OCCUPATIONAL NOISE AND NERVOUS SYSTEM CANCER RISK: A STUDY AMONG WELDING WORKERS IN GIANYAR 2025

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Occupational noise exposure is a major health risk that not only causes hearing problems but may also trigger long-term systemic effects. This study was conducted on 35 welding workshop workers in the working area of UPTD Puskesmas Gianyar I in 2025 to examine the association between noise intensity and subjective hearing complaints. The results showed an average noise level of 83.7 dBA (range 60.7–101.0 dBA), approaching the permissible exposure limit of 85 dBA, with most complaints classified as moderate (77.2%). Fisher Exact Test analysis demonstrated a significant relationship between noise intensity and hearing complaints ($p = 0.012$; $CC = 0.434$). Biologically, chronic noise exposure can increase oxidative stress, inflammation, sleep disturbance, and immune suppression. These mechanisms may create conditions that promote carcinogenesis, including in nervous tissue. Several studies have suggested an association between long-term noise exposure and nervous system tumors, such as acoustic neuroma. So, occupational noise should be regarded not only as a risk factor for hearing impairment but also as a potential contributor to nervous system cancer when exposure persists without proper control. These findings highlight the importance of workplace noise management and hearing protection as part of preventive occupational health strategies and as a means to reduce long-term cancer risks.

Keywords : Noise, Welding workshop, Nervous system cancer

Introduction

Noise is sound originating from nature or human activities that is unwanted by our ears, expressed in decibels (dB). Prolonged exposure to noise can cause hearing fatigue and lead to hearing damage[5]. Noise is considered unwanted sound that may cause discomfort to human hearing if exposure lasts for a considerable period of time[4]. Noise generated from industrial activities is one of the most common forms of occupational environmental pollution, particularly in welding workshops. Welding workers are frequently exposed to sounds from cutting machines, grinders, the reflection of welding waves, and other supporting tools. Chronic exposure to high-intensity noise not only causes hearing disorders but also triggers physical and psychological stress, hormonal system dysfunction, sleep disturbances, and inflammatory reactions in the body.

Several biomedical studies indicate that noise not only endangers auditory function and cardiovascular health but can also cause damage to DNA and nerve cells as a consequence of oxidative stress and disrupted regulation of cellular defense mechanisms. One study demonstrated that prolonged exposure to loud noise may trigger a DNA damage response, such as the occurrence of DNA double-strand breaks in certain tissues[11].

The hypothesis that noise could be a risk factor for neural cancer, although not yet strongly proven, has begun to receive attention in scientific literature. For example, in a systematic review entitled "Noise exposure and the risk of cancer", there is evidence that occupational or recreational noise exposure is associated with an increased risk of acoustic neuroma, a benign tumor that develops on the auditory nerve[9]. The occurrence of acoustic neuroma indicates that neural structures may undergo abnormal proliferation associated with exposure to loud sounds. Other studies have also reported that noise exposure can stimulate the production of nerve growth factors and induce cellular changes that may open pathways to carcinogenic processes.

In Gianyar, many welding workshops operate with inadequate noise control and occupational safety protection. Workers often perform long-duration tasks without sufficient ear protection and in spaces poorly insulated against sound wave reflections. This condition allows for continuous noise exposure, both in terms of decibel levels and exposure duration, which poses a significant potential risk of systemic effects that have not been extensively studied.

Considering the scarcity of local research in Gianyar that examines the relationship between noise and neural cancer, this study is crucial. Its purpose is not only to clarify whether there is an association between noise exposure in welding workshops and the risk of neural cancer, but also to identify possible biological mechanisms involved (such as DNA damage, oxidative stress, inflammation, and neural regulation disorders). The findings could serve as a basis for recommendations on occupational health protection and local policy-making.

Research Methods

This research employed a quantitative approach with an analytical observational cross-sectional design. The sample was determined using a total sampling method, encompassing all workers from 10 welding workshops within the catchment area of UPTD Puskesmas Gianyar I (n = 35). Primary data were collected through measurements of noise intensity using a Sound

Level Meter, as well interviews regarding subjective complaints of hearing disturbances. Subjective complaints were classified into mild, moderate, and severe categories. Data were analyzed using univariate methods to describe the distribution of variables, and bivariate analysis was conducted using the Chi-Square test at a significance level of $\alpha = 0.05$. When the assumptions of the Chi-Square test were not fulfilled, the Fisher's Exact Test was applied. The strength of association between variables was assessed using the Contingency Coefficient (CC).

Results and Discussion

A. Noise Intensity Results among Welding Workshop Workers in Gianyar

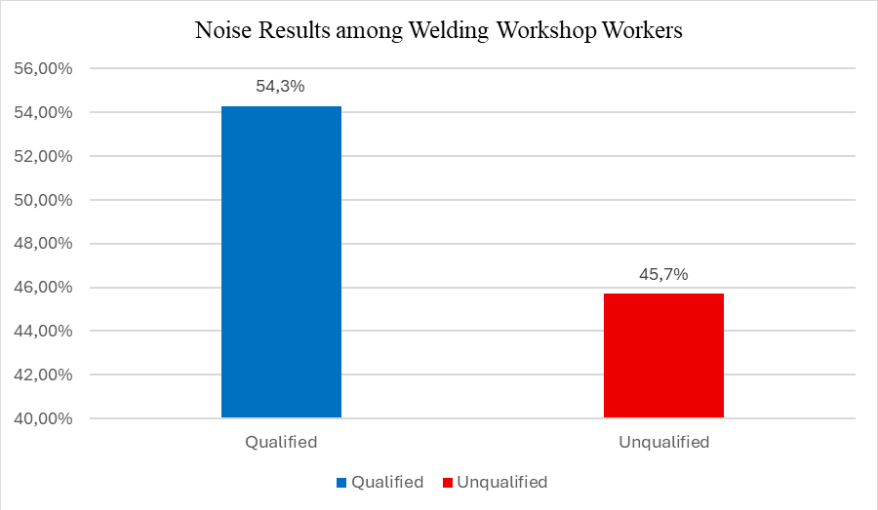
Table 1
Noise Intensity of Welding Workshop Workers in Gianyar Region, 2025

No. Responden	Intensitas Kebisingan (dBA)	Keterangan
(1)	(2)	(3)
01	84,6	Qualified
02	81,1	Qualified
03	81,7	Qualified
04	101,0	Unqualified
05	93,0	Unqualified
06	81,1	Qualified
07	86,5	Unqualified
08	70,3	Qualified
09	75,7	Qualified
10	79,2	Qualified
11	85,1	Unqualified
12	85,5	Unqualified
13	85,7	Unqualified
14	81,9	Qualified
15	65,2	Qualified
16	65,4	Qualified
17	60,7	Qualified
18	66,1	Qualified
19	81,2	Qualified
20	81,8	Qualified
21	84,7	Qualified
22	79,9	Qualified
23	88,1	Unqualified
24	84,5	Qualified
25	83,3	Qualified
26	88,9	Unqualified
(1)	(2)	(3)

27	85,9	Unqualified
28	94,1	Unqualified
29	97,8	Unqualified
30	94,6	Unqualified
31	73,0	Qualified
32	93,1	Unqualified
33	94,8	Unqualified
34	97,2	Unqualified
35	96,9	Unqualified

The permissible noise exposure limit for a maximum of 8 working hours per day is 85 dBA[2]. The respondent with the highest recorded noise intensity was respondent number 04 with 101,0 dBA, while the lowest was respondent number 17 with 60,7 dBA. The average noise intensity measured was 83.7 dBA.

The variation in noise intensity among welding workshop workers was influenced by the type of tasks performed, particularly those involving more extreme activities that generate higher levels of noise, such as hammering and cutting iron. The friction between metal surfaces under high force produces substantial noise. Prolonged exposure to high noise levels can lead to hearing impairment. However, subjective complaints serve as the early indicators of an individual's discomfort toward the surrounding noise.



Picture 1. Graph of Noise Results among Welding Workshop Workers in Gianyar Region, 2025

The chart above presents the percentage of noise exposure levels among welding workshop workers in the working area of UPTD Puskesmas Gianyar I, consisting of 35 study subjects. The results show that 19 workers (54,3%) were exposed to noise levels within the permissible limit, while 16 workers (45,7%) were exposed to levels exceeding the limit.

The average noise level across all welding workshops was 83,7 dBA, which is below the Threshold Limit Value (TLV). However, this average may obscure the fact that some workshops experienced exposures above the TLV. Even though the mean value was below the limit, noise levels greater than 80 dBA can still cause discomfort, auditory fatigue, restlessness, and circulatory problems[6]. Therefore, the average noise level of 83,7 dBA remains a potential health threat to workers, particularly in the absence of personal protective equipment (PPE).

B. Subjective Hearing Complaints among Welding Workshop Workers in Gianyar

Table 2
Results of Subjective Hearing Complaints among Welding Workshop Workers in Gianyar Region, 2025

Subjective Complaints	Total	
	Frequency	Percentage (%)
Mild	4	11,4
Moderate	27	77,2
Severe	4	11,4
Total	35	100

Based on the table above, the results of interviews regarding physiological disturbances among 35 welding workshop workers showed that 4 workers (11,4%) reported mild complaints, 27 workers (77,2%) reported moderate complaints, and 4 workers (11,4%) reported severe complaints.

Subjective hearing complaints refer to a condition in which an individual experiences signs or sensations of discomfort in the auditory system caused by fatigue and workload. Such complaints are typically influenced by factors such as age, gender, length of service, noise intensity, duration of exposure, frequency of exposure, and non-compliance with the use of ear protective devices (EPD). An individual is considered to have subjective hearing complaints if they experience one or more disturbances, including physiological, psychological, or communication-related problems[7].

Interviews regarding communication-related complaints revealed that these symptoms often appear earlier than psychological or physiological disturbances, as their impact is directly noticeable in daily interactions. Workers may also be more sensitive to communication difficulties caused by noise exposure[8]. Previous studies on noise have shown that excessive noise exposure can cause physiological damage to the brain, including inflammation, disruption of the blood–brain barrier (BBB), and neuronal cell death, thereby linking noise to nervous system damage. However, current evidence remains insufficient to conclude that noise

alone is a direct causal factor of neural cancers, particularly malignant tumors of the central nervous system (CNS)[10].

C. Fisher's Exact Test on the Relationship between Noise Intensity and Subjective Hearing Complaints among Welding Workshop Workers in Gianyar

Tabel 3
Fisher's Exact Test of the Relationship between Noise Intensity and Subjective Hearing Complaints among Welding Workshop Workers in Gianyar Region, 2025

Noise Intensity Level	Category of Subjective Complaints						Total		P Value (Exact)
	Mild		Moderate		Severe				
	F	%	F	%	F	%	F	%	
Qualified	4	11,4	15	42,9	0	0	19	54,3	0,012
Unqualified	0	0	12	34,3	4	11,4	16	45,7	
Total	4	11,4	27	77,1	4	11,4	35	100	

Based on the results of the Fisher's Exact Test, the p-value obtained for the association between noise intensity and subjective hearing complaints was 0,012 (< 0,05). This indicates a statistically significant relationship between noise intensity and subjective hearing complaints among welding workshop workers in the working area of UPTD Puskesmas Gianyar I. Furthermore, the Contingency Coefficient (CC) was calculated to assess the strength of the association between variables. The CC value obtained for the relationship between noise intensity and subjective hearing complaints was 0,434, which falls within the range of 0.40–0.599. Thus, the strength of the association between noise intensity and subjective hearing complaints can be categorized as moderate.

D. Potential Risk of Research Findings Related to the Occurrence of Neural Cancer

The discussion in this study aims to analyze the findings and interpret the relationship between noise intensity and subjective complaints among welding workshop workers in the working area of UPTD Puskesmas Gianyar I in 2025. The main focus of the study is to assess whether noise exposure in welding workshop environments contributes to the emergence of subjective complaints, including hearing-related disorders such as tinnitus and temporary hearing loss, as well as other subjective symptoms such as headaches, sleep disturbances, fatigue, and difficulty concentrating. The findings of this research are expected to provide an overview of the importance of maintaining noise intensity in the workplace to prevent more

serious health problems, including chronic diseases and potential nervous system disorders such as neural cancer.

Chronic noise exposure, whether from the workplace or the residential environment, can have widespread health impacts. Noise not only affects the auditory system but also triggers physiological stress through activation of the sympathetic nervous system and increased secretion of stress hormones such as cortisol and adrenaline. These conditions may lead to physiological disturbances including elevated blood pressure, sleep disruption, and long-term psychological stress[1].

Prolonged stress resulting from noise exposure can also induce alterations in the immune system, including decreased Natural Killer (NK) cell function and cytokine dysregulation, both of which play crucial roles in monitoring and eliminating abnormal cells. Such immune dysfunction ultimately increases the risk of cellular damage, as indicated by elevated oxidative stress, chronic inflammation, and impaired DNA repair mechanisms.

DNA damage and immune system failure in controlling abnormal cells are fundamental mechanisms in the development of cancer. Although direct evidence linking chronic noise exposure to neural cancer remains limited, several studies have indicated an association between noise exposure and acoustic neuroma (a tumor of the auditory nerve), as well as an increased risk of cancer through pathways involving chronic stress and immune dysfunction[3].

To date, no studies have specifically demonstrated a direct causal relationship between noise exposure and neural cancer. However, the present study highlights that noise may not only contribute to hearing impairment and cardiovascular disease but may also potentially play a role in carcinogenic processes, including those affecting neural tissues.

Conclusion

This study demonstrates a significant association between noise intensity and subjective hearing complaints among welding workshop workers in the working area of UPTD Puskesmas Gianyar I in 2025. The average noise intensity was found to be close to the Threshold Limit Value (TLV), with some workers exposed to levels exceeding the standard, resulting in subjective complaints, particularly in the moderate category. These findings highlight that noise exposure contributes to physiological, psychological, and communication disturbances, which in turn affect workers' health and productivity. Although no studies have yet provided direct evidence linking noise exposure to neural cancer, these results underscore the importance of noise control in the workplace to prevent further health problems.

Recommendations

Based on the findings, it is recommended that health authorities and relevant stakeholders strengthen monitoring efforts of noise intensity in the workplace, particularly in the welding industry. Regular noise assessments and hearing health examinations should be conducted as part of early detection measures. In addition, education on the proper use of ear protective devices (EPDs) and the implementation of workplace policies that support workers' health protection are essential to mitigate the long-term impacts of noise. Given the limited scientific evidence on the direct relationship between noise and neural cancer, further research is necessary to deepen understanding of the potential role of noise in carcinogenesis. Such findings may serve as an important foundation for promoting noise control as part of preventive strategies against both degenerative diseases and neural cancers.

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