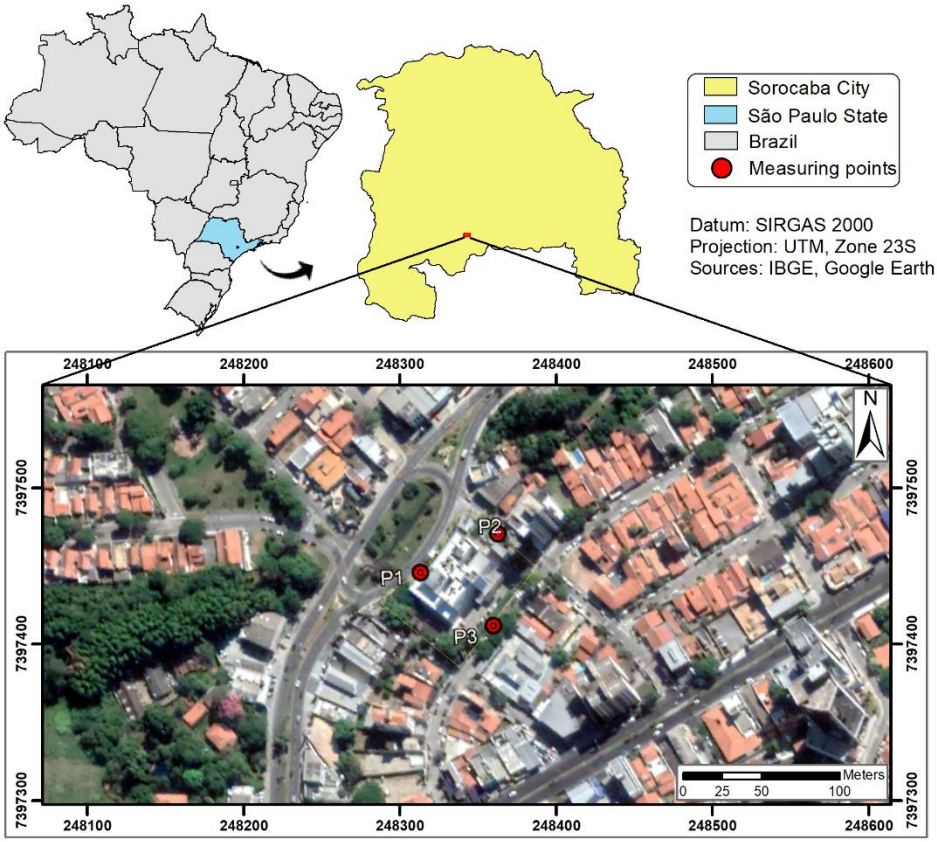
The city of Sorocaba is located in the interior of the State of São Paulo, approximately 100 km from the capital, and has about 679,378 inhabitants (IBGE, 2020). It has great representation in the trade and services sector, in addition to the industrial sector, and is also a regional and national reference in some medical-hospital segments.

The hospital of the present study, The Group of Research and Care for Childhood Cancer (GPACI), makes pediatric care (clinical, surgical, and oncologic specialties), being an oncology reference for the thousands of people from the 48 municipalities served by the hospital (Regional Health Directorate XVI - Sorocaba) and in clinical and surgical pediatrics for the city of Sorocaba. It serves an average of 700 patients per week.

The hospital is located in an urban environment in the city center, in a region with high population density and with several vertical constructions. The avenue located in front of the hospital is a route of interconnection between several neighborhoods, from north to south and from east to west in the municipality. Figure 1 shows the location of the city of Sorocaba and the noise measurement points around the hospital.

Revista Nacional de
Gerenciamento de Cidades
ISSN eletrônico 2318-8472, volume 09, número 69, 2021

Figure 1: Location of the hospital and noise measurement points.



Source: Prepared by the authors (2020).

2.2 ACOUSTIC MEASUREMENTS AND VEHICLE COUNTING

Noise measurements were performed around the hospital at night (from 10:00 pm to 6:00 am), before the COVID-19 pandemic (June/2019) and during the pandemic (April/2020). There were three sound pressure level measurement points in the surrounding streets – P1, P2, P3 -, where each point had a period of recording sound levels for ten minutes each, in triplicate, made on different working days (FIEDLER and ZANNIN, 2015; SOUZA FILHO et al., 2015).

The equipment used were: BK 2260 analyzer (Brüel & Kjær, Denmark), acoustic calibrator BK 4231 (Brüel & Kjær, Denmark), and tripod with adjustable height. The measurements and allocation of equipment followed the guidelines of NBR 10151/2019. The equipment was adjusted at fast response time, weighting circuit "A" (which best represents the response level of the human ear), and the measuring range was adjusted between 20 and 120 dB(A). The sound levels measured were the equivalent sound level (Leq), the minimum equivalent level (Lmin) and the maximum equivalent level (Lmax). At the same points, the manual counting of light vehicles (LV) was performed, characterized by cars, vans and pickup trucks; heavy vehicles (HV) such as trucks and buses; and motorcycles (M), for 1 hour.

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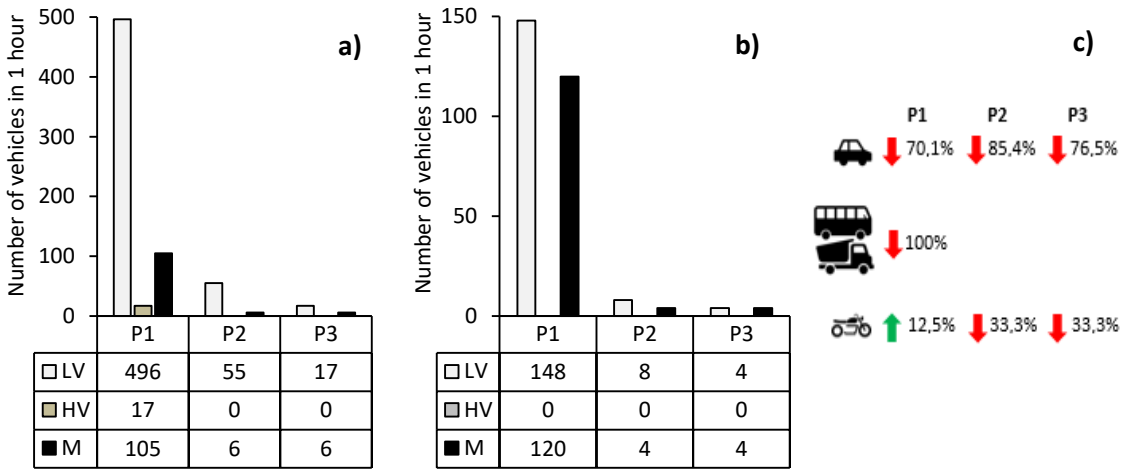
2.3 STATISTICAL ANALYSIS

For statistical analysis, data normality was verified using the Shapiro-Wilk test and, later, the differences in sound levels before and during the pandemic through the paired t-test. The correlation between sound levels and the number of vehicles was verified by Spearman's correlation. The significance level adopted was α=0.05 and the statistical software used was Past version 4.03 (HAMMER et al., 2001).

3. RESULTS AND DISCUSSION

Differences in the number of vehicles before and during the pandemic can be seen in Figure 2. There was a reduction from 70.1 to 85.4% (P1 and P2) in the number of LV during the pandemic. For HV, the reduction was more significant, with 100% in P1. On the other hand, there was an increase of 12.5% in the circulation of motorcycles in P1, the avenue of greater circulation around the hospital, and a reduction of 33.3% in points P2 and P3.

Figure 2: Number of vehicles before and during the pandemic.



	P1	P2	P3
LV	496	55	17
HV	17	0	0
M	105	6	6

	P1	P2	P3
LV	148	8	4
HV	0	0	0
M	120	4	4

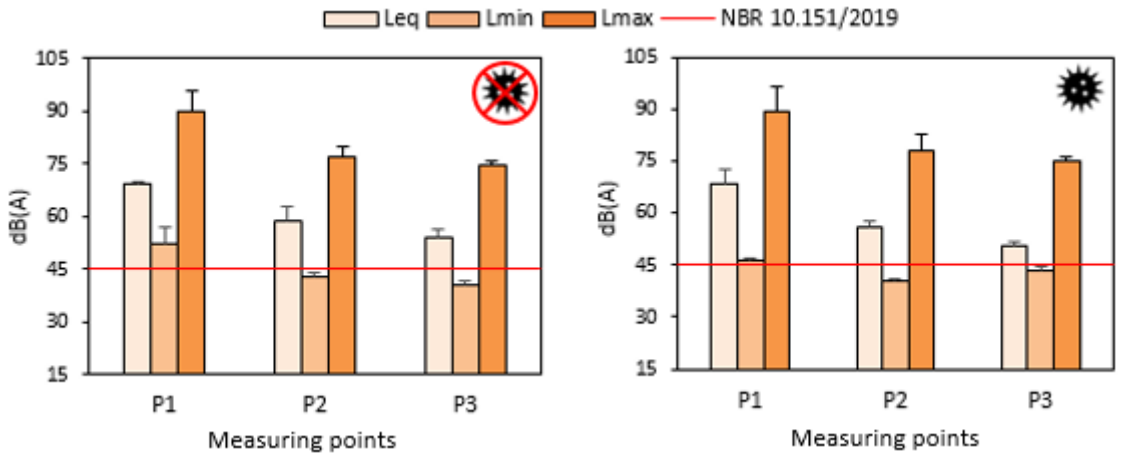
Legend: a) average number of vehicles before the pandemic; (b) the average number of vehicles during the pandemic; (c) reduction rates and increase in the number of vehicles during the pandemic.
Source: Prepared by the authors (2020).

The significant reduction in the number of HV in P1 and absence in P2 and P3 can be explained by the reduction in bus traffic due to quarantine by the pandemic, decreed by the Municipality of Sorocaba, and closure of many commercial, industrial, and service facilities, where trucks would be the main sources of supply of inputs. According to the Federation of Trade in Goods, Services and Tourism of the State of São Paulo (FecomercioSP), almost all commercial and service segments were closed during quarantine measures, and only essential services, such as hospitals, pharmacies, fuel stations, and delivery remain in operation (FECOMERCIOSP, 2020). In relation to LV, the reductions are a reflection of quarantine and social isolation measures, together with the closure of commercial establishments. On the other hand, due to the increase in orders per delivery, mainly in the food sectors, there was an increase in

the circulation of M in P1 and a smaller reduction in P2 and P3, when compared to LV and HV. According to a survey by the Brazilian Association of Bars and Restaurants in São Paulo (ABRASEL/SP), during the pandemic, about 73.5% of establishments are working with deliveries (ABRASEL, 2020).

Figure 3 shows sound pressure levels before and during the pandemic.

Figure 3: Sound pressure levels before and during the pandemic.



Source: Prepared by the authors (2020).

The mean values and standard deviations in dB(A) of Leq, Lmin and Lmax before the pandemic were, respectively: P1 - 69 ±0.7; 52 ±4.6; 89.7 ±5.8; P2 - 58.9 ±3.9; 42.8 ±1; 76.6 ±3.3; P3 - 54.2 ±2.3; 40.3 ±1.4; 74.3 ±1.7. During the pandemic the values were, in dB(A): P1 - 68.4 ±4.1; 46.6 ±0.2; 89.3 ±7.2; P2 - 56 ±1.8; 40.4 ±0.5; 77.8 ±5.2; P3 - 50.3 ±1.3; 43.3 ±1.2; 74.7 ±1.6. Statistically, there was no significant difference between sound pressure levels (Leq, Lmin, Lmax) before and during the pandemic ($p>0.05$). The differences in equivalent sound levels before and during the pandemic were -0.6 dB(A) in P1, -2.9 dB(A) in P2 and -3.9 dB(A) in P3. It is observed that before and during the pandemic, P1 presented the lowest variation and the highest levels of sound pressure, attributed to the higher flow of vehicles and the speed of the road being higher than the other points, being 50 km/h against 30 km/h allowed in P2 and P3. Although there is a strong correlation between the number of LV, HV and M and Leq, before the pandemic ($r = 0.93$, 0.88 and 0.84 respectively; $p<0.05$) and LV and M during the pandemic ($r = 0.90$; 0.93 respectively; $p<0.05$), Leq values were above that recommended by NBR 10151/2019.

In the study by Gozalo et al. (2019), the authors verified a strong correlation ($r = 0.92$; $p\leq0.001$) between the number of circulating vehicles and the sound levels measured in the city of Cáceres, Spain and report that the speed of the vehicles causes differences between the measured and simulated values. Asensio et al. (2020b) observed a reduction from 4.1 to 4.6 dB(A) at night noise on weekdays during the pandemic and report that this value is lower than expected, given the huge reduction in vehicle traffic in Madrid (approximately 85%), assigning as one of the factors to maintain high levels, the speed of the remaining vehicles.

4. CONCLUSION

It is concluded with this work that there was a significant reduction in the circulation of light and heavy vehicles during the COVID-19 pandemic around the hospital at night. For motorcycles, there was a reduction only in the streets with lower circulation (P2 and P3), while on the main avenue (P1), there was an increase of 12.5%, related to the increase, probably, in the orders for delivery.

P1 was the point with the highest sound pressure levels and the lowest variation in dB(A) during the pandemic in relation to P2 and P3, associated with higher permitted road speed and greater vehicle circulation. On the other hand, statistically, there was no difference in the equivalent sound pressure levels, minimum and maximum during the pandemic, showing that other factors should also be taken into account, such as the speed of vehicles, a fact observed during *in situ* measurements.

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