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## A STUDY ON NOISE POLLUTION IN THE CITY OF TEHRAN, IRAN

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### Abstract

Adverse consequences of noise pollution affect many aspects of human life. This study aims to investigate the noise pollution in District 2 in the center of Tehran. To achieve this aim, noise pollution indicators during three periods of rush hour were monitored at 72 stations scattered over nine regions of this district throughout the period of July and August 2016. After analyzing the data, the level of noise pollution, critical points, and the regions with above-standard noise levels were determined and reported. The average equivalent noise level (Leq) was about 71.85 dB(A) with the highest level being 84.5 dB(A) in Azadi Station in region 5 and the lowest level being 57.4 dB(A) in Pardisan Park Station in Region 7. The highest equivalent noise levels (L10, L90), traffic noise index (TNI) and the level of noise pollution (LNP) were 95.2 dB(A) in Sadeghiyeh Station in region 2, 83.1 dB(A) in Habibullah and Shadman subway stations in regions 5

of this study show that the equivalent noise level in all noise measurement stations is higher than the standards.

**Keywords:** Noise pollution, Noise level, Traffic noise index, Sound, Tehran.

## **1. Introduction**

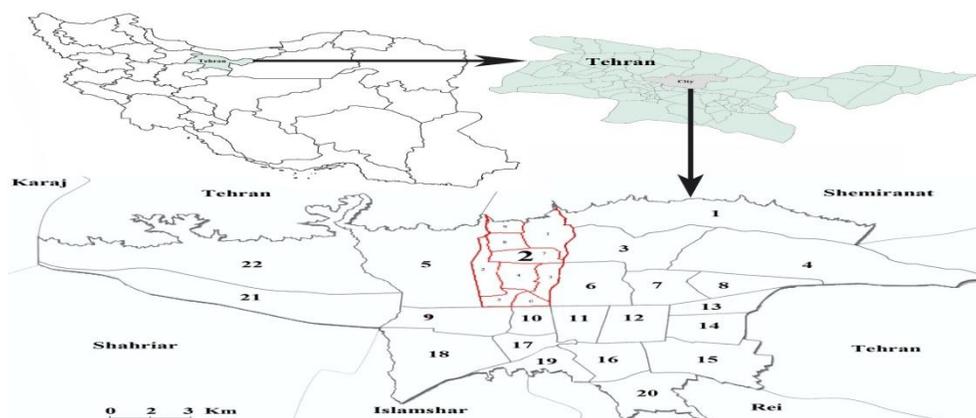
In recent decades, noise pollution in metropolises has become a widespread problem and attracted global attention (1-3). Nowadays, noise pollution is an important measure for the quality of urban life and affects social welfare (4). Noise pollution in high sound pressure levels (over 85 dB(A)) leads to direct effects on the auditory organ, including temporary threshold shifts (TTS) and even Permanent Threshold Shift (PTS) in case of long-term exposure. However, the main effects of noises of lower levels (between 50 and 80 dB(A)) can be expressed with terms such as annoyance, disturbance, bother and intrusion; in other words, a part of the effects of noise is related to its impact on the nervous system, mood and behavioral disorders (5, 6).

The physiological and psychological impacts of repeated and persistent noise on humans often appear gradually and as a result of long term exposure. The human body's reaction to loud noise is similar to its reactions to an imminent threat, such as adrenaline release, change in heart rate and blood pressure, headache, aggressiveness, anxiety, and mood swings, which can also cause domestic conflicts (7, 8). The physiological and psychological effects of noise on humans are likely to appear gradually, because over time, they directly affect the human nervous system and leave negative consequences (9, 10). Recent studies have demonstrated that more than 30 percent of the residents of European countries are exposed to noises of over 55 decibels and out of those, 20 percent who are exposed to noises of over 65 decibels during the day complain about conditions such as sleep disorders (11). Through measuring and monitoring noise pollution, maps of the noise level can be prepared and necessary control measures in regard with constructions can be adopted (12). In this study, the level of noise pollution in the 2th District of Tehran was investigated.

## **2. Materials and Methods**

Considering the number of intersections and sensitive spots in District 2 of Tehran, a total of 72 stations scattered over 9 regions, including 12 stations in educational zones, 12 stations in medical zones, 12 stations in residential zones, 20 stations in commercial-residential zones and 16 stations in commercial zones were selected (Figure 1). All noise pollution measurements were conducted within 8 weeks (during July and August 2016) at the peak traffic and office hours from 8 am to 8 pm. Measurement duration was 30 minutes per station and measurements were repeated 3 times. The first

measurement was performed from 8 to 10 am, the second from 1 to 3 pm, and the third from 5 to 7 pm. Noise parameter such as  $L_{max}$ ,  $L_{min}$ ,  $L_{10}$ ,  $L_{50}$ ,  $L_{90}$ ,  $L_{eq}$ , and SPL (Sound Pressure Level) were measured and indexes such as TNI (Traffic Noise Index), and NPL (Noise Pollution Level) were calculated. Noise level was measured using a TES sound meter and according to BS 7445-1-2003 and 7445-3-1991BS. Calibration was done before and after each series of measurements using the dedicated calibrator at a frequency of 1 kHz and noise levels of 94 and 104 dB(A). The device was mounted on a tripod with a height of 1.5 meters from ground level and at a distance of 3.5 meters from the wall of side walk and 0.5 meters from the curb, across from and facing the source (pedestrians were prevented from standing in front of or speaking near the microphone) (13). Also, protective foam was used to eliminate the effect of air flow on the surface of the microphone. In cases where the condition of a measurement spot did not meet the standard measurement requirements, maximum attempt was made to provide the best possible condition.



**Figure-1: Location of District 2 in Tehran**

## Results and Discussion

The results showed that the highest noise pollution level (LNP) among all the measurements was 102.57 dB(A) in Azadi-Enqelab station in region 5 and the lowest level was 66.7 dB(A) in Pardisan park station in region 7. In Figure 2 the Equivalent Noise Level ( $L_{eq}$ ) in all three measurement periods in each station is displayed. The highest value of Traffic Noise Index (TNI) in all noise measurement stations, 95.2 dB(A), belongs to a commercial station in Sadeghiyeh Square in region 2. Figure 3 shows the average equivalent noise level measured at each measurement period in 72 noise monitoring stations. According to Figure 3, the highest equivalent noise levels belong first to the evening period, then to the noon period and lastly to the morning period. Figure 4 shows the average values of traffic noise index (TNI) and equivalent noise level ( $L_{eq}$ ) at different stations. According to Figure 4, the average traffic noise index was 75.35 dB(A), which was higher than the average equivalent noise level by an average of 3.53 dB(A).

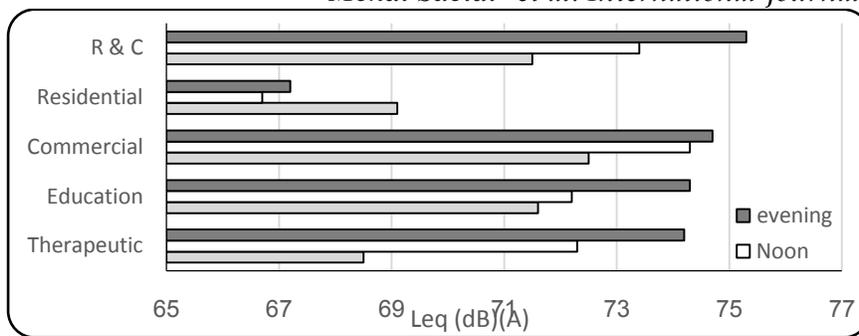


Figure- 2. The average of noise level in three time measurements at different stations.

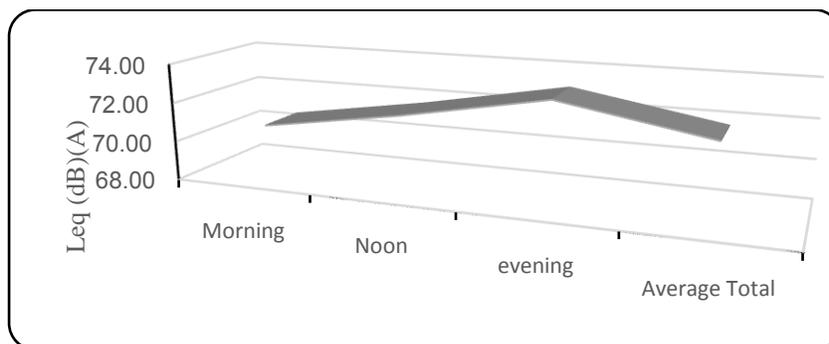


Figure 3- The average of noise level in each measurement at 72 noise-monitoring stations

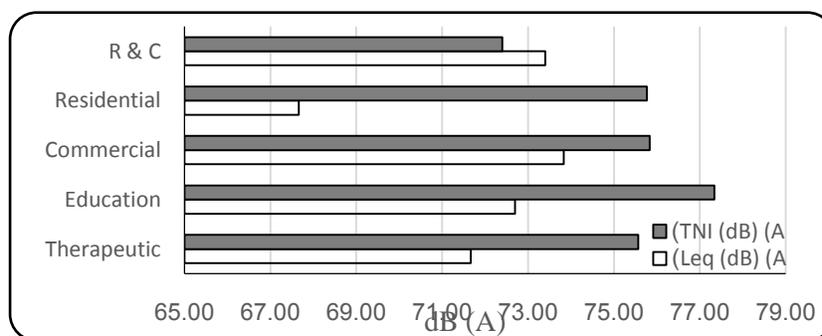


Figure-4. Average of traffic noise index (TNI) and equivalent noise level (Leq) at different stations

Table-1: Average, minimum and maximum noise index measurements at 72 stations.

| Parameters | Leq   | L10   | L50   | L90  | TNI    | LNP   |
|------------|-------|-------|-------|------|--------|-------|
| Average    | 71.85 | 88.76 | 85.6  | 82.4 | 77.34  | 89.34 |
| Max        | 84.5  | 95.2  | 89.43 | 83.1 | 102.57 | 96.2  |
| Min        | 57.4  | 73.1  | 73.1  | 69.4 | 58.3   | 74.6  |

Characteristics of Tehran’s District 2, such as significant population and its dense residential fabric, presence of various highways, high-traffic squares and streets, commute of heavy vehicle seven in residential zones, deteriorating paved, etc., have exacerbated the problem of noise pollution in this district. This problem is becoming even more tangible for oblivious citizens. One of the main sources of noise pollution in urban regions is the distinct sound of contact between automobile wheels and road surface (1, 4, 13). In most streets of District 2, the presence of newly built and multi-story

buildings eliminates the possibility of widening the streets, so few such control measures can be used in this region. However, building wider and multi-layered streets and preventing the construction of tall buildings around the main streets and highways to prevent echo and exacerbation of noise pollution are recommended. Also, the distance between the buildings and the main streets, highways, etc. must be respected. Planting and preservation of green space will also help reduce noise pollution (1, 11). The average equivalent noise level measured in most parts of District 2 was higher than the national standard. The average equivalent noise level ( $Leq$ ) was about 71.85 dB(A) with the highest level being 84.5 dB(A) in Azadi Station in region 5 and the lowest level being 57.4 dB(A) in Pardisan Park Station in Region 7 (Figure 3). This value was lower than the equivalent noise level measured in the city of Khorramabad (78dB(A)) and the central regions of the city of Kermanshah (76.6) during the morning (14, 15). In total, 75% of the measured noise levels were within the unacceptable range, 53% of the average measured noise levels were quite unacceptable, 22% were somewhat acceptable and the rest of the stations were perfectly acceptable. Average traffic noise index (TNI) obtained for all noise monitoring stations in District 2 in Tehran was 75.138 dB(A) (Table 1), which was higher than the average measured TNI in the city of Mashhad (71.26 dB(A)) (16). In all stations except the residential ones, TNI was higher than the average equivalent noise level. The larger the difference between these two is, the more annoying the traffic noise becomes (17). The highest traffic noise index (TNI), 77.34 dB(A), was observed in medical buildings in the station positioned in educational zones. This was due to the irregular car commutes and large differences between moments of calm and traffic noise. The causes of this observation include proximity to the squares, being surrounded by three main streets, close proximity to busy streets, proximity to taxi stand, and the main street being surrounded by tall commercial, office and even residential buildings. It is obvious that establishing educational and medical centers in such locations is not desirable and compliance with the necessary measures to prevent the entry of sound waves is necessary. When possible, noise pollution indicators should be incorporated into the modern urban development programs so that the new layouts would be optimal and as risk-free as possible for citizens (18). The highest measured noise equivalent level ( $Leq$ ), 73.83 dB(A), was observed in stations located in commercial zones (Figure 1). This is the result of close proximity to the highways and streets, frequent vehicle traffic, high traffic volume, and presence of various squares and shopping centers in the commercial zones (19). The highest average equivalent sound levels ( $L_{10}$ ,  $L_{90}$ ) were 95.2 dB(A) in Sadeghiyeh station in region 2 and 83.1 dB(A) in Habibullah and Shadman subway stations in region 5 and 6 (Table 1). The presence of reflective surfaces (walls of the bridge) and reflection of the noise generated by vehicles movement and horns, high

speed commute of vehicles, depreciation and deterioration of asphalt, commute of heavy vehicles, and the narrow width of this street cause the noise level to be higher than the daily standard (20). The average equivalent noise level in stations located in medical zones was 68.5 dB(A) and the lowest level was 57.4 dB(A) at Pardisan Park station (Table 1). Needless to say, the green space of the park, the long distance from the street and the absence of reflective surfaces are significant factors contributing to reduction of noise level (21, 22).

## **Conclusion**

This study aimed to investigate the noise pollution in District 2 of Tehran, and the results showed that in 75% of the stations, the average equivalent noise levels are higher than Iran's national standards (53% were quite unacceptable, 22% were somewhat acceptable). The results of this study showed that the equivalent noise levels in most regions of the 2<sup>nd</sup> district of Tehran are higher than the standard and need further attention in this respect.

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