

An ecological study to assess relationship between noise pollution and cardiovascular diseases in India

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ABSTRACT

Excessive noise can cause a number of serious short- and long-term health problems. This study was planned to test the hypothesis to determine correlation (if any) between noise pollution levels and cardiovascular diseases in rural areas of Delhi, India. This was an ecological study conducted in a 150 bedded secondary care hospital. Data was collected from the year 2010 to 2015 for total number of cases of cardiovascular diseases reported in the hospital over the same period. Analysis was done to find any correlation between the average noise pollution levels over the years (2010-2015) and number of cases of cardiovascular diseases reported in the hospital. Pearson's correlation coefficient was used to test for strength of correlation. The mean (\pm SD) noise level was from 2010-2015 was 79dB (\pm 8.23) which was higher than the recommended levels of 55dB. There was significant correlation between number of cases of cardiovascular diseases with mean noise levels reported in the area ($p= 0.02$). The study found significant correlation between noise levels and cardiovascular diseases in rural areas of Delhi, India.

INTRODUCTION

Noise is an underestimated threat and is becoming a major public health problem around the world. Excessive noise can cause a number of serious short- and long-term health problems which can lead to chronic disability. It has been estimated that about 40% of the population in European Union countries is exposed to noise at levels exceeding 55 db(A) [1].

As per estimates given by World Health Organization (WHO) in Western Europe, annually 45,000 years are lost due to noise-induced cognitive impairment in children, 903,000 due to noise-induced sleep disturbance, 61,000 due to noise-induced cardiovascular disease, and 22,000 due to tinnitus. Noise-induced annoyance also decreases the quality of life thereby causing disability and has been calculated to cause 587,000 disability-adjusted life years (DALYs) lost in the same population [2].

Noise exposure can induce various biochemical, physiologic, or psychosocial changes in human body that can lead to harmful effects on human body. The adverse health effects of excessive noise are auditory disorders such as hearing impairment, tinnitus, ear ache, noise-induced hearing loss. Non-auditory manifestations include headache, irritability, inability to concentrate on work thereby reducing work efficiency, disturbance in sleep, and interference with speech communication [3].

There has been increasing research on relationship between cardiovascular diseases and noise exposure. Noise causes physiological responses in human body mediated through the autonomic nervous system. Possible mechanism includes physiological activation in response to excessive noise leading to increase in heart rate and blood pressure, peripheral vasoconstriction and thus increased peripheral vascular resistance [3].

Although many observational studies and reviews on noise exposure and cardiovascular effects have been carried out, epidemiologic evidence is still limited [4-6]. Since cardiovascular diseases have a number of determinants like lifestyle factors and genetic predisposition, it is difficult to gain insight into the contribution of noise to cardiovascular disease. Thus, noise exposure is considered to contribute to the prevalence of cardiovascular disease, the evidence for a relation between noise exposure and ischemic heart disease is still inconclusive because of the limitations in exposure characterization, adjustment for important confounders, and bias [7].

When it comes to developing countries regarding noise exposure and its relationship to health, the scenario is different from developed countries. Increasing population, transportation demands, increase in number of vehicles, set up of industries etc are factors that have intensified noise pollution significantly. The major gaps include lack of standardised guidelines for noise levels, no mechanism of monitoring noise levels continuously in major cities, lack of research and no public awareness about noise and its related health effects.

In India, noise is regarded as a pollutant under the air (Prevention and Control of Pollution) Act, 1981 [8]. Despite of noise being a major issue, only in the year 2011, Central Pollution Control Board in India started Real Time National Ambient Noise Monitoring Network. It covers various locations in seven metro cities including capital city of Delhi to measure ambient noise levels. [9]

Also, there is scarce published scientific literature on the health effects of community noise pollution in India. Therefore keeping the above aspect in view, this study was planned to test the hypothesis to determine correlation (if any) between noise pollution levels and cardiovascular diseases in rural areas of Delhi, India.

Materials and methods

This was an ecological study conducted in a 150 bedded secondary care hospital situated in a village in north-west region of Delhi. The hospital is situated around 30 kilometres from Delhi. Monthly adult patient load in the hospital was approximately 36,000. The study was conducted over a period of 6 months from February to July 2016. The hospital was established in the year 2006 and was fully functional by the year 2008. This hospital had preventive, curative and rehabilitative services. General Out-Patient services and In-patient care in medicine, surgery, gynaecology, obstetrics, ophthalmology, otorhinolaryngology, paediatrics, orthopaedics and dermatology were present alongwith emergency and trauma care services.

The hospital maintained a monthly record of total number of patients seen in both inpatient and outpatient departments. The records were maintained as per International Classification of Diseases -10 (ICD -10) system. Data was collected from the year 2010 to 2015 for total number of cases of cardiovascular diseases reported in the hospital over the same period.

Cardiovascular diseases included in the analysis were coronary heart disease, cerebrovascular disease (stroke), peripheral arterial disease, heart failures, hypertension and arrhythmias.

Data on noise pollution was taken from Delhi Pollution Control Board (DPCC). DPCC is state wing of Central Pollution Control Board (CPCB) in India run by Government of India. Central Pollution Control Board, under the Ministry of Environment and Forests, Government of India, has set standards of sound for different categories of areas (residential, commercial, industrial and silence zones), separately for day-time and at night.

DPCC collect continuous data on pollution indicators in different regions of Delhi. They have 40 sites covering whole of Delhi. For current study, data on noise levels was collected from nearest monitoring site where the hospital was situated. The area where the data monitoring site was situated was the main catchment area for the hospital. Majority of population in the area report to the abovementioned hospital for health seeking. The reason for choosing the particular hospital was to remove contamination of the area where data was collected and noise levels monitoring was reported. The other hospitals in Delhi receive patients from a wider region including different states where the noise level data monitoring was not done. Such condition would have lead to selection bias due to different sites of data collection for cardiovascular diseases and noise level monitoring data. The whole data was used only for research purpose. Permission was taken for the study from Institutional Ethics Committee.

Data was analysed using SPSS software (version 17). Results were presented in mean (standard deviation), simple proportions and percentages. Analysis was done to find any correlation between the average noise pollution levels over the years (2010-2015) and number of cases of cardiovascular diseases reported in the hospital. Pearson's correlation coefficient was used to test for strength of correlation. The results were accepted significant if "p" value was less than 0.05.

RESULTS

The study was conducted based on data collected in secondary care hospital situated in a rural village of Delhi, India. There was a fluctuating trend in the number of cases of cardiovascular diseases over the years as shown in the Figure 1. The cases increased from 2010 to 2012 from 11079 to 15002. The number decreased afterwards to 13523 in the year 2015.

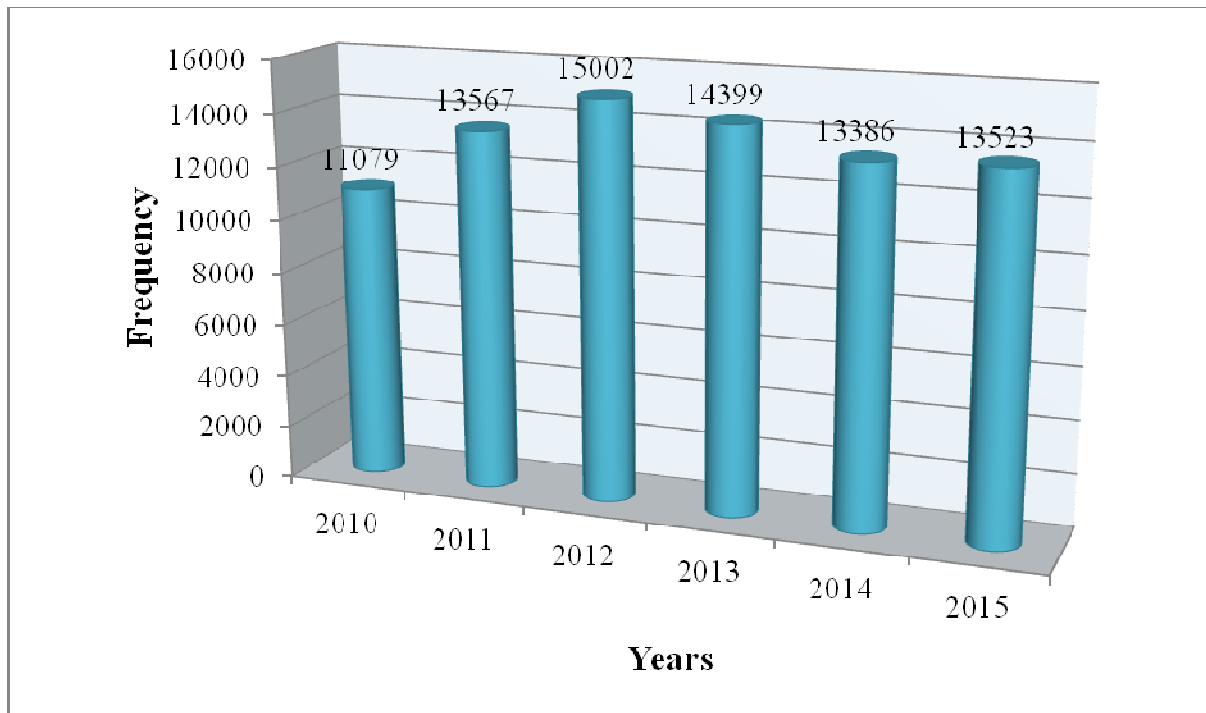


Figure 1: Total number of cases of cardiovascular diseases reported from 2010-2015

Figure 2 shows that trend of total number of patients reported in the hospital from 2010 to 2015 and number of cardiovascular diseases patients. The cardiovascular diseases patients constituted about 2.2% of total patient load in 2010. It became 2.1% in the year 2011 and 2012, 2.0% in the year 2013, 1.8% in 2014 and 2015.

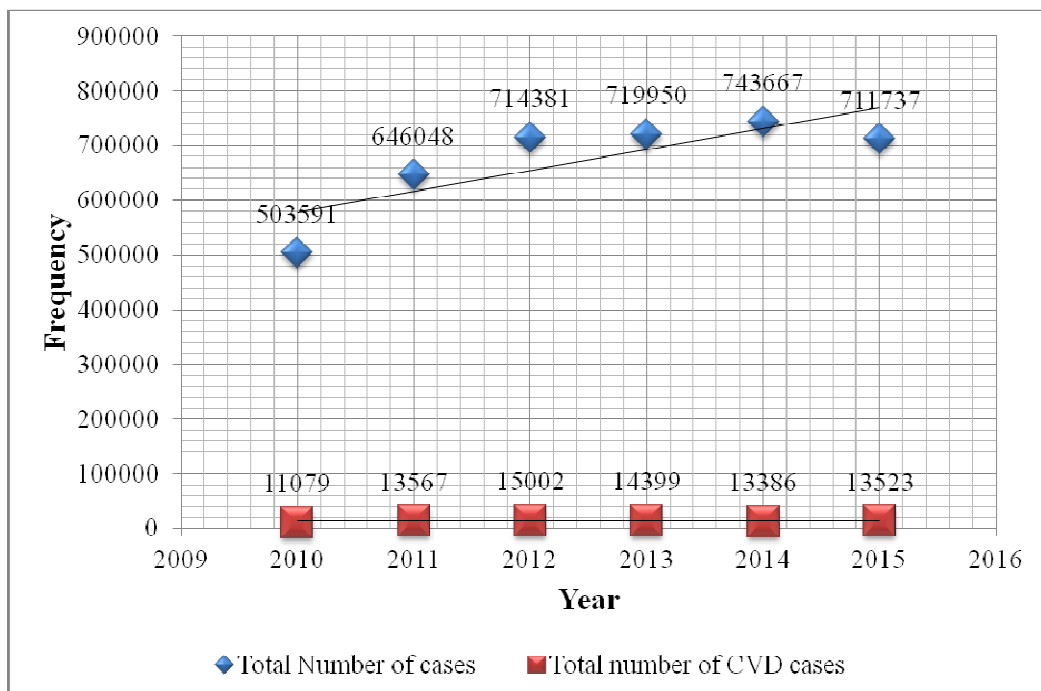


Figure 2: Total number of patients with number of cardiovascular diseases patients reported in the hospital from 2010-2015

The mean (\pm SD) noise level was from 2010-2015 was 79dB (\pm 8.23) which was higher than the recommended levels of 55dB given in the area as per regulations of CPCB. When the number of cases of cardiovascular diseases were analyzed for its relationship with mean noise levels reported in the area, it was found that there was significant correlation between them. The Pearson's correlation coefficient among the two was 0.86 ($p= 0.02$) as shown in Figure 3.

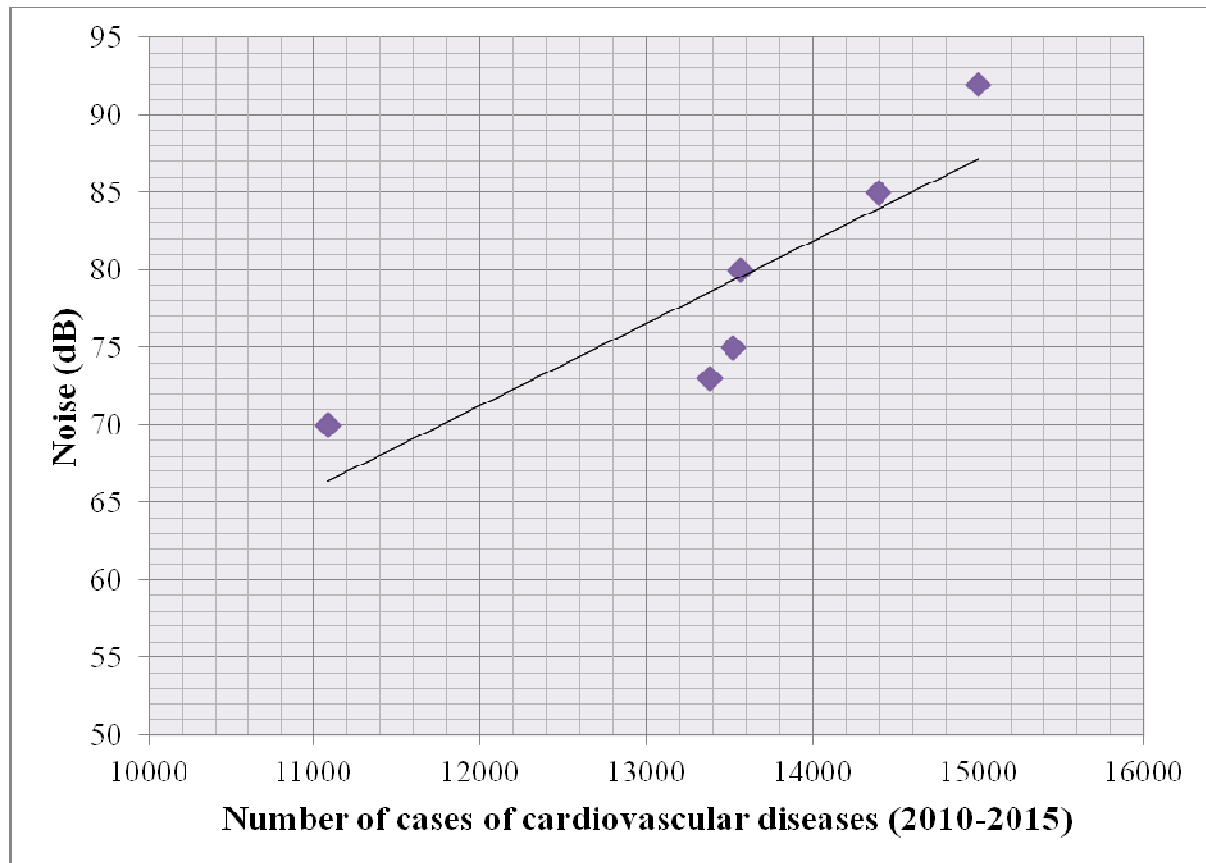


Figure 3: Relationship between noise levels and cardiovascular diseases cases

DISCUSSION

The present study was conducted with a research hypothesis to assess any relationship between noise levels and cardiovascular diseases. Secondary data taken from a secondary care hospital in rural Delhi was analyzed. This study showed that there was a significant correlation between noise levels and number of cardiovascular diseases cases reported in the hospital.

The study found that the mean noise levels were higher than the recommended levels for that area. Several studies have been conducted to assess the noise levels in different parts of the India. Grave situation of noise pollution in Delhi has already been studied earlier where in majority of areas in Delhi, the noise levels were way above the permissible levels [10].

In a study done by Banerjee D et al to measure noise levels in the four zones as categorized by the Central Pollution Control Board, the highest average day-time noise level was detected in silence zones (73.53 dB[A]), and lowest in residential areas (63.5 dB[A]). The highest

average noise level for night time was in traffic intersection areas (71.18 dB[A]) and lowest in the industrial areas [11].

In addition to the noise from traffic, construction activities and industries to which people are constantly exposed to, community festivities and celebrations also increase the exposure to noise. According to a study conducted in a residential area in Delhi during Diwali festival (big cultural festival celebrated in whole of India), the average ambient noise level on Diwali ranged from 76 to 80 dB(A), which was 1.2-1.3 times higher than on normal days in the area (57-69 dB[A] Leq) [12].

Similar results were reported in Delhi by another author where average ambient noise levels increases upto 10%, 4% and 3.5% in residential, commercial and sensitive/silence zones respectively on Diwali in comparison to normal days over the years and are exceeding the permissible limits/standards [13]. Studies previously have documented about relationship between noise and cardiovascular diseases. A meta-analysis of 24 cross-sectional studies was done by *van Kempen E et al* to assess the relationship between road traffic noise and the prevalence of hypertension. The authors reported an odds ratio of 1.07 per 10 dB increase of the 16-hour day-time average road traffic noise level in the range of <50 to >75 dB [14].

Similarly, a significant higher systolic blood pressure per 10 dB increase of the road traffic noise level was found in subjects participating in a cohort study, with significant associations in men and older subjects [15]. A large hospital-based case-control study was conducted in Berlin city to determine the risk of road traffic noise for the incidence of myocardial infarction. The results stated that the adjusted odds ratio for myocardial infarction among men exposed to sound levels of more than 70 dB(A) was 1.3 as compared with those where the sound level did not exceed 60 dB(A). The authors concluded that the results support the hypothesis that chronic exposure to high levels of traffic noise increases the risk for cardiovascular diseases as shown in the present study as well [16].

Noise levels and stroke relationship has also been studied by some authors. A study was done by *Sørensen M et al*, to analyze association between residential road traffic noise and stroke. There was higher risk of stroke with environmental noise levels as associated with a higher risk for stroke among people older than 64.5 years of age, showing a risk increase per 10 dB increase of the noise level.[17]

Strengths and limitations

The study was conducted in rural areas of Delhi in India where not much data is available regarding the epidemiological relationship between noise and cardiovascular diseases. This may be first ecological study conducted in the area to focus on long terms effects of noise at population level. The major limitation of the study remains due to its study design that the results cannot be generalized at individual level. Another limitation was that the noise levels were represented as mean levels over a large period of time (year) which made it difficult to analyze the relationship between noise and cardiovascular cases on a shorter period of time duration. Also, since the study was conducted in a secondary care hospital in rural area, there may be differences in clinical algorithms followed in diagnosis and management of cardiovascular diseases depending upon the resources available.

Conclusion and recommendation

The study found significant correlation between noise levels and cardiovascular diseases in rural areas of Delhi, India. It supports the hypothesis about the relationship between noise and cardiovascular diseases. However, larger epidemiological studies should be conducted with

better study designs in different areas to retest this hypothesis so as to strengthen the scientific evidence. There is a need to take immediate measures to reduce the noise levels in the community and to strengthen the monitoring mechanism of noise levels at all places. People should be made aware about the harmful effects of noise and ways to reduce noise pollution. Intensive Information, education and communication (IEC) activities should be carried to sensitize communities about the same.

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Conflict of Interest

None

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