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Risk of low back pain among Indonesian volcano sulfur miners: a retrospective cohort study

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Introduction. *Kawah Ijen is the main volcano sulfur-producing in Indonesia. There is still a lot of conventional Sulfur mining going on there. Every day, Sulfur miners work walking about 8.5 km to transport Sulfur weighing 70–100 kilograms using simple transporters that are only held on one shoulder to the Sulfur collection site. The health problem that is the focus of this study is the incidence of low back pain (LBP) in volcano sulfur miners.*
Aims and objectives. *This study aims to determine the magnitude of the risk of low back pain in sulfur miners to prevent occupational diseases..*
Materials and methods. *This research was carried out for three months. This study adopted a retrospective cohort study design. The research sample amounted to 140 respondents taken by simple random sampling. The data collection technique was carried out by interview and lasegue test and Patrick's test to see the respondents' positive or negative of low back pain. Data analysis was carried out using rank spearmen test.*
Results. *The results showed a relationship between the incidence of low back pain in the community and work (p-value < 0.000). Indonesian volcano sulfur miners are 5,032 times more at risk of low back pain than other public workers.*
Conclusion. *Volcano Sulfur Miners are more at risk of experiencing low back pain than other occupations.*

Keywords: *active Volcano Mountain; Indonesia Miners; Ergonomic; Brimstone; Sulphur*

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Риск дорсалгии у горняков серных шахт вулканов в Индонезии: ретроспективное когортное исследование

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Введение. *Кава Иджен – основной вулкан, где добывают серу в Индонезии. До сих пор здесь размещено много обычных шахт, где добывают серу. Каждый день горняки серных шахт, используя простые обычные корзины, которые они переносят на одном плече, проходят 8,5 км для транспортировки 70–100 кг серы к месту сбора руды. Это исследование посвящено изучению дорсалгии у горняков вулканических серных шахт.*
Цель исследования – *определить степень риска дорсалгии у горняков серных шахт для профилактики этой профессиональной патологии.*
Материалы и методы. *В течение трёх месяцев проведено ретроспективное когортное исследование. Под наблюдением находились 140 респондентов, отобранных случайным образом. Данные получены путём интервьюирования, с применением тестов Ласега и Патрика для выявления дорсалгии. При обработке данных использовали ранговый тест Спирмена.*
Результаты. *Обнаружена взаимосвязь между частотой дорсопатии у населения и работой (p < 0,000). У индонезийских горняков вулканических серных шахт риск дорсалгии в 5,032 раза выше, чем у рабочих других профессий.*
Заключение. *Риск развития дорсалгии у горняков вулканических серных шахт выше, чем у рабочих других специальностей.*

***Ключевые слова*:** *горы на активном вулкане; горняки Индонезии; эргономика; серная руда; сера*

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Конфликт интересов. Автор декларирует отсутствие явных и потенциальных конфликтов интересов в связи с публикацией данной статьи.
Финансирование. Исследование выполнено при поддержке факультета здравоохранения Джемберского университета и университета Эйрланга, Индонезия.

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Original article

Introduction

Indonesia is an archipelagic country consisting of many active and non-active volcanoes [1, 2]. With many active volcanoes in Indonesia producing several natural resources useful for the surrounding community and the Indonesian people, one of the natural resources produced is sulfur. These minerals are helpful for a mixture of cosmetics, medicines, bleach,. Most of the sulfur mining products in Kawah Ijen will be deposited in factories in Banyuwangi district. Due to the sublimation process, sulfur is an unlimited mineral. With Indonesia being rich

In natural sulfur resources, imports are still being carried out. This is due to the lack of being able to explore more of the sulfur in Indonesia to meet the growing demand for sulfur every year [3, 4].

Kawah Ijen is the main sulfur-producing volcano in Indonesia. Information from the management of Alas Purwo National Park, which oversees, among others, the Kawah Ijen area that at least 14 tons of sulfur per day are successfully mined. Meanwhile, the Center for Volcanology and Geological Hazard Mitigation analysis stated that this value was only about 20% of the actual potential provided by nature [5, 6]. The main obstacle causing the lack of results is the rugged terrain and technology [7].

Various writings and coverage on television discuss the lives of sulfur miners in Kawah Ijen and admit that they are concerned and very impressed with the work they do. The daily work of sulfur miners is walking about 8.5 km to transport 70–100 kilograms of sulfur with a simple means of transport that is only held on one shoulder to the sulfur collection point. For every kilogram of sulfur he brought, he was paid 800 rupiahs. So each work will get around Sixty thousand rupiah or equal to 4.13 USD [8, 9].

Sulfur miners face many risks in carrying out their work, one of which is the risk of health problems [7]. The health problem that is the focus of this study is the incidence of low back pain. Low back pain (LBP) is a pain in the back area between the lower costal angle (ribs) to the lumbosacral (around the tailbone). Pain can also radiate to other areas such as the upper back and groin. LBP, or low back pain, is one of the musculoskeletal disorders caused by poor body activities [10, 11].

Ijen crater sulfur miners risk suffering from low back pain due to poor work activities and heavy loads carried while working. The risk of low back pain in sulfur miners is still unknown. Therefore, this study seeks to determine the magnitude of the risk of low back pain in sulfur miners to prevent occupational diseases in the Ijen community, Banyuwangi District.

Material and methods

This study was a retrospective cohort study. A retrospective cohort is a study design in which groups that have previously had the same exposure are now seen for their incidence of illness. This research will be conducted in Kawah Ijen Volcano, Banyuwangi district, Indonesia.

The research sample used was 70 sulfur mining workers and 70 other sector workers, so the total sample was 140 respondents. The sampling method used in this research is systematic random sampling. The sample in this study is an object that represents sulfur miners in the Kawah Ijen. The inclusion criteria of this research sample are:

1. work as a sulfur miner from Kawah Ijen
2. Male
3. Willing to be a respondent in a research

As for the non-mining worker group, the inclusion criteria are as follows:

1. I never worked as a sulfur miner from Kawah Ijen
2. Male
3. Willing to be a respondent in a research

Research data were collected in two ways, namely through questionnaires and also LBP test.

Sociodemographic. The research data was obtained through interviews related to sociodemographic aspects, including occupation, age, years of service, complaints of LBP, frequency of LBP, and history of injury from respondents who were the research sample.

Low Back Pain (LBP). Lasegue test. The Lasegue test is a test by carrying out the activity of lifting the leg in an extended state. Positive if the patient cannot lift the leg less than 60° and pain along the sciatic nerve. Pain and limitation of movement often accompany radiculopathy, especially in lumbar disc herniation / lumbosacral [12, 13].

Indonesian Volcano Sulfur Miners. Source: Bombastis.com (accessed 2 December 2021).

Горняки вулканических серных шахт в Индонезии. По материалам Bombastis.com (от 02.12.2021 г.).

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Table 1 / Таблица 1

Cross-tabulation between sociodemographic variables and low back pain (140 respondents)

Перекрёстная таблица социодемографических характеристик дорсалгии (140 респондентов)

Variable Характеристика	Low back pain Боль в пояснице		Total Всего
	positive есть	negative нет	
Job: / Профессия:			
sulfur miner горняк серной шахты	39	31	70
non-sulfur miner не связана с работой на серной шахте	14	56	70
Age (y.o): / Возраст (годы):			
17–25	1	5	6
26–35	9	21	30
36–45	31	28	59
46–55	8	20	28
56–65	3	8	11
> 65	1	5	6
Work experience, years: Стаж, лет:			
< 10	15	28	43
10	5	12	17
> 10	33	47	80
Complaints of LBP: Жалобы на боли в пояснице:			
yes / да	51	48	99
no / нет	2	39	41
Duration of LBP: Продолжительность дорсалгии:			
no / нет	2	39	41
have Less than 3 months беспокоят менее 3 мес	2	0	2
have More than 3 months беспокоят более 3 мес	49	48	97
History of back injury: Травмы позвоночника в анамнезе:			
yes / да	30	32	62
no / нет	23	55	78

Patrick's test and anti-Patrick. Patrick's and anti-Patrick's tests are tests by doing Flexion-abduction-external rotation-extension of the hip joint. Positive if involuntary movement is limited, often accompanied by pain. Positive in hip-joint disease, damaging in ischialgia [14].

Statistical analysis in this study used a computer program through the Spearman rank statistical test with = 0.05. The selection of the Spearman rank test is used because the research data is ordinal.

Results

Based on the study results, it was found that the number of respondents was 140, with a distribution of 70 miners and 70 non-miners. The study was conducted on a group of male workers. The majority of respondents are of productive age and have a working period of 10 years or more. This shows the vulnerability of a worker to be exposed to work-related hazards, either in the form of workloads or additional work-related burdens.

The study results in table 1 explain that the majority of respondents complain of low back pain with varying pain frequencies. This is directly proportional to the length of a person's work. This is because the length of work is one indicator of workers carrying out repetitive movements for a long time, with most respondents claiming to have worked for 10 years or more. Repetitive and static movements in one place can increase tension in specific muscles and reduce muscle flexibility, which will lead to various movement disorders in the future. One of the consequences of repetitive and static work is low back pain [15]. So it is necessary to observe the length or period of work with complaints and the frequency of pain the respondent recognizes.

Low back pain can also be seen or observed from the length of prolonged back pain [16, 17], so in this study, the length of back pain was used as a measuring tool. The results showed that the duration of pain felt by most respondents was more than 3 months (Table 1). This indicates the result of repetitive and static activities for a long time followed by complaints of prolonged back pain.

This study also asked about the history of back injury, aiming to minimize the incidence of low back pain experienced by respondents not because of work but because of injury. From the study results, it is known that the majority of workers have never experienced back injuries. This shows that research bias regarding the causes of low back pain can be minimized.

Diagnosis of low back pain can be made in various ways, starting from MRI, X-ray, and lasegue and Patrick tests [18, 19]. In this study, the tests used to diagnose low back pain were the lasegue and Patrick tests, which had good sensitivity and specificity. In addition to the two tests, history must be taken by the examining doctor.

The results of the anamnesis examination showed that the majority of workers experienced low back pain (Table 2). Doctors carry out the history itself for each respondent to build an initial diagnosis of a patient. The high tendency of respondents in the history of low back pain examination is closely related to the subjectivity of the respondents. Therefore, further tests were carried out to strengthen the anamnesis as the doctor's initial suspicion.

The Lesague test is a test by carrying out the activity of lifting the leg in an extended state. The examining physician performs

Table 2 / Таблица 2

Relationship and odd ratio between all variables and low back pain

Соотношение и отношение шансов между всеми характеристиками и дорсалгией

Variable Характеристика	*R* Spearman *R* Спирмена	*p*	OR Отношение шансов (ОШ)	CI 95% of OR Доверительный интервал ОШ	
				Lower нижнее	Upper верхнее
Job / Профессия	0.368	0.000*	5.032	2.372	10.673
Age (y.o) Возраст (годы)	–0.036	0.676	N/A Нет данных	–	–
Work experience Стаж работы	0.070	0.411	N/A Нет данных	–	–
Complaints of LBP Жалобы на боли в спине	0.438	0.000*	20.718	4.741	90.530
Duration of LBP Длительность дорсалгии	0.372	0.000*	N/A Нет данных	–	–
History of back injury Травмы позвоночника в анамнезе	0.194	0.022*	2.241	1.117	4.498

Note: * – significant with α =0.05. – blank table, those variables don't have OR. N/A – no data available. Age (y.o), Work Experience and Duration of LBP cannot calculate OR because not on 2×2 mode.

Примечание. * – значимо при α =0,05. – пустыми оставлены ячейки параметров, для которых нет значений ОШ. Вычисление ОШ для возраста (годы), стажа и продолжительности дорсалгии не представляется возможным, поскольку эти параметры нельзя сопоставить в формате 2×2.

this test. Based on the test results above, it is known that most respondents, both miners, and non-miners, did not feel pain when the lasegue test was performed. The research continued on the Patrick's test; it is known that the respondents, from 140 respondents, 59 of them experienced pain in carrying out Patrick's test.

Based on the lasegue test, Patrick's test, and anamnesis, which doctors carried out, the examining doctor determined a positive diagnosis of low back pain in 53 respondents. The final result of the diagnosis of low back pain is done by observing the test results and the respondent's spontaneous reaction, and the respondent's ability to indicate where the pain is felt when the test is carried out.

Discussion

The study results in table 1 and table 2 are used to calculate the risk analysis of low back pain in sulfur miners in Mount Kawah Ijen, Banyuwangi District, with a control group of residents who do not work as sulfur miners in Mount Kawah Ijen. Spearmen's statistical results in table 2 show a significant relationship between the work variables Complaints of LBP, Duration of LBP, History of Back Injury, and the incidence of low back pain.

Statistical calculations are carried out after knowing the relationship between variables is to see the direction of the relationship and the magnitude of the risk. Statistical results show that miners have a greater risk of being diagnosed with low back pain than respondents who work not as miners, with a value of 5.032. This figure shows that the risk of miners experiencing low back pain is 5.032 times greater than in other occupations.

The results of the risk analysis are closely related to the workload and working methods and the work attitude of miners in carrying out sulfur mining at Mount Kawah Ijen, Banyuwangi district. The workload of sulfur miners who are carried out manually is hefty, between 70–100 kilos per batch with a distance of 8.5 km. Such a workload causes the shoulders and upper body to experience significant pressure to withstand the heavy load of sulfur. The spine gets a significantly heavy load due to the weight of the sulfur being lifted for too long over a relatively long distance. In addition, the way of working and work attitude also aggravate the risk of low back pain in sulfur miners. This can be observed by looking at the working position of miners in transporting sulfur, namely by using the lower back as support when lifting sulfur and placing a basket full of sulfur on the shoulders; as a result, the heavy pressure affects the muscles and bones of workers who work beyond the threshold.

Conclusion

Based on the research, it is known that the work factor is one of the factors in the occurrence of low back pain. Volcano Sulfur Miners are more at risk of experiencing low back pain than other occupations. To reduce the risk of low back pain on Volcano Sulfur Miners, we recommended to conduct further research related to engineering to obtain modern, more ergonomic tools for use by Volcano Sulfur Miners in Indonesia.

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