

## DETERMINATION OF INDIVIDUAL NOISE EXPOSURE LEVEL IN MOTORCYCLE COURIERS

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### Keywords

Motorcycle couriers  
Noise exposure  
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Noise measurement

### Abstract

This paper presents an attempt to measure individual exposure to noise of motorcycle couriers working in Istanbul under real working conditions. Noise measurements were done by using the MIRE technique according to the ISO 11904-1 standard along three chosen routes. Noise sources on the relevant routes include engine noise, wind turbulence and urban traffic. It was determined that noise levels on the riskiest route reached 86.84 dBA and exceeded the upper exposure action value (85 dBA). On other routes, exposure was detected at similar levels, but below this value. Analysis showed that the main contributing frequencies to noise are concentrated in the range of 100–1000 Hz. Since high noise exposure increases the risk of hearing loss, the use of noise-reducing technologies such as improved helmet design becomes important. This paper highlights the need for protection measures with a view ensuring the auditory health of motorcycle couriers is safeguarded, particularly in the context of metropolitan cities. Recommendations in this article include regular hearing health assessments, optimized delivery routes, and awareness campaigns on occupational noise risks.

## MOTOSİKLETLİ KURYELERDE BİREYSEL GÜRÜLTÜ MARUZİYET SEVİYESİNİN BELİRLENMESİ

### Keywords

Motosikletli kuryeler  
Gürültü maruziyeti  
İş sağlığı ve güvenliği  
Gürültü ölçümü

### Abstract

Bu çalışma, İstanbul'da motosikletli kuryelerin gerçek çalışma koşullarındaki bireysel gürültü maruziyet seviyelerini değerlendirmeyi amaçlamaktadır. Ölçümler, ISO 11904-1 standartlarına uygun olarak Mikrofonla Gerçek Kulak (MIRE) tekniği kullanılarak üç belirli güzergâhta gerçekleştirilmiştir. İlgili güzergâhlarda gürültü kaynakları arasında motor sesi, rüzgâr türbülansı ve şehir trafiği yer almaktadır. En riskli güzergâhta gürültü seviyeleri 86,84 dBA'ya ulaşmış ve en yüksek maruziyet eylem değerini (85 dBA) aştığı tespit edilmiştir. Diğer güzergâhlarda ise bu değer altında olsa da yakın seviyelerde maruziyet tespit edilmiştir. Analizler, gürültüye ana katkı sağlayıcı frekansların 100–1000 Hz aralığında yoğunlaştığını ortaya koymuştur. Bu yüksek maruziyet, işitme kaybı riskini artırdığından geliştirilmiş kask tasarımı gibi gürültü azaltıcı teknolojilerin kullanımı önem kazanmaktadır. Çalışma, özellikle yoğun kentsel bölgelerde motosikletli kuryelerin işitme sağlığını korumak için koruyucu önlemlerin aciliyetine dikkat çekmektedir. Bu makalede verilen öneriler arasında düzenli işitme sağlığı değerlendirmeleri, optimize edilmiş teslimat güzergâhları ve mesleki gürültü riskleri konusunda farkındalık artırıcı kampanyalar yer almaktadır.

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## 1. Introduction

Due to the widespread adoption of online shopping habits post-pandemic, there has been a significant increase in the demand for motorcycle couriers. The growing prevalence of the motorcycle courier profession has also led to an increase in the number of accidents. Various institutions' published accident statistics highlight the rise in recent years. According to the data from the Turkish Statistical Institute, the number of registered motorcycles in traffic was 3,331,326 in 2019, and it increased to 5,636,583 as of June 2024 (Turkish Statistical Institute, 2024b). In 2019, motorcycles accounted for 16.3% of fatal and injury traffic accidents in Türkiye, while this rate increased to 23.8% in 2023 (Turkish Statistical Institute, 2020, 2024a). As can be seen, while we can access detailed statistics on motorcycle traffic accidents, there are no statistics on occupational diseases caused by motorcycles. Additionally, there is insufficient research in the literature on the risk of occupational diseases that may arise from the physical risk factors (noise, vibration, atmospheric conditions, etc.) that workers in this sector are exposed to.

Although there is a significant amount of research on noise exposure, many of these studies have been conducted for fixed working environments (Barrero et al., 2022; Chen et al., 2013; Gopinath et al., 2011; He et al., 2025; Jo & Baek, 2024; Williams et al., 2007). In addition to motorcycles being a noise source in themselves, the noise generated by other vehicles in traffic also increases exposure. Especially in cities with heavy traffic like Istanbul, environmental noise is also significantly high in areas with main roads. In places with numerous irregular noise sources, such as traffic, the calculation of resultant noise does not provide realistic results. Instead, the measurement of sound intensity at the receiver is applicable.

In environmental measurements, noise is measured using a sound level meter, while a noise dosimeter is used to measure individual noise exposure. Since the motorcyclist's head is inside a helmet, traffic and engine noise are somewhat reduced. However, the microphones of sound level meters and noise dosimeters do not fit inside the helmet. When placed outside the helmet, wind noise results in inaccurate measurements. Therefore, measuring noise from inside the ear is the most appropriate method for determining personal noise exposure in this line of work.

High-performance motorcycles operate at higher noise levels, and thus, there are recommendations regarding the use of earplugs among motorcyclists and trainers. Modifications made to the exhaust system generally increase the existing noise level. To control this situation, the Regulation on the Type Approval of the External Noise Emissions and

Exhaust Systems of Motor Vehicles has been in effect since 2000 in Türkiye. According to this regulation, the noise levels from motor vehicles listed in Table 1 are the maximum acceptable levels. Vehicles exceeding these levels during traffic inspections are subject to penalties.

The aim of this study is to determine the individual noise exposure of motorcycle couriers and to reveal whether the exposure levels exceed the limits prescribed by local regulations and international standards.

**Table 1. Maximum Noise Levels That Motor Vehicles Can Emit** (Regulation on the Type Approval of the External Noise Emissions and Exhaust Systems of Motor Vehicles (70/157/AT), 2000)

Motor Vehicle Type	Maximum External Noise Levels dB(A)
M2/N1 Maximum Loaded Weight ≤ 2 tons	78+1
M2/N1 2ton < Maximum Loaded Weight ≤ 3,5 tons	79+1
M2/M3 Engine power < 150 KW	80
M2/ M3 Engine power ≥ 150 KW	83
N2/N3 Engine power < 75 KW	81
N2/N3 75 KW ≤ Engine power <150 KW	83
N2/N3 Engine power ≥ 150 KW	84

The maximum noise levels given in Table 1 can be considered acceptable for daily exposure duration in recreational activities or transportation purposes, excluding commercial use. However, in cases of intense commercial use, such as 8-9 hours a day and 5-6 days a week, it may have short- and long-term adverse effects on hearing organs.

According to the Regulation on the Protection of Workers from Risks Related to Noise, the exposure action values and exposure limit values in the working environment are provided as follows:

- Lower exposure action values: ( $L_{ex}$ , 8 hours) = 80 dB(A)
- Upper exposure action values: ( $L_{ex}$ , 8 hours) = 85 dB(A)
- Exposure limit values: ( $L_{ex}$ , 8 hours) = 87 dB(A)

In this notation  $L_{ex}$  is equivalent sound level ( $L_{eq}$ ) corrected to 8 hours. Within this framework, the statement "The weekly noise exposure level determined by adequate measurement shall not exceed the exposure limit value of 87 dB(A)" is also

included.

## 2. Literature Review

The health impacts of noise pollution are multiple, pervasive, long-lasting, and medically and socially significant. Noise produces direct and cumulative adverse effects that damage health and degrade residential, social, work, and educational environments, causing tangible economic as well as intangible losses of well-being (Goines & Hagler, 2007). Motorcycle noise, mainly due to wind and engine vibrations, often exceeds permissible thresholds, increasing the likelihood of hearing impairment (Jordan et al., 2004). The noise which couriers are exposed can vary based on factors such as helmet styles and motorcycle configurations.

Additionally, the psychological impact of prolonged exposure to noise is significant, leading to a reduced quality of life and heightened stress levels. Riders in high-traffic environments report greater annoyance and mental fatigue due to noise pollution (Lechner et al., 2020). The broader ecological consequences of motorcycle noise are evident in its contribution to the degradation of urban soundscapes. This underscores the importance of adopting sustainable transportation solutions to mitigate the environmental footprint of motorcycles (Muazu, 2019). Comparisons across different modes of transportation reveal that motorcyclists are exposed to significantly higher noise levels than commuters using cars or public transport (Apparicio et al., 2018). To address this situation, advanced methodologies for measuring noise and vibration levels have been developed, enabling improved assessment and mitigation strategies for motorcyclists (Figlus et al., 2019).

Electric motorcycles have been a promise of being very hopeful through quieter alternatives for urban motorized mobility, thus tending to reduce the complete noise pollution in cities substantially (Hernandez et al., 2019). At the community, noise from motorcycle traffic presents annoyance in urban areas it is an needed urgent call for policy interventional activity that limits intrusion of noise in residential, commercial areas, and during recreational activities (Paviotti & Vogiatzis, 2012). Motorcyclists are also exposed to physical fatigue and musculoskeletal disorders due to continuous vibration; thus, the importance of ergonomic designs and occupational health policies becomes prominent (Diyana et al., 2017). In general, research on commuting, bikers also were identified as one of the most vulnerable groups because of the long duration of exposure to the noise, added to which was the compounded effect from the urban traffic conditions (Yao et al., 2017). Occupational motorcyclists, such as couriers and police riders, are particularly at risk

due to their continual high level of exposure (Brown & Gordon, 2011).

Noise generated from five brands of commercial motorcycles in Nigeria were studied by Amine et al. (2023) with a view to informing noise management strategies. The loudest noise was produced by Jincheng motorcycles, which attained 97 dB(A) at full throttle without silencers, exceeding the limits set by World Health Organization (WHO) and US Environmental Protection Agency (FEPA). Noise emitted from used motorcycles was higher than that of new ones; noise increased with speed and decreased when the motorcycles carried loads. Noise emissions were drastically reduced by the use of silencers, and their importance was emphasized. The findings recommend more effective enforcement of noise regulations, maintenance, and noise-reduction technologies to mitigate the impact of motorcycle noise on the environment and human health. Contributory factors to this high exposure to noise include the speed at which the vehicles were ridden, open-face helmets, and the lack of windscreen protection. Such noises carried risks of hearing loss-both temporary and permanent-noise, and increased stress and distraction. Time-weighted average noise exposures were all above 90 dBA for the evaluated standards in Occupational Safety and Health Administration, Hearing Conservation (OSHA-HC), Permissible Emission Level (OSHA-PEL), and American Conference of Governmental Industrial Hygienists/ National Institute of Occupational Safety and Health (ACGIH/NIOSH); in fact, the 8-hour time-weighted average in the latter was 85.16 dBA. The findings emphasize the need for standardized noise assessment protocols, awareness of auditory risks, and interventions such as quieter helmets to mitigate health impacts among motorcyclists (Ali & Dom, 2018).

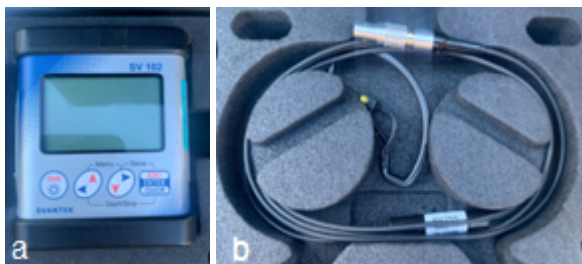
The study by Ali et al. (2020) revealed that noise levels were higher in male drivers than in female drivers, who preferred motorcycles with lower engine capacity and safer speeds. Noise exposure levels of motorcyclists for different occupational noise standards at various speeds, LAeq for all the measurement series, considering OSHA-HC yields an average value of 85 dBA, that of OSHA-PEL at 78 dBA, and ACGIH/NIOSH at 87 dBA, which gives a maximum 8-hour TWA (Time-Weighted Average) of 69 dBA under the ACGIH/NIOSH. Noise exposures increased with speed and reached a peak of 88 dBA at 80 km/h, but at lower speeds-ranging between 40 to 60 km/h-the noise exposure was substantially reduced. No great correlation of the engine capacity with the noise level was seen as the main determining factors were wind and speed. This study concluded that there should be standard measurement methods of noise, safe riding practices,

and the use of quieter helmets to reduce health risks and ensure better safety outcomes.

These studies point out the complexity in addressing motorcycle noise exposure. Agreed, comprehensive strategies combining technological innovations, public health initiatives, and strictly enforced policies will help cut down the adverse impact both on the riders and society.

### 3. Method

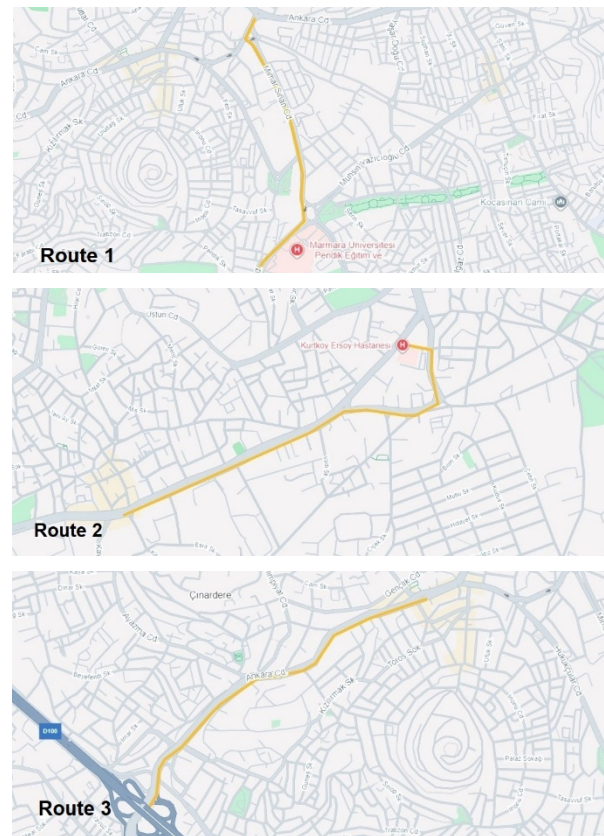
In this article, noise exposure of motorcycle couriers in their real work situations was measured. Noise measurement was carried out according to the requirements of ISO 11904-1. In-ear noise measurement was made by using a Svantek SV102 sound level meter with an SV25S microphone, according to ISO 11904-1. The devices are shown in Figure 1. This procedure uses the Microphone in Real Ear (MIRE) technique, which is designed to evaluate noise levels right at the entrance of the ear canal.



**Figure 1 a) Svantek SV102 Sound Level Meter and b) SV25S Microphone**

The equipment calibration was verified and found to be in conformance with the internal laboratory procedures, which follow ISO/IEC 17025. Calibration intervals for the Svantek SV102 device are two years, and the device was checked to be within the valid period of calibration before measurement. On the day of measurement, the temperature was 14°C, the relative humidity was 61%, and the atmospheric pressure was 101.19 hPa. These parameters were continuously measured for reliability during noise measurement tests.

Noise exposure was measured during the courier's real-life motorcycle use on 3 specific routes, each 1.5 km long, on the Pendik-Istanbul region. The map view of the routes is given in Figure 2. The measurement time is 3 minutes along the route. Measurements were made using the MIRE technique to obtain the most realistic representation of noise levels at one ear. The measurements were made under regular working conditions using RS1 Full Face Helmet and Asya Motor Shark 150 Motorcycle.



**Figure 2. Routes Where Noise Measurements Were Made**

For each route, the “outbound” and “return” directions were evaluated separately. Noise levels were measured in 28 different frequency bands between 20 Hz and 10 kHz. With the help of a 1/3 octave band filter, each band is measured by the sound level meter. Instantaneous noise level recorded in every band, then corrected using A and C weighting filters according to human hearing sensitivity with respect to various frequencies. The difference between A and C weighting filters is given below.

- **dBA:** A-weighting emphasizes mid-range frequencies where human hearing is most sensitive.
- **dB(C):** C-weighting includes a broader range of frequencies.
- **dBZ:** No weighting applied, representing raw measured values.

The recorded data were processed to calculate the equivalent continuous sound levels ( $L_{eq}$ ) adjusted to dBA values.  $L_{eq}$  is mathematically expressed as (Svantek, 2025):

$$L_{eq} = 10 \cdot \log_{10} \left( \frac{1}{T} \int_0^T 10^{\frac{L(t)}{10}} dt \right) \quad (1)$$

Where:

- $L_{eq}$ : Equivalent continuous sound level (dBA)
- $L(t)$ : Instantaneous sound level at time  $t$  (dB)
- $T$ : Measurement duration (seconds)

## 4. Results

### 4.1. Noise Exposure Levels

The noise exposure levels of motorcycle couriers were measured during their routine rides on selected routes. The results are summarized in Table 2, presenting the adjusted equivalent continuous sound levels ( $L_{eq}$ ) in A-weighted decibels (dBA), C-weighted decibels (dBC), and unweighted decibels (dBZ).

**Table 2. Noise Exposure Levels by Route and Direction**

Route	Direction	Adjusted Leq (dBA)	Total A-weighted (dBA)	Total C-weighted (dBC)	Total Unweighted (dBZ)
Route 1	Outbound	84.17	85.6	95.4	99.5
	Return	84.58	86.0	95.1	98.6
Route 2	Outbound	82.63	84.2	91.6	94.4
	Return	84.75	86.2	94.7	97.9
Route 3	Outbound	86.84	88.3	97.2	100.5
	Return	86.82	88.5	96.3	98.5

During this scenario Route 1-outbound, the adjusted Leq in dBA was 84.17. Total sound pressure levels were recorded at 85.6 dBA (A-weighted), 95.4 dBC (C-weighted), and 99.5 dBZ (unweighted). For the return route, the adjusted Leq in dBA was slightly higher at 84.58, reflecting increased exposure on the return trip. Maximum sound pressure levels were 86.0 dBA, 95.1 dBC, and 98.6 dBZ.

For Route 2-outbound, the adjusted Leq in dBA was 82.63, the lowest recorded among all routes. The other related sound pressure levels were 84.2 dBA, 91.6 dBC, and 94.4 dBZ. For the return route, the adjusted Leq in dBA was measured at 84.75, showing increased exposure during the return leg. Maximum sound pressure levels were 86.2 dBA, 94.7 dBC, and 97.9 dBZ.

In the case of Route 3-outbound, the highest adjusted Leq was observed at 86.84 dBA, indicating significant noise exposure along this route.

Maximum sound pressure levels were recorded as 88.3 dBA, 97.2 dBC, and 100.5 dBZ. For the return route, noise levels remained high, with an adjusted Leq of 86.82 dBA. The total noise levels reached 88.5 dBA, 96.3 dBC, and 98.5 dBZ.

Route 3 has the highest noise exposure for both the outbound and return journeys among the routes studied. Route 2 has the lowest exposure levels throughout, which showed that route characteristics such as traffic density and road quality have a great impact on noise exposure.

### 4.2. Frequency Analysis

Frequency band analysis showed that peak sound levels are in the range of 100 Hz to 1,000 Hz, corresponding to the engine noise and wind turbulence commonly associated with motorcycle operations. There are significant variations among routes, while higher frequencies-for example, 4,000 to 8,000 Hz-showed a relatively lower contribution to the total noise levels.

## 5. Discussion

The study showed that motorcycle couriers are exposed to high levels of noise while performing their routine work. These results indicate that noise levels on all routes are close to the exposure limit value (87 dBA) associated with the possibility of noise-induced hearing loss according to occupational health guidelines.

Significant differences between noise levels were measured concerning noise exposure of various routes and directions of movement. Route 3 exhibited the highest adjusted Leq: 86.84 dBA while going and 86.82 dBA returning. These results might illustrate specific conditions of an environment or operation mode. Factors such as traffic density, road conditions, and speed limits likely contributed to these elevated levels.

On the other hand, the minimum values of exposure were measured for Route 2, especially during the outbound, with an average value of 82.63 dBA. Therefore, it seems that the characteristics of the route weigh significantly on noise exposure.

Frequency band analysis confirmed that the bulk of noise energy was concentrated in the frequency range between 100 Hz and 1,000 Hz, representing engine noise and wind turbulence-a very common occupational hazard among motorcycle couriers. High-frequency bands between 4,000–8,000 Hz are less important for the overall noise exposure, which emphasizes that engine dynamics and road interaction dominate the sound profile.

Thus, any exposure to noise exceeding this 87 dBA threshold entails potential damage, as established through ISO 1999:2013 and related occupational

safety standards. In fact, the adjusted Leq values recording in all routes and directions suggest routine hazards of noise levels among the motorcycle couriers during working periods, thus there is a need to devise preventive mechanisms on preserving their auditory health.

While the work was conducted within ISO 11904-1 specifications and with high-precision, calibrated apparatus, several limitations were considered. It is possible that the various helmets are fitted some couriers more than others and also differences in posture and local environmental conditions such as variations in wind speed and traffic flow might have served to affect noise exposure measurements. The courier number (one courier) and routes (three routes) tested were limited, which might limit the results found here in terms of external validity.

The high exposure noise values in this study clearly demonstrate that interventions are urgently needed to safeguard hearing in motorcycle couriers. Recommendations include better helmet designs, the adoption of electric motorcycles, and urban policies to manage traffic-related noise. These interventions would not only improve occupational health outcomes but also contribute to quieter and more sustainable cities.

Accordingly, the following were the recommendations to employers:

1. Providing individually fitted ear protection compatible with helmets.
2. Periodic hearing assessments to monitor long-term auditory health.
3. Optimization of delivery route to avoid high-traffic exposure.
4. Awareness campaigns emphasize the risks associated with noise and preventive measures.

The current research comes with strong evidence that motorcycle couriers are under hazardous noise exposure during regular operations, especially on route 3, with the highest adjusted Leq values. This result shows the occupational health risks due to prolonged exposure to noise pollution-a very critical but usually ignored aspect of the work of a courier. These risks, on the other hand, require immediate mitigation actions through the application of noise control measures, policy interventions, and education programs among couriers. Further research will be extended to a larger sample size, other environmental conditions, and an assessment of the long-term health effects of noise exposure among couriers.

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### Ethics

Since the study involves measurements of environmental factors that do not contain any personal data and these measurements are not associated with individuals, ethics committee approval is not required.

### Conflict of Interest

No conflict of interest was declared by the authors.

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