International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 09 Issue: 11 | Nov - 2025 SJIF Rating: 8.586 ISSN: 2582-3930

# Noise-Induced Stress and Fatigue in Public Transport Employees

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**Abstract** :- In the present study, we evaluated noise-related annoyance and its effects on the health of bus drivers. A total of 200 drivers from a public transport company participated in this cross-sectional study. Annoyance and health outcomes were assessed using an analog scale that measured sleep quality, occurrence of tinnitus, headaches, irritation, and annoyance caused by the bus engine, traffic, and passengers. Information regarding age and years of service was also collected. To assess noise exposure, equivalent continuous sound pressure levels (LAeq) were measured in 80 buses.

Statistical analyses included descriptive measures (mean, standard deviation, minimum and maximum values), the Kruskal–Wallis test with post-hoc Dunn's analysis, one-way ANOVA with post-hoc Tukey's test, and Spearman's correlation coefficient. Based on the annoyance levels, participants were categorized into three groups: not annoyed (N.A.), little annoyed (L.A.), and highly annoyed (H.A.). Drivers in the H.A. group were generally younger and had fewer years of experience, with age showing a statistically significant difference among groups.

There were no significant group differences in sleep quality. However, tinnitus, headaches, and post-work irritation were reported at significantly higher levels in the H.A. group. Annoyance due to bus engine noise was also significantly greater in the H.A. group compared to the L.A. and N.A. groups. Although annoyance related to traffic and passengers showed no significant differences, the highest values were observed in the L.A. group, followed by H.A. and N.A.

The measured LAeq values in buses exceeded recommended limits for occupational comfort. Overall, the findings indicate that bus drivers experience considerable noise-related annoyance and exhibit noticeable health effects. Therefore, occupational noise should be recognized as an ergonomic discomfort factor with potential implications for the health and well-being of bus drivers.

**Introduction :-**

Urban bus transportation is an essential service in modern society.[1] Despite ongoing technological advancements in public transportation, the full responsibility for vehicle operation still rests on the driver. Consequently, this profession holds a crucial and irreplaceable role in today's industrialized world. However, bus drivers are routinely exposed to multiple ergonomic stressors that may adversely affect their health, including high levels of noise, vibration, air pollution, occupational stress, and postural overload.[2,3,4,5]

Although several studies have examined working conditions and health problems among drivers of different types of buses,[3] few investigations have specifically addressed noise sensitivity within the driver's work environment.[6] Earlier research has quantified noise exposure levels inside buses, but most have not assessed the degree of noise annoyance or its associated health impacts on drivers.[2,7,8,9]

Given the long working hours—typically averaging 8 hours per day—combined with operation of older buses (often with mechanical deficiencies and engines positioned close to the driver's seat), poor road conditions, and high passenger volumes, noise exposure may frequently exceed recommended occupational limits.[2] Prolonged daily exposure to elevated noise levels can lead to adverse health effects, including reduced hearing thresholds and potentially permanent hearing loss. Additionally, several non-auditory consequences may arise, such as digestive problems, sleep disturbances, behavioral changes, and cardiovascular complications.[10,11] Reinforcing these risks, the World Health Organization recognizes chronic noise exposure as a contributing factor to hypertension.[12,13]

These noise-related health effects may influence driver behavior, causing irritation, mental fatigue, frustration, and stress. Consequently, noise can impair work performance and contribute to increased absenteeism, as well as social conflicts between drivers and coworkers or passengers.[6] According to Brazilian occupational legislation (NR-15: Insalubrious Operations),[14] the maximum permissible exposure limit is 85 dB(A) for an 8-hour workday. However, NR-17 (Ergonomics)[15] specifies that exposure above 65 dB(A) over the same duration is considered uncomfortable, highlighting the discrepancy between comfort and legally allowable limits.

**Methods:-**

The aim of the present study was to evaluate the sensation of noise annoyance and its relationship with selected health parameters in bus drivers from Curitiba, Paraná, Brazil. Curitiba has received several awards for its innovative public transportation system, making it relevant to examine the working conditions experienced by its bus drivers.

A purposive sample of 200 drivers, selected from a total of 357 employees of a local public transport company, participated in the study. The drivers operated four main types of vehicles: conventional buses with front engines; “ligeirinho” or direct buses with rear engines; micro-buses with front engines; and articulated buses, usually with front engines but including some newer models with rear engines.

**Subjective Assessment**

To assess drivers’ subjective perception of noise annoyance and related health effects, the authors developed a questionnaire using a 10-cm continuous analog scale anchored by contrasting descriptors such as “nothing” and “very.” Participants indicated their perceived intensity by marking a point along the line. Prior to data collection, the entire procedure was explained to all participants to ensure accurate completion.

Demographic data, including age and years of service, were recorded at the beginning of the workday. The analog scale was then used to measure perceived intensity for the following items:

- Annoyance from bus noise (“not annoyed” to “highly annoyed”)
- Sleep quality (“poor” to “excellent”)
- Occurrence of tinnitus after the workday (“never” to “always”)
- Irritation after the workday (“never” to “always”)
- Headache after the workday (“never” to “always”)
- Discomfort due to engine noise (“never” to “always”)
- Discomfort due to traffic noise (“never” to “always”)
- Discomfort due to passenger noise (“never” to “always”)

Responses on the analog scales were converted into numerical indices ranging from 0 to 10, with values closer to zero representing more negative perceptions and those closer to 10 indicating more positive perceptions. The reliability of the seven analog-scale items was confirmed using Cronbach’s alpha (0.758).

To classify drivers according to noise annoyance levels, responses to the first analog-scale question were used. Drivers were categorized as:

- **Not annoyed (N.A.):** 0–1
- **Little annoyed (L.A.):** 1.1–4.9
- **Highly annoyed (H.A.):** ≥ 5.0

**Noise Measurement**

Noise levels were measured in 80 buses, equally distributed across four sub-samples:
(1)20conventionalbuses,
(2)20“speedy”/directbuses,
(3)20micro-buses,and
(4) 20 articulated buses.

Measurements followed ISO 9612:2009 standards[16] and were taken during normal operating conditions on various bus routes. The microphone of the sound level meter was positioned 0.10 ± 0.01 m from the ear receiving the highest equivalent continuous A-weighted sound pressure level (Leq,T). Noise exposure was normalized to an 8-hour workday (LEX,8h) using the formula:

LEX,8h=Leq,Te+log⁡(Te/T0)LEX,8h = Leq,Te + \log (Te/T_0)LEX,8h=Leq,Te+log(Te/T0)

where *Leq,Te* is the measured A-weighted equivalent sound pressure level, *Te* is the effective working duration, and *T0* = 8 hours. In Curitiba, bus drivers typically work 6 hours per day with a 10–15-minute break halfway through the shift; therefore, *Te = 6 h*.

Noise measurements were performed using a Bruel & Kjaer Mediator 2238 sound level meter, type/class 1 (precision ±0.41 dB(A)), set to fast response with A-weighting.

**Results:-**

The questionnaire was administered to a purposive sample of 200 drivers out of a total of 357 employees, representing 56% of all drivers in the company. All participants received detailed instructions on how to use the analog scale, and none reported difficulties in completing the questionnaire.

Based on the level of annoyance produced by bus noise, drivers were grouped into three categories: those reporting annoyance between 0 and 1 were classified as not annoyed (N.A.); those reporting annoyance between 1.1 and 4.9 were classified as little annoyed (L.A.); and those reporting annoyance above 5.0 were classified as highly annoyed (H.A.).

Among the 200 drivers evaluated, 104 (52%) fell into the N.A. group, 39 (19.5%) into the L.A. group, and 57 (28.5%) into the H.A. group. The descriptive statistics for age and years of service, as well as the inferential comparisons among the three annoyance groups. The results regarding sleep quality, occurrence of tinnitus, headache, irritation, and discomfort related to engine noise, traffic noise, and passenger noise are summarized below (or “in Table X,” depending on your formatting).

**Discussion :-**

The assessment of annoyance caused by noise was performed subjectively by means of questionnaires with different scales aimed at quantifying the sensitivity of the exposed subject. The sensation in relation to noise is related to the individual personality of each subject, which can affect his reaction toward a noise source.[19] According to the results of psychoacoustic studies, the sensitivity to noise has no relationship to hearing acuity, but reflects a predisposition, an evaluative judgment for the perception of noise sources.[20] However, other studies have related subjects with noise annoyance with greater perception of the effects on their health, and objective evaluations showing a decreased quality of health in individuals with high exposure to noise.[21]

Annoyance questions in different studies do not use the same number of response categories. Some questions have only 3 response categories, whereas others use as many as 11 categories. Often a cutoff point is chosen on the scale, and the percentage of the responses exceeding the cutoff is reported. Miedema and Oudshoorn[22] proposes the cutoff with 72 on a 0-100 scale, then the result is called the percentage of H.A. persons; with a cutoff at 50 it is the percentage "annoyed", and with a cutoff at 28 it is the percentage "(at least) a L.A." In our study, it is proposed an alternative scale (0-10) and different cutoffs (0-1: N.A., 1, 1-4,9: A L.A. and >5 with H.A.). The alternative scale and different cutoffs facilitates the assessment of subjects with low educational level (bus drivers), with the reduction in the number of classifications in relation to the noise annoyance.

According to the results obtained, group L.A. was the one with the lowest average age, followed by groups H.A. and N.A. Heinonen Guzejev[23] assessed the sensitivity to noise in a sample of individuals and found similar results, where younger subjects had higher levels of sensitivity to noise compared to older subjects. Sandrock et al.[24] point to an adaptation of the auditory system of individuals exposed to environments with high noise levels for several years, reducing their sensitivity and thus, perhaps disguising their effects on the subject.

The results for the three groups showed no significant differences in relation to the working time. However, there was a decreasing relationship between working time and noise annoyance; drivers exercising their function for a longer time reported lower levels of annoyance (N.A. 9.36 years; L.A. 7.72 years; H.A. 7.63 years). Thus, it is noteworthy that there is a possible inverse relationship between higher annoyance and lower age or working time among drivers in this study (age x annoyance caused by the bus noise: 0.617, working time x annoyance caused by the bus noise: 0.576, verified by Spearman's correlation).

In assessing the relationship between noise annoyance and sleep quality, no significant difference was found; however, the result remained decreasing for the three groups, and group that had no noise annoyance showed the highest sleep quality, compared to the group with much noise annoyance (N.A. 9.36, H.A. 7.65). Several authors have reported that continuous exposure to noise can cause sleep-related disorders.[25,26] Thus, measures of association between loss of sleep quality and noise exposure are important indicators of quality of life of workers, since sleep is an essential factor for job performance.[27]

For the evaluation of the occurrence of tinnitus, headache and irritation after the working day, significant difference was found for the three groups, and group H.A. was the one that had the highest indexes, followed by groups L.A. and N.A. Thus, it appears that the group with the highest noise annoyance has greater sensitivity to these factors.

One of the major health consequences resulting from exposure to noise in bus drivers is related to the occurrence of hearing disorders.[28] These effects on the health of bus drivers are worrisome, since they influence not only the work environment, but also their quality of life as a whole. Hearing loss, irritation and continuous episodes of headache contribute for the profession of the bus driver to become one with the highest stress load;[29] thus, leading these workers to have harmful consequences to their health such as cardiovascular diseases, among others.[10,30] These health effects cause trouble also for transport companies, because drivers with high stress load and hearing loss tend to show lower performance in their jobs and more time off from work.[30,31]

**Conclusion :-**

The findings of this study indicate that the bus driver sample presents several factors that should be taken into account when attempting to reduce annoyance caused by engine noise and the resulting health implications. It was observed that the sensation of discomfort was more prominent among younger drivers compared to older drivers and those with longer working experience.

Across the N.A., L.A., and H.A. groups, the highest intensity of tinnitus, headache, and irritation was reported by the H.A. group. This suggests that drivers who experience greater annoyance also tend to present more health-related issues associated with noise exposure.

Regarding perceived noise sources—engine, traffic, and passengers—the results show that the vehicle engine is the primary source of discomfort, followed by traffic noise and, lastly, passenger noise. Although the measured noise levels within the buses complied with Brazilian occupational standards, they exceeded recommended comfort limits for work environments.

These findings highlight the need for organizational adjustments in the work setting. Additionally, the adoption of vehicles equipped with rear-mounted engines may help improve working conditions for bus drivers by reducing exposure to engine noise.

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