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Perceptions and attitudes of individuals exposed to traffic noise in working places

Saad Abo-Qudais*, Hani Abu-Qdais

Civil Engineering Department, Jordan University of Science and Technology, P.O. Box 3030, Irbid 22110, Jordan

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Abstract

The main objective of this study was to evaluate the impact of traffic noise on exposed owners and employees of businesses near to road edge. To achieve this objective, a field survey in Amman, Jordan was performed. The survey consisted of collecting data on equivalent noise levels and evaluating the perception of exposed individual at the evaluated locations.

The results of the study indicated that about 81% of the interviewed people working around the major streets in Amman are annoyed by traffic noise, and their daily routine activities are interfered by this noise. Also, the results indicated that higher income and education level of the interviewed individuals directly related to their annoyance level and awareness about the health impact of traffic noise. Martial status and gender were also found to be significantly affecting annoyance by traffic noise. At the same equivalent noise level, single individuals reported to be more annoyed than married individuals. Single females were found to be more annoyed by traffic noise than single males. While for married individuals, female were found to be less annoyed than males.

1. Introduction

Sound is the quick varying pressure wave within a medium. Usually it refers to audible sound, which is the sensation (as detected by the ear) of very small rapid changes in the air pressure above and below a static value. This static value is atmospheric pressure (about 100,000 Pascals, Pa). Noise is an undesirable sound emanated from different sources. It can be annoying, and interfere with conversation, work, sleep, and or recreation. In extremes, it may cause physical and psychological damage. While exposure to noise emanating from many different sources can be avoided, transportation noise is perhaps the most difficult source to avoid. Traffic noise might reduce property values. As a result, planners, policymakers, and legislators must consider the noise damage caused by motor vehicles when evaluating transportation alternatives.

Sound pressure levels are used to measure the intensity of sound and are described in terms of decibels. The decibel (dB) is a logarithmic unit, which expresses the ratio of the sound pressure level being measured to a standard reference level, that is usually taken 20 μPa, which is the threshold of human hearing. Sound is composed of various frequencies; frequencies to which the human ear does not respond must be filtered out when measuring highway noise levels.

The majority of sounds detected by human hearing are within the range of 0–140 decibels (dB). The noise created by traffic normally resides in the range of 50–95 dB. A frequently used measurement for continuous noise is the equivalent sound level (L_{eq}), known also as the energy mean sound level. L_{eq} represents the equivalent noise energy level of a steady and unvarying sound. It includes both intensity and length of all sounds occurring during a given period [1].

Generally, heavier traffic volumes, higher speeds, and greater numbers of trucks increase the loudness of traffic noise. Defective mufflers or other faulty equipment on vehicles can also increase the loudness of traffic noise.

*Corresponding author. Tel.: +962-27201000; fax: +962-27095123.
E-mail addresses: aboqdais@just.edu.jo (S. Abo-Qudais), hqdais@just.edu.jo (H. Abu-Qdais).

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Any condition (such as a steep incline) that causes heavy laboring of vehicle engines will also increase traffic noise levels. In addition, there are other more complicated factors that affect the loudness of traffic noise. Such as lateral distance from the road, terrain, vegetation, pavement surface texture, and man made obstacles [1].

Transportation noise affects people in a variety of ways and people perceive noise subjectively. An individual located hundreds of feet from a highway may experience a very low level of transportation noise; compared to an individual located at the road edge who may experience high noise level. Transportation noise may be perceived more annoying than other natural noises, such as birds and insects that may be louder. Reflected noise from noise barriers, rock cliffs and other structures may also be perceived as annoying, even though the measured levels of sound are quite low. Transportation noise may affect the ability of people to carry on conversations, concentrate in work and school settings, and sleep [2].

It is strongly recommended to avoid unprotected exposure to sound pressure levels above 100 dB. Hearing protection should be used when exposed to levels above 85 dB, and especially when prolonged exposure (more than a fraction of an hour) is expected. Damage to hearing from loud noise is cumulative and is irreversible. Exposure to high noise levels is also one of the main causes of tinnitus [3].

Loudness is the human impression of the strength of a sound. The loudness of a noise does not necessarily correlate with its sound level. Loudness level of any sound is expressed in phons, which is the decibel level of an equally loud 1 kHz tone, heard binaturally by an ontologically normal listener. Historically, loudness was that simple frequency weighting "sound level meter" was accepted as giving a satisfactory approximation to loudness. The ear senses noise on a different basis than simple energy summation, and this can lead to discrepancy between the loudness of certain repetitive sounds and their sound level. For example, a 10 dB sound level increase is perceived to be about twice as loud. The sone is a unit of comparative loudness with 0.5 sone = 30 phons, 1 sone = 40 phons, and 2 sone = 50 phons. Loudness level calculations take into account masking. Masking is the process by which the audibility of one sound is reduced due to the presence of another at a close frequency. The redundancy principles of masking are applied in digital audio broadcasting, leading to a considerable saving in bandwidth with no perceptible loss in quality [4].

In the European Union, about 40% of the population is exposed to road traffic noise with an equivalent sound pressure level exceeding 55 dB during daytime, and 20% are exposed to levels exceeding 65 dB. When all transportation noise is considered, more than half of all European Union citizens are estimated to live in zones that do not ensure acoustical comfort to residents. At night, more than 30% are exposed to equivalent sound pressure levels exceeding 55 dB, which are disturbing to sleep. Noise pollution is also severe in cities of developing countries. It is caused mainly by traffic, and on densely traveled roads the equivalent sound pressure levels for 24 h can reach 75–80 dB [5].

The impacts of environmental noise may be evaluated by assessing its interference with social behavior and other human activities. For many communities, noise interference with rest, recreation, and TV watching seem to be the most significant impact. There is fairly consistent evidence that noise above 80 dB causes reduced efficient behavior, and that loud noise also increases aggressive behavior in individuals predisposed to aggressiveness [6].

According to a study conducted by Hasebe and Kaneyasu [7], in order to protect the majority of people from being seriously annoyed during the daytime, the outdoor sound level from steady, continuous noise should not exceed 55 dB L_{eq} on balconies terraces and in outdoor living areas. To protect the majority of people from being moderately annoyed during the daytime, the outdoors sound level should not exceed 50 dB L_{eq}.

Another similar study by Krichagian [8] investigated the effects of impulse noise on mood and on cardiovascular functions. Two separate experiments were performed to achieve this purpose: 238 females and males (30–60 years old) participated in the first experiment (100 normotensive and 89 hypertensive), both subgroups were matched with regard to sex and self-estimated sensitivity to noise, and 49 normotensive persons who felt indifferent to noise. In the first experiment pink noise, traffic noise and impulse noise with a repetition rate of 2 shots/s were applied at L_{eq} of 62, 68, 74, and 80 dB as well as an impulse noise at L_{eq} of 71 dB but with repetition rates of 1, 2, 4, and 8 shots/s. These 16 noises each lasted 19 s and occurred randomly three times at intervals of 27 to 50 s. The second experiment was restricted to impulse noise where the L_{eq} was stepwise increased from 62 to 80 dB by elevating the peak levels. Generally, the responses to noise in all subgroups consisted of displeasure, heart rate acceleration, and vasoconstriction.

During the daytime, few people are highly annoyed at L_{eq} levels below 55 dB, and few are moderately annoyed at L_{eq} levels below 50 dB. Sound levels during the evening and night should be 5–10 dB lower than during the day. For intermittent noise, it is necessary to take into account both the maximum sound pressure level and the number of noise events. When the background noise is low, maximum noise levels should not exceed 45 dB, if possible, and for sensitive persons an even lower limit is preferred. Noise mitigation targeted to the first part of the night, which is believed to be an effective mean for helping people fall asleep. It should be noted