

Occupational Health Profile of Neurointerventionists in Indonesia: A National Cross-Sectional Survey Study

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Introduction: Neurointerventional practice may increase the risk for musculoskeletal problems, fatigue, and sleep disturbance due to prolonged radiation exposure, physical strain, and irregular working hours. However, data from developing countries remains limited. **Objective:** This study aimed to provide information and analyze the occupational health profile and associated risk factors among neurointerventionists in Indonesia. **Method:** A national cross-sectional survey was conducted using a structured questionnaire assessing demographic profiles, workload, radiation protection practices, and health outcomes. Associations between variables were analyzed using appropriate statistical tests. **Result:** A total of 150 neurointerventionists participated in this study. Most were male (76%) and aged 40-49 years (48%). Nearly half performed <2 procedures weekly (48.7%), while 67.3% spent <5 hours in the catheterization laboratory. Although protective equipment use was common, only 34.7% consistently wore dosimeters, and 19.3% routinely monitored radiation exposure. Musculoskeletal pain was reported by 35.3% of participants, while fatigue and sleep disturbance affected 68.7% and 32.7% of participants, respectively. Musculoskeletal pain was significantly associated with fatigue, sleep disturbance, shorter sleep duration, and higher on-call workload, whereas regular exercise showed a protective effect (all $p < 0.05$). Longer catheterization laboratory duration was also associated with fatigue and sleep disturbance ($p = 0.033$ and $p = 0.048$, respectively). **Conclusion:** Neurointerventionists in Indonesia face significant occupational health challenges. Targeted strategies, such as workload management, improved radiation monitoring, and institutional support, are required.

Keywords: Fatigue, Musculoskeletal pain, Neurointervention, Occupational health, Radiation

Received: March 31, 2026

Revised: May 15, 2026

Accepted: May 16, 2026

Published: May 30, 2026

Highlights

- First national survey of neurointerventionists in Indonesia.
- Fatigue, sleep disturbance, and musculoskeletal pain were common.
- Radiation monitoring and occupational protection remain limited

Introduction

Neurointervention is a rapidly evolving field in the management of cerebrovascular diseases, including intracranial aneurysms, arteriovenous malformations, and acute ischemic stroke. These procedures use fluoroscopy-

guided endovascular techniques, enabling minimally invasive treatment with high success rates. Physicians in interventional laboratories face escalating occupational health risks as case complexity and procedural volume rise.¹

One of the primary occupational risks in interventional practice is chronic exposure to ionizing radiation during fluoroscopic procedures. Healthcare professionals working in interventional laboratories may accumulate substantial radiation exposure over the course of their careers. This exposure may increase the risk of long-term biological effects, including cataracts, thyroid disorders, and malignancy, especially when radiation protective protocols are inadequately implemented.^{2,3,4}

In addition to radiation exposure, interventional physicians also face a significant risk of musculoskeletal disorders due to prolonged static postures and the use of heavy lead aprons during procedures. Previous studies have shown a higher prevalence of musculoskeletal pain among catheterization laboratory personnel involved in radiation-based procedures compared with non-exposed healthcare workers.⁵ Another study reported that up to 88% of interventional physicians experienced musculoskeletal symptoms within the previous 12 months, most commonly involving the lower back, neck, and shoulders.⁶

Besides musculoskeletal disorders, the demanding nature of interventional practice, which includes prolonged working hours, high procedural workload, and frequent emergency cases, may also lead to other health problems, such as fatigue, burnout, sleep disturbances, and reduced quality of life. These factors may affect a physician's well-being and, in turn, professional performance and patient safety. Consequently, occupational health for interventional physicians has emerged as an important concern in modern healthcare systems.

Although several studies have investigated occupational health risks among interventional physicians in developed countries, data on the health status of neurointerventionists in Indonesia remain limited. Differences in healthcare systems, workload, and availability of radiation protection facilities may influence the occupational health risk profile in this population.

We hypothesized that neurointerventionists in Indonesia experience substantial occupational health problems, particularly musculoskeletal symptoms, fatigue, and sleep disturbances, which could be associated with procedural workload, radiation safety practices, and lifestyle factors. As a result, this study aimed to analyze the occupational health profile and related risk factors among Indonesian neurointerventionists.

Objective

This study aimed to provide information and analyze the health profile, occupational factors, and work-related health complaints among Indonesian neurointerventionists. The study's findings are expected to provide an overview of the occupational health status of neurointerventionists and serve as a basis for developing strategies to improve

occupational health and safety for Indonesian interventional specialists.

Method

This study was designed as a descriptive analytic cross-sectional survey to evaluate occupational health conditions among Indonesian neurointerventionists. The study used a structured questionnaire distributed to physicians who perform neuroendovascular procedures in Indonesian hospitals between February and March 2026. The Ethics Committee of the Faculty of Medicine, Pelita Harapan University (approval Number: 232/K-LKJ/ETIK/III/2026) provided ethical permission for this study, which followed the Declaration of Helsinki's standard.

Eligible participants were neurointerventionists currently performing endovascular procedures for cerebrovascular diseases in Indonesia. Participants who did not complete the questionnaire or declined to participate were excluded. Participation was voluntary, and all responses were collected anonymously.

Data were collected via a self-administered online questionnaire to assess demographic profiles, workload, radiation protection practices, and health outcomes among neurointerventionists. The questionnaire included several domains covering demographic characteristics (age group and sex); occupational characteristics (years of practice, procedures per week, average weekly working hours, and frequency of on-call procedures); radiation protection practices (type of lead apron [one-piece or two-piece vest and skirt], use of personal dosimetry & monitoring of cumulative radiation exposure); work-related health complaints/health profile (musculoskeletal symptoms, fatigue, sleep disturbances, and average sleep duration on working days); medical history and health status (comorbidities, hair loss, and sexual drive); health monitoring and lifestyle factors (frequency of medical check-ups, exercise frequency, smoking habits, and caffeine and alcohol consumption); and perceptions of occupational risk (perceived occupational health risks and adequacy of institutional occupational health support). All questionnaire items were presented as categorical responses.

The primary outcomes of interest included the prevalence of work-related health complaints, particularly musculoskeletal symptoms, fatigue or burnout, and sleep disturbances among neurointerventionists, as well as their associated factors. Other variables assessed included demographic characteristics, occupational workload indicators, radiation protection practices, lifestyle factors, and medical history.

All questionnaire responses were recorded as categorical variables and analyzed using IBM SPSS Statistics version 31.0.2.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics were used to summarize respondent characteristics, with categorical variables presented as frequencies and percentages.

Result

A total of 191 respondents received the questionnaire, of whom 41 were excluded due to incomplete responses. Finally, 150 respondents completed the questionnaire and were included in the final analysis. The largest proportion of respondents was in the 40-49-year age group (48%), followed by those aged 30-39 years (35.3%), 50-59 years (14.7%), and ≥ 60 years (2%). Among the respondents, 76% were male, and 24% were female.

The majority of respondents had 1-5 years of neurointerventional practice experience (36%). Most respondents performed fewer than two procedures per week (48.7%), and 67.3% spent less than 5 hours per week in the catheterization laboratory. On-call procedures were relatively infrequent, with 78% reporting only 1-2 cases per month, while a smaller proportion reported more frequent on-call duties.

Most respondents used standard radiation protection equipment. A two-piece apron (vest and skirt) was used by 76.7% of respondents, while 23.3% used a one-piece apron. However, only 34.7% consistently used dosimeters, and less than one-fifth (19.3%) regularly monitored cumulative radiation exposure.

In relation to certain work-related health issues associated with neurointerventionists, musculoskeletal pain was reported by 35.3% of respondents. Fatigue symptoms were common, with 68.7% of respondents reporting occasional fatigue, while 32.7% reported sleep disturbances. Regarding sleep duration, the most frequently reported duration was 5-6 hours per night (48.7%).

Most respondents (83.3%) believed that neurointerventionists face higher occupational health risks than other specialties. However, only 30.7% reported adequate institutional occupational health support.

Table 1. Characteristics and occupational health profile of Indonesian Neurointerventionists (n = 150)

Research Variables	n	%
A. Demographic characteristics		
Age		
30-39 years	53	35.3
40-49 years	72	48
50-59 years	22	14.7
≥ 60 years	3	2
Sex		
Male	114	76
Female	36	24
B. Occupational characteristics		
Years of practice		
< 6 months	31	20.7
6 months – 1 year	29	19.3
1 – 5 years	54	36
6 – 10 years	18	12
>10 years	18	12
Procedures per week		
< 2 cases	73	48.7
2 – 5 cases	52	34.7
5 – 10 cases	19	12.7
>10 cases	6	4
Average weekly working hours		
<5 hours	101	67.3
5-10 hours	23	15.3
10-15 hours	21	14
>15 hours	5	3.3
Frequency of On-call procedures		
Rare (1-2 times/month)	117	78
1-2 times/week	26	17.3
3-5 times/week	6	4
Almost daily	1	0.7
C. Radiation protective practices		
Apron type		
Two-piece (vest & skirt)	115	76.7
One piece	35	23.3
Dosimeter monitoring		
Never	66	44
Occasionally	55	36.7
Always	29	19.3
Dosimeter use		
Always	52	34.7
Occasionally	49	32.7
Never	49	32.7
D. Work-related health complaints or health profile		
Musculoskeletal symptoms		
No pain	97	64.7
Pain	53	35.3

Table 1 continued. Characteristics and occupational health profile of Indonesian Neurointerventionists (n = 150)

Research Variables	N	%
Fatigue		
Never	38	25.3
Occasionally	103	68.7
Frequently or almost always	9	6
Sleep disturbance		
Never	94	62.7
Occasionally	49	32.7
Frequently or almost always	7	4.7
Average sleep duration		
<5 hours	10	6.7
5-6 hours	73	48.7
6-7 hours	56	37.3
>7 hours	11	7.3
E. Medical history and health status		
Comorbidities		
None	93	62
Present	57	38
Hair loss		
No hair loss	96	64
Hair loss	54	36
Sexual drive		
No decrease	133	88.7
Decrease	17	11.3
F. Health monitoring and lifestyle factors		
Medical checkup		
Every year	81	54
Every 2-3 years	20	13.3
When feeling sick	44	29.3
Never	5	3.3
Exercise frequency		
None	22	14.7
1-2 times/week	80	53.3
3-4 times/week	35	23.3
≥5 times/week	13	8.7
Smoking/vaping/pods		
Non-smoker	130	86.7
Active smoker/Vaper/pods	13	8.7
Former smoker/Vaper/pods	7	4.7
Caffeine consumption		
< 1 glass/day	65	43.3
1-3 glass/day	83	55.3
>3 glass/day	2	1.3
Alcohol consumption		
< 1 glass/day	150	100
G. Perception of occupational risk and institutional support		
Perceived higher occupational risk compared to other specialties		
Yes	125	83.3
No	16	10.7
Unsure	9	6
Institutional health support		
Yes	46	30.7
No	72	48
Unsure	32	21.3

Significant associations were identified between musculoskeletal pain and several occupational and lifestyle factors. Fatigue was strongly associated with musculoskeletal symptoms; respondents reporting frequent fatigue had a significantly higher prevalence of pain ($p < 0.001$).

Sleep-related factors were also significantly associated with musculoskeletal pain. Both sleep disturbances ($p = 0.003$) and shorter sleep duration ($p = 0.005$) were associated with an increased prevalence of musculoskeletal complaints.

Physical activity had a protective effect, with regular exercise being associated with a lower prevalence of musculoskeletal pain ($p = 0.034$). In addition, a higher emergency or on-call workload was significantly associated with musculoskeletal pain ($p = 0.039$).

Longer time spent in the catheterization laboratory was significantly associated with fatigue or burnout symptoms ($p = 0.033$) and sleep disturbances ($p = 0.048$).

Table 2. Factors associated with musculoskeletal pain

Variable	Direction of association	p-value
Fatigue	Higher prevalence of pain	<0.001
Sleep disturbance	Higher prevalence of pain	0.003
Short sleep duration	Higher prevalence of pain	0.005
Regular exercise	Lower prevalence of pain	0.034
On-call workload	Higher prevalence of pain	0.039

Table 3. Factors associated with fatigue and sleep disturbance

Variable	Outcome	Direction of association	p-value
Time in the catheterization laboratory	Fatigue	Higher prevalence	<0.001
Time in the catheterization laboratory	Sleep disturbance	Higher prevalence	0.003

Discussion

This study offers a comprehensive overview of the occupational health profile of neurointerventionists in Indonesia, highlighting a substantial burden of musculoskeletal symptoms and fatigue, as well as poor occupational health practices. The incidence of musculoskeletal pain among neurointerventionists in this study indicates a considerable number of occupational health problems. This finding is similar to previous studies among interventional specialists, in which musculoskeletal pain has commonly been attributed to prolonged standing, heavy lead aprons, and repetitive procedural tasks.^{5,7,8} Previous studies have reported that musculoskeletal symptoms affect 50-60% of interventional operators, suggesting that the burden observed in this study may be underestimated.⁸

The significant association between fatigue and musculoskeletal pain ($p < 0.001$) observed in this study supports the concept that cumulative physical and mental strain contributes significantly to occupational morbidity. Fatigue may exacerbate poor posture and reduce ergonomic awareness during procedures, thereby increasing the risk of musculoskeletal injury.

Sleep-related issues emerged as important contributors to musculoskeletal symptoms. Sleep disturbance and short sleep duration were both found to be significantly associated with pain. These findings are consistent with previous literature demonstrating that inadequate sleep increases sensitivity to noxious stimuli and decreases endogenous pain-inhibitory processes.⁹ Furthermore, longer time spent in the catheterization laboratory was significantly associated with fatigue ($p = 0.033$) and sleep disturbance ($p = 0.048$), which could contribute to the increased prevalence of musculoskeletal pain.

Regular physical exercise was associated with a lower prevalence of musculoskeletal pain ($p = 0.034$), suggesting a potential protective role. Exercise may improve muscle strength, posture, and endurance, which

are essential for neurointerventionists working in physically demanding environments.¹⁰ These findings are consistent with global recommendations emphasizing physical activity as an important strategy for reducing the risk of work-related musculoskeletal pain.

An increased emergency or on-call workload was significantly associated with musculoskeletal pain ($p = 0.039$), indicating that irregular scheduling and acute procedural demands contribute to increased physical strain. Emergency procedures are frequently performed under time limitations and inadequate ergonomic conditions, increasing the risk of injury. Even though most respondents reported low procedural volumes, repeated exposure to interventional procedures appeared to be sufficient to induce measurable health effects. This underscores the necessity of ergonomic optimization and workload management, even in lower-volume settings.

Despite the widespread use of radiation protective equipment, important gaps were identified in radiation safety practices. Only 34.7% of respondents consistently used dosimeters, and fewer than 20% regularly monitored their cumulative radiation exposure. These findings are concerning, given the established long-term risks of chronic radiation exposure, including cataracts, tissue reactions, and malignancy. Recent literature has emphasized the importance of comprehensive radiation safety strategies, including routine dosimetry monitoring, ergonomic optimization, and institutional occupational health support for interventional staff.^{4,11,12} Although 83.3% of respondents perceived neurointervention as a specialty with higher occupational risks, only 30.7% reported receiving adequate institutional support, indicating a substantial gap between risk awareness and the implementation of systemic protection.

This study also contributes to the broader understanding of occupational health challenges among neurointerventionists, not only in Indonesia but also in healthcare systems that are still growing and have limited resources. To the best of our knowledge, this is the first national study to analyze the occupational health profile of neurointerventionists in a developing-country setting. Musculoskeletal symptoms, fatigue, inadequate radiation monitoring, and limited institutional support all remain important occupational health concerns, even in low-volume interventional settings. These results may help inform the development of occupational health policies, radiation safety strategies, and ergonomic interventions applicable to neurointerventional practice in other countries with similar healthcare environments and workforce conditions. Furthermore, this study provides baseline data that may support future international comparisons and multicenter collaborative research on occupational health issues in neurointervention.

This study has several strengths, including its nationwide scope and relatively large sample size, which provide valuable baseline data on the occupational

health profile of neurointerventionists in Indonesia, a setting where such data remain limited. The comprehensive assessment of multiple domains, including workload, radiation safety practices, lifestyle factors, and health outcomes, enables a holistic evaluation and the identification of modifiable risk factors, such as sleep, exercise, and workload. However, several limitations should be acknowledged. The cross-sectional design precludes causal inference, and the use of self-reported data may introduce recall and reporting bias. In addition, occupational health outcomes such as fatigue, musculoskeletal pain, and sleep disturbance were measured using non-validated questionnaire items rather than standardized instruments, which may limit measurement reliability and comparability with other studies. Detailed specifications for angiography equipment and radiation-reduction technology were not systematically recorded, which may have affected radiation-exposure comparisons across institutions. Furthermore, differential exclusion bias cannot be ruled out, as more complex or failed procedures may have been underrepresented, potentially influencing the observed findings.

Future studies are encouraged to incorporate validated assessment tools and longitudinal study designs to provide a more comprehensive evaluation of occupational health risks among neurointerventionists.

Conclusion

Neurointerventionists in Indonesia face a significant burden of occupational health problems, including musculoskeletal pain, fatigue, and sleep disturbances. These conditions were significantly associated with occupational factors, such as procedural workload and time spent in the catheterization laboratory, as well as modifiable lifestyle factors, including physical activity and sleep patterns. Despite a high risk awareness, there are gaps in radiation safety practices and institutional occupational health systems. Future studies are warranted to further explore causal relationships and evaluate targeted interventions.

Acknowledgement

The authors would like to express their sincere appreciation to all neurointerventionists who generously participated in this study and contributed valuable data.

Conflict of Interest

The two authors of this manuscript are members of the editorial team of the Journal of Neurointervention and Stroke. However, they were completely blinded to the peer-review process and had no role or influence in the submission, evaluation, or decision-making for this manuscript. This article was managed entirely by an independent editor and underwent the journal's standard double-blind peer-review process.

Ethic consideration

Ethical approval was obtained from the Ethics Committee of the Faculty of Medicine, Pelita Harapan University (Approval Number: 232/K-LKJ/ETIK/III/2026).

Funding

The authors declare that this study did not receive any external funding.

Author contribution

Fritz Sumantri U: Conceptualization, Methodology, Supervision. **Merlin P. Kastilong:** Methodology, Supervision. **Leny Kurnia:** Data curation, Supervision. **Hugo Dwiputra W:** Data curation, Writing-original draft preparation. **Petrus Nilwan G:** Visualization, software. **Bambang Sutrisno:** Writing-reviewing & editing. **Evlyne Erlyana S:** Validation

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