



Original Article

Prevalence and Occupational Determinants of Noise-Induced Hearing Loss Among Traffic Police Personnel in Mumbai: A Cross-Sectional Study Using Pure Tone Audiometry

Dr. Shrinivas Chavan¹, Dr Anuja Madhukar Gaikwad², Dr. Ranjit Mankeshwar³, Dr. Shamolee Sethi⁴, Dr Ankita Kamath⁵

¹Professor and Head of Department, Department of Otorhinolaryngology (E.N.T.), Grant Government Medical College & Sir JJ Group of Hospitals, Mumbai.

²Post Graduate Resident, Department of Otorhinolaryngology (E.N.T.), Grant Government Medical College & Sir JJ Group of Hospitals, Mumbai.

³Associate Professor, Department of Community Medicine, Grant Government Medical College & Sir JJ Group of Hospitals, Mumbai.

⁴Post Graduate Resident, Department of Otorhinolaryngology (E.N.T.), Grant Government Medical College & Sir JJ Group of Hospitals, Mumbai

⁵ Post Graduate Resident, Department of Otorhinolaryngology (E.N.T.), Grant Government Medical College & Sir JJ Group of Hospitals, Mumbai

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Corresponding Author:

Dr Anuja Madhukar Gaikwad
Post Graduate Resident,
Department of Otorhinolaryngology
(E.N.T.), Grant Government Medical
College & Sir JJ Group of Hospitals,
Mumbai

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ABSTRACT

Background: Noise-induced hearing loss (NIHL) is one of the most common preventable occupational disorders worldwide and remains a significant public health concern among workers exposed to prolonged environmental noise. Traffic police personnel are particularly vulnerable because of continuous exposure to high-intensity urban traffic noise.

Objectives: To determine the prevalence of noise-induced hearing loss among traffic police personnel using pure tone audiometry and to identify demographic, occupational, and clinical factors associated with its occurrence.

Material & Methods: A cross-sectional observational study was conducted from 1 January 2025 to 31 December 2025 among traffic police personnel in Mumbai, India. The study was carried out by the Department of Otorhinolaryngology, in a Tertiary Care Hospital of Mumbai, in collaboration with the Mumbai Traffic Police Department. A total of 235 traffic police personnel aged 21–58 years were enrolled. Participants underwent clinical evaluation and pure tone audiometry. Associations between NIHL and demographic, occupational, and clinical variables were analysed using chi-square tests. Multivariable binary logistic regression was performed to identify independent predictors of NIHL.

Results: Among 235 participants, 74 demonstrated audiometric findings compatible with NIHL, yielding a prevalence of 31.5%. The prevalence increased significantly with age, from 14.6% among participants aged 21–30 years to 48.7% among those aged 51–58 years ($p=0.001$). NIHL prevalence also increased progressively with duration of service, reaching 66.7% among personnel with more than 20 years of service ($p<0.001$). Male sex ($p=0.029$), longer daily traffic-duty duration ($p=0.013$), and non-use of hearing protection devices ($p=0.001$) were significantly associated with NIHL. On multivariable analysis, daily traffic duty exceeding eight hours (adjusted odds ratio [AOR] 2.33; 95% confidence interval [CI]: 1.05–5.16), never using hearing protection (AOR 5.18; 95% CI: 1.68–15.96), smoking (AOR 2.14; 95% CI: 1.05–4.34), and hypertension (AOR 2.80; 95% CI: 1.20–6.51) emerged as independent predictors of NIHL.

Conclusions: Nearly one-third of traffic police personnel in Mumbai demonstrated audiometric evidence of noise-induced hearing loss. Increasing age, prolonged occupational exposure, extended daily duty duration, smoking, hypertension, and lack of hearing protection were significant determinants of NIHL. Regular audiometric surveillance, implementation of hearing conservation programmes, and promotion of hearing protection use are essential to reduce the burden of occupational hearing loss among traffic police personnel.

Keywords: Noise-induced hearing loss; Traffic police; Occupational noise exposure; Pure tone audiometry; Hearing conservation; Occupational health.

INTRODUCTION

Noise pollution is a growing environmental and occupational health concern worldwide. Rapid urbanization, increasing vehicular density, industrialization, and expanding transportation networks have resulted in sustained exposure to high environmental noise levels, particularly in metropolitan cities.[1,2] Occupational noise exposure is a well-recognized hazard that affects millions of workers globally and remains one of the leading causes of preventable hearing impairment.[3–5]

Noise-induced hearing loss (NIHL) is a permanent sensorineural hearing loss resulting from prolonged exposure to excessive noise. Although largely preventable, NIHL continues to be one of the most prevalent occupational disorders worldwide.[3–5] Repeated exposure to high-intensity noise causes irreversible damage to cochlear hair cells and auditory neural pathways, resulting in progressive hearing impairment.[6–9] A characteristic audiometric feature of NIHL is the presence of a notch at 4 kHz on pure tone audiometry, often accompanied by high-frequency hearing loss with relative preservation of speech frequencies.[8,9]

The burden of hearing loss extends beyond impaired auditory perception. Hearing impairment adversely affects communication, workplace performance, social interaction, quality of life, and mental well-being.[10] Occupational hearing loss has also been associated with reduced productivity, increased risk of workplace accidents, social isolation, and substantial economic costs.[11]

Traffic police personnel represent an occupational group at particularly high risk for NIHL because of their continuous exposure to vehicular traffic noise. In large metropolitan cities such as Mumbai, traffic police personnel spend prolonged periods at busy intersections where noise levels frequently exceed recommended occupational exposure limits.[12] In addition to chronic exposure to vehicle engines, horns, sirens, and urban environmental noise, many personnel work extended duty hours with limited access to hearing conservation measures.[3,4]

Several studies from India and abroad have reported a high prevalence of hearing impairment among traffic police personnel and other occupationally noise-exposed populations. Thomas et al. reported a high prevalence of NIHL among traffic point-duty personnel in Kuala Lumpur, while Tandel and Macwan demonstrated significant hearing impairment among traffic policemen in Surat, India.[13,14] Similar findings have been reported among traffic police personnel in Kathmandu, Nepal.[15,16] Systematic reviews have consistently identified occupational noise exposure as a major contributor to hearing loss across multiple occupational settings.[3,4]

However, despite Mumbai being one of the most densely populated metropolitan cities in India, with a large traffic-police workforce exposed to heavy vehicular noise, published data on noise-induced hearing loss among Mumbai traffic police personnel remain limited. The present pilot study was therefore undertaken to determine the prevalence of noise-induced hearing loss among traffic police personnel in Mumbai using pure tone audiometry and to evaluate the demographic, occupational, and clinical factors associated with its occurrence.

MATERIALS AND METHODS

Study Design and Setting

This hospital- and field-based cross-sectional observational study was conducted in the Department of Otorhinolaryngology, in a Tertiary Care Hospital of Mumbai, in collaboration with the Mumbai Traffic Police Department for the duration of twelve months.

The study was approved by the Institutional Ethics Committee of the Tertiary Care Hospital, Mumbai (Approval dated 05 May 2025), prior to commencement of the study. Written informed consent was obtained from all participants before enrolment. The study was conducted in accordance with the principles of the Declaration of Helsinki.

Study Population

A total of 235 traffic police personnel were enrolled in the study.

Inclusion Criteria

- Traffic police personnel aged 21–58 years
- Personnel working in areas with high traffic volume

Exclusion Criteria

- Individuals with pre-existing hearing loss not related to noise exposure
- Individuals with ear infections or diseases affecting hearing

Audiological Assessment

All participants underwent detailed otorhinolaryngological examination followed by pure tone audiometry in a sound-treated audiology booth at the Department of Otorhinolaryngology. Pure tone audiometry was performed using a calibrated PROTON Dx-3 audiometer.

Noise-induced hearing loss was identified based on characteristic audiometric findings, including high-frequency sensorineural hearing loss and/or the presence of a 4-kHz notch, after exclusion of alternative causes of hearing impairment.

Statistical Analysis

Data were entered into Microsoft Excel and analysed using IBM SPSS Statistics for Windows. Categorical variables were expressed as frequencies and percentages, while continuous variables were expressed as mean \pm standard deviation. Associations between categorical variables were analysed using Pearson's chi-square test or Fisher's exact test, as appropriate. Risk ratios with 95% confidence intervals were calculated for selected exposures. Multivariable binary logistic regression analysis was performed to identify independent predictors of NIHL. A p-value of less than 0.05 was considered statistically significant.

RESULTS

A total of 235 traffic police personnel were enrolled in the study. The age of participants ranged from 21 to 58 years with a mean age of 40 years. The majority belonged to the 31–40 years age group (32.3%), followed by the 41–50 years age group (30.6%). Male participants constituted 84.3% of the study population.

Of the 235 participants evaluated, 133 (56.6%) had normal hearing. Noise-induced hearing loss-compatible hearing loss was identified in 74 participants, yielding a prevalence of 31.5%. Probable age-related sensorineural hearing loss and conductive/mixed hearing loss were each observed in 14 participants (6.0%).(Table1)

Personnel performing more than eight hours of traffic duty per day demonstrated a prevalence of NIHL of 48.9%, compared with 21.1% among those working six hours or less per day ($p=0.013$).

A significant dose-response relationship was observed between duration of service and NIHL, with prevalence increasing from 13.5% among personnel with less than five years of service to 66.7% among those with more than twenty years of service ($p<0.001$).

The prevalence of NIHL increased with age, from 14.6% among participants aged 21–30 years to 48.7% among those aged 51–58 years ($p=0.001$). NIHL was more common among males than females (34.3% vs. 16.2%; $p=0.029$). (Figure1)

Decreased hearing, tinnitus, hyperacusis, and difficulty hearing in noisy environments were significantly associated with NIHL (all $p<0.001$). The most common audiometric finding was an isolated 4-kHz notch (43.2%), followed by high-frequency hearing loss with preservation of speech frequencies (32.4%). All participants demonstrating a 4-kHz notch had NIHL-compatible hearing loss.(Table2)

Only 20.4% of participants reported occasional use of hearing protection devices. The prevalence of NIHL was significantly higher among personnel who had never used hearing protection than among occasional users (36.4% vs. 12.5%; $p=0.001$).

Multivariable logistic regression identified daily traffic duty exceeding eight hours (AOR 2.331; 95% CI 1.052–5.162), never using hearing protection (AOR 5.183; 95% CI 1.683–15.958), smoking (AOR 2.136; 95% CI 1.050–4.342), and hypertension (AOR 2.795; 95% CI 1.199–6.514) as independent predictors of NIHL. (Table3)

Table 1: Overall hearing status among study participants

Hearing status	Frequency	Percentage
Normal hearing	133	56.6%
NIHL-compatible hearing loss	74	31.5%

Probable age-associated SNHL	14	6.0%
Conductive/mixed hearing loss	14	6.0%
Total	235	100.0%

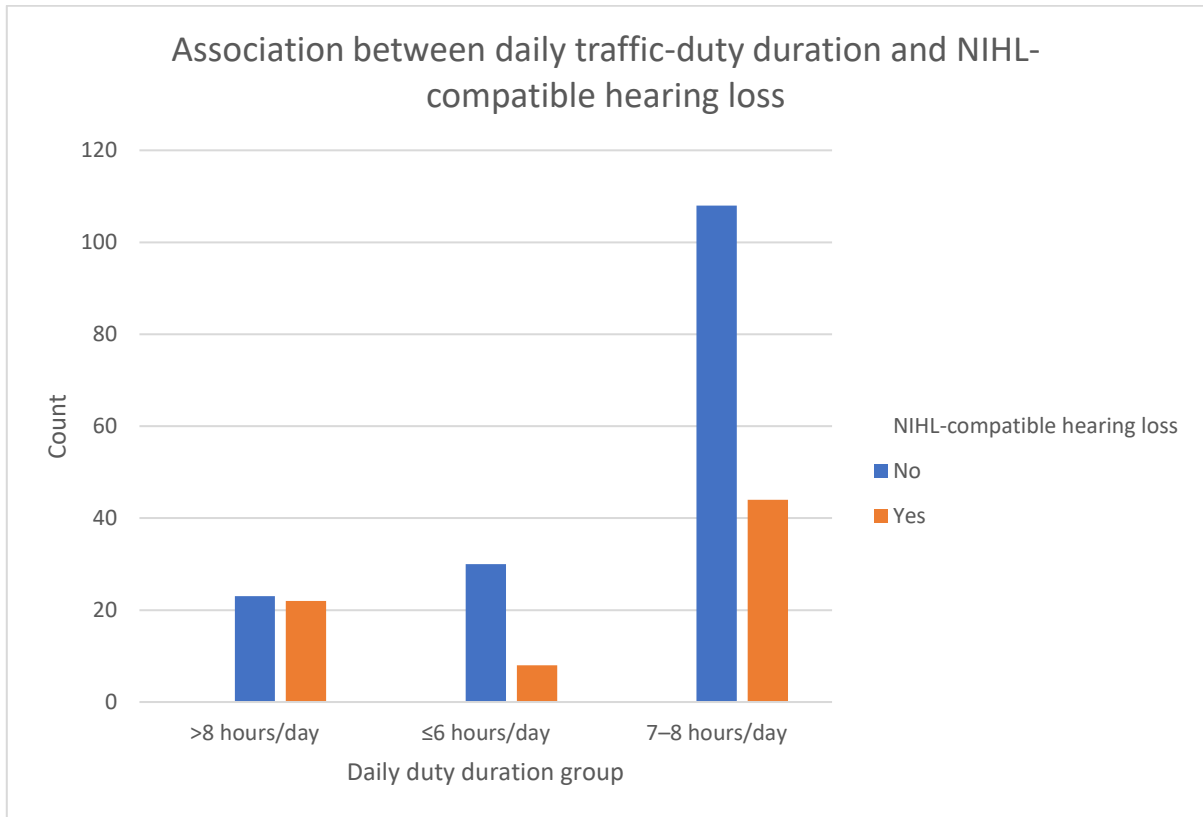


Figure 1: Association between daily traffic-duty duration and NIHL-compatible hearing loss

Table2: Association between symptoms and NIHL-compatible hearing loss

Symptom	Symptom status	NIHL Absent, n (%)	NIHL Present, n (%)	Total	χ^2 value	p value
Decreased hearing	Present	14 (25.5%)	41 (74.5%)	55	61.703	<0.001
	Absent	147 (81.7%)	33 (18.3%)	180		
Tinnitus	Present	37 (45.1%)	45 (54.9%)	82	31.936	<0.001
	Absent	124 (81.0%)	29 (19.0%)	153		
Hyperacusis	Present	11 (35.5%)	20 (64.5%)	31	18.056	<0.001
	Absent	150 (73.5%)	54 (26.5%)	204		
Difficulty hearing in noisy environment	Present	38 (43.2%)	50 (56.8%)	88	41.835	<0.001
	Absent	123 (83.7%)	24 (16.3%)	147		
Headache	Present	42 (65.6%)	22 (34.4%)	64	0.339	0.560
	Absent	119 (69.6%)	52 (30.4%)	171		

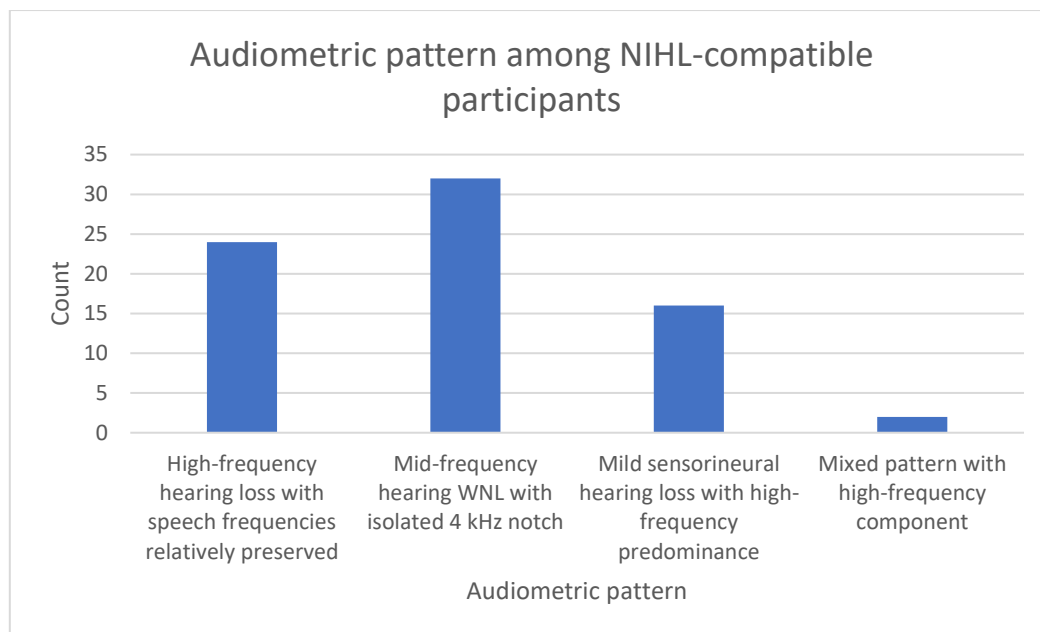


Figure 21: Audiometric pattern among NIHL-compatible participants

Table 3: Multivariate Regression Analysis

Multivariate Regression Analysis

A Forest Plot Dashboard of Adjusted Odds Ratios (OR) and Model Performance Metrics

Predictor Variable	(Forest Plot of OR, Base-10 Log Scale)	Wald χ^2	Adjusted OR (95% CI)	p-value
Male gender		0.839	1.664 (0.560–4.945)	0.360
Age >40 years	[Unstable Estimate – Not Plotted]	0.000	0.000	0.999
Service duration >10 years	[Unstable Estimate – Not Plotted]	0.000	4270212477.196	0.999
Daily traffic duty >8 hours		4.349	2.331 (1.052–5.162)	p 0.037
Never used hearing protection		8.222	5.183 (1.683–15.958)	p 0.004
Current or past smoker		4.393	2.136 (1.050–4.342)	p 0.036
Alcohol consumption present		3.810	2.186 (0.997–4.794)	p 0.051
Diabetes mellitus present		3.454	2.439 (0.953–6.247)	p 0.063
Hypertension present		5.667	2.795 (1.199–6.514)	p 0.017
Nasal allergy history present		4.596	0.429 (0.198–0.930)	p 0.032

DISCUSSION

The present cross-sectional study evaluated the prevalence of noise-induced hearing loss (NIHL) among traffic police personnel in Mumbai and identified demographic, occupational, and clinical factors associated with its occurrence. The study demonstrated that nearly one-third (31.5%) of traffic police personnel had audiometric findings compatible with NIHL, highlighting the substantial burden of occupational hearing impairment in this population.

The prevalence observed in the present study is comparable with reports among traffic police personnel from other regions. Thomas et al. reported significant hearing impairment among traffic point-duty personnel in Kuala Lumpur, while Tandel and Macwan demonstrated a high prevalence of hearing loss among traffic policemen in Surat, India.[13,14] Similar findings have been reported among traffic police personnel in Kathmandu, Nepal.[15,16] These observations collectively indicate that chronic exposure to vehicular and environmental traffic noise constitutes an important occupational hazard for traffic police personnel irrespective of geographic location. The prevalence observed in the present study also falls within the range reported among other occupationally noise-exposed populations worldwide.[17]

Daily duration of traffic-duty exposure was significantly associated with NIHL. Personnel performing traffic duty for more than eight hours per day demonstrated substantially higher prevalence of hearing loss than those working shorter shifts. Extended daily duty duration remained an independent predictor of NIHL in multivariable analysis. These findings support the well-established relationship between cumulative noise dose and auditory damage and are consistent with previous occupational studies demonstrating increased risk of hearing loss with prolonged daily exposure.[3,18]

Duration of service emerged as a major determinant of NIHL. The prevalence increased progressively from 13.5% among personnel with less than five years of service to 66.7% among those with more than twenty years of service, demonstrating a clear dose-response relationship between cumulative occupational noise exposure and hearing impairment. Similar findings have been reported among industrial workers, transportation personnel, and traffic police populations, where years of exposure were strongly associated with progressive hearing deterioration.[18–20] This trend is biologically plausible because repeated exposure to hazardous noise levels results in cumulative cochlear hair-cell and neural damage over time.[6–9]

A significant age-related increase in NIHL prevalence was observed, with prevalence rising from 14.6% in the youngest age group to 48.7% among participants aged 51–58 years. Similar age-related trends have been reported in occupational hearing-loss studies worldwide.[17,21] Although age-related cochlear degeneration may contribute to hearing impairment in older individuals, the observed association likely reflects the combined effects of presbycusis and prolonged occupational noise exposure. Dillard et al. demonstrated that lifetime noise exposure accelerates age-related hearing decline, supporting the findings of the present study.[22]

The audiometric findings observed in the present study were characteristic of chronic noise exposure. The 4-kHz notch was the most common audiometric pattern and was observed exclusively among participants classified as having NIHL. High-frequency hearing loss with preservation of speech frequencies was also frequently observed. These findings are consistent with the established pathophysiology of NIHL and reflect selective vulnerability of cochlear outer hair cells and auditory neural pathways responsible for high-frequency sound perception.[6–9]

Symptoms including decreased hearing, tinnitus, hyperacusis, and difficulty hearing in noisy environments were strongly associated with NIHL. Similar symptom profiles have been reported among noise-exposed workers in previous studies.[9,23,24] Recognition of these symptoms may facilitate earlier referral for audiological assessment and implementation of preventive measures before significant hearing disability develops.

Smoking and hypertension emerged as additional independent predictors of NIHL. These findings support evidence suggesting that vascular and metabolic factors may potentiate cochlear injury through impaired cochlear microcirculation, oxidative stress, and increased susceptibility to acoustic damage.[18–20] The interaction between occupational noise exposure and systemic health factors highlights the multifactorial nature of NIHL and suggests that preventive strategies should incorporate broader occupational health interventions beyond noise control alone.

The use of hearing protection devices among the study population was notably poor. Nearly four-fifths of participants reported never using hearing protection, and the prevalence of NIHL among non-users was almost three times that observed among occasional users. Non-use of hearing protection emerged as the strongest independent predictor of NIHL. Similar deficiencies in hearing conservation practices have been reported among occupationally noise-exposed populations in both developing and developed countries.[20,25] Hearing protection remains one of the most effective and economical preventive measures available. Structured hearing conservation programmes incorporating education, provision of hearing protection devices, routine audiometric surveillance, and compliance monitoring have been shown to significantly reduce occupational hearing loss.[18,25]

The implications of hearing impairment extend beyond auditory dysfunction. Previous studies have demonstrated adverse effects of hearing loss on communication, workplace performance, social interaction, quality of life, and occupational safety.[10,11,24,26] For traffic police personnel, impaired hearing may compromise situational awareness and response to auditory warning signals, thereby increasing occupational risk. Consequently, preservation of hearing should be regarded as an integral component of occupational safety policy.

The present study has important public-health and occupational-health implications. Mumbai is among the most densely populated metropolitan cities in India, with persistent vehicular congestion and high environmental noise levels. The findings suggest an urgent need for comprehensive hearing conservation programmes, including regular audiometric surveillance, enforcement of hearing protection use, periodic duty rotation, and awareness programmes regarding occupational noise hazards. Such measures may substantially reduce the burden of NIHL among traffic police personnel. The study has certain limitations. Its cross-sectional design limits causal inference, and environmental noise levels were not measured directly at individual duty locations. Hearing protection use was self-reported and therefore subject to recall bias. The study was conducted in a single metropolitan setting, which may limit generalizability. Nevertheless, strengths of the study include a relatively large sample size, objective audiometric assessment using pure tone audiometry, and evaluation of multiple occupational risk factors through multivariable analysis.

In conclusion, nearly one-third of Mumbai traffic police personnel demonstrated evidence of NIHL. Increasing age, longer service duration, prolonged daily traffic-duty exposure, smoking, hypertension, and non-use of hearing protection devices were significant predictors of hearing loss. These findings underscore the need for comprehensive hearing conservation strategies and periodic occupational health surveillance to prevent avoidable hearing disability among traffic police personnel.

CONCLUSION

Noise-induced hearing loss is a significant occupational health problem among traffic police personnel in Mumbai, with nearly one-third of participants demonstrating audiometric evidence of NIHL. The risk of hearing loss increased progressively with longer duration of service, extended daily traffic-duty exposure and advancing age. Lack of hearing protection use emerged as the strongest modifiable risk factor; while smoking and hypertension were also independently associated with an increased risk of NIHL.

Regular audiometric screening, implementation of structured hearing conservation programmes, provision and enforcement of hearing protection devices, periodic duty rotation, and increased awareness regarding occupational noise hazards are essential to reduce the burden of hearing impairment in this occupational group.

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