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The relationship between analysis of upper limb function, physical activity, and neck pain in wood carvers

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ABSTRACT

Background: Indonesia has a large workforce and frequent work accidents. The work of woodcarving artisans in Ubud village has a high risk of accidents. Neck pain is a common problem these artisans face due to static movements, vibrations, and excessive physical activity. Ergonomics in the work environment is the key to preventing pain and fatigue, but non-ergonomic working positions often occur in wood artisans. Therefore, this study aims to explore the relationship between rapid upper limb assessment (RULA) analysis, physical activity, and complaints of neck pain among woodcarvers.

Methods: This type of research is an analytic observational with a cross-sectional design. The sampling technique is total sampling. The number of subjects obtained is 31 people according to predetermined criteria. The instruments used were the International Physical Activity Questionnaire (IPAQ) questionnaire to measure physical activity levels, the RULA form to assess work position, and the Numeric Rating Scale (NRS) questionnaire to measure complaints of neck pain. This study used two techniques, namely univariate and bivariate analysis, using the SPSS program.

Results: Based on bivariate analysis using *Spearman's rho* non-parametric method on 31 respondents, a significant correlation was found between RULA analysis and complaints of neck pain with a correlation coefficient of 0.55 and also found that there is a significant relationship between physical activity and complaints of neck pain with a correlation coefficient of 0.83.

Conclusion: There is a relationship between RULA analysis and complaints of neck pain in woodcarving craftsmen in Ubud Village and there is a relationship between physical activity and complaints of neck pain in complaints of neck pain in woodcarving craftsmen in Ubud Village.

Keywords: IPAQ, neck pain, NRS, physical activity, RULA.
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INTRODUCTION

The prevalence of musculoskeletal pain in the neck in workers for a year has ranged from 6-76% and is higher in women and men. Globally the majority of neck pain is 16.7% to 75.1%. The neck supports the head's weight and has good flexibility so that the crown can bend, shake, or rotate. In the event of neck pain, the muscles experience excessive contraction and cause fatigue in the neck, especially the muscles around the neck and back. Neck pain can cause severe morbidity in the form of obstacles in carrying out daily activities. Therefore, knowing and applying preventive aspects of neck pain to reduce patient morbidity is essential. Neck pain is very likely to occur in carpenters, considering that carpenters often perform repetitive upper arm and neck movements, considering that most of the patterns in woodcarving are in the form of repetitions. Static loads on the neck and shoulder muscles and extreme neck positions when performing carvings that have a high degree of complexity.[1]

Rapid upper limb assessment (RULA) is a method developed in the field of ergonomics to investigate and assess work positions performed by the upper body. The process of using RULA does not carry out special tools in providing neck and upper body posture measurements in line with muscle function and external loads supported by the body. Assessment using the RULA method takes a little time to complete. It performs general scoring on a list of activities that indicate the need for risk reduction due to physical lifting carried out by the operator.[2]

Neck pain is a disease caused by a non-ergonomic body position during activities, namely a clinical syndrome characterized by the main symptom of pain or an unpleasant feeling in the lower neck area. Neck pain is a pain in the neck area caused by nerve problems, muscle irritation, or bone lesions. Neck pain can occur in people with strenuous physical activity with a standard spinal structure or in people with regular physical activity but an abnormal spinal system.[3]

Physical activity is one of the causes of neck pain. These physical activities such as holding weights, lifting, and moving things. This can happen when someone works extra hours for more than 6 hours. He gets to lift a heavy box like someone in a factory warehouse. He did this activity for 8 hours (standard working time), whereas

normally, a person can only do strenuous activities for 6 hours. Research by Wenur 2013 found that a high musculoskeletal rate of 7.84% affects someone who works hard. This proves that physical activity can cause neck pain.[4]

Hand embroidery artisans in nagari koto gadang jorong subring tigo jorong (100% hand embroidery artisans) complained of pain in the waist while doing hand embroidery work. In addition, there were also complaints on the right shoulder in 34 people (38.2%), below the waist in 27 people (30.3%), and buttocks in 28 people (31.5%). The number of musculoskeletal complaints felt by hand embroidery artisans makes them uncomfortable doing their daily work.[5]

Workers carried out the above production activities in a standing position and were found to have unnatural attitudes, such as bending the neck, bending the body, and squatting. If an eccentric work attitude occurs over a long period, there will be an accumulation of complaints which can eventually lead to muscle injury. Based on the description above, the writer is interested in researching the definition of work attitudes and musculoskeletal complaints, so it is essential to explore the relationship between RULA analysis and physical activity with complaints of neck pain in woodcarving artisans.

METHODS

This study used an analytical observational method with a cross-sectional research design. This cross-sectional research determines disease exposure and outcomes simultaneously in each research subject.[5] The research design has been used to obtain an overview of the relationship between RULA analysis and physical activity with neck pain complaints in wood carving artisans. This research was conducted in Ubud Village, Gianyar, in July 2023. Subjects in this study have been determined by total sampling according to the characteristics of exclusion and inclusion. The inclusion criteria that have been determined, namely subjects with complaints of pain in the neck area, subjects aged 25-50 years, male subjects who can communicate verbally and in writing in Indonesian, work as wood craftsmen, subjects who work with more work duration per day or up to 6 hours per day, subjects who have worked as wood craftsmen >5 years, and have agreed to participate as respondents through signing informed consent. Exclusion criteria have been determined if they have a history of fractures in the neck area. This study involved 31 people as samples. The independent variables in this study were RULA analysis and physical activity, while the dependent variable was neck pain complaints. The control variables in this study were age, gender, tenure, and length of work.

RULA is a method developed in the field of ergonomics that investigates and assesses the working position of the upper body. The RULA method was used in assessing the working position of the sample. The RULA worksheet has been divided into two sections, namely sections A (arms and wrists) and B (neck, back, legs). This division is necessary to ensure that any restricted postures of the neck, back, and legs that may affect the arm and wrist postures are included in the RULA assessment. The output of the RULA assessment tool is the final RULA Score, which is a single score representing the risk level of Musculoskeletal disorders (MSDs) for the job task being evaluated. Minimum RULA score = 1, and maximum RULA score = 7.13.[4]

This study's measurement of physical activity has used the International Physical Activity Questionnaires (IPAQ). Based on IPAQ, there are three levels (categories) of physical activity: low, medium, and high. Measuring neck pain complaints using a measuring instrument using a numeric rating scale (NRS). NRS is one of the most commonly used pain scales in medicine. The pain scale on the NRS can be categorised into four categories, namely 0 as no pain, scale 1-3 as mild pain, scale 4-6 as moderate pain, and scale 7-10 as pain with intense feeling.[6]

Statistical tests used in this study are univariate analysis and bivariate analysis. Univariate analysis has been conducted to see an overview of physical activity, RULA analysis, neck pain complaints, age, and gender.[7] The bivariate analysis used in this study is the *Spearman rho* correlation test. *Spearman's rho* is a non-parametric statistical test using two variables. The data scale of the two variables is ordinal. This test serves as a measure of the strength and direction of the correlation between two variables. Then it was analysed to obtain information related to data distribution which has the function of performing descriptive analysis.[8]

RESULTS

Table 1 shows that the respondents have an average age of 37.2 years, with the youngest respondent being 26 years old and the oldest being 47 years, and a standard deviation of 6.5.

Based on Table 2, this study obtained that the frequency of ergonomic risk levels analyzed by RULA had a moderate level of 5 respondents (16.1%), a high level of 18 respondents (58.1%), and a very high level of 8 respondents (25.8%).

Table 3 shows that the frequency of ergonomic risk levels analyzed by IPAQ has moderate activity as many as 12 respondents (38.7%) and high activity as many as 19 respondents (61.3%).

Based on Table 4, the frequency of neck pain complaints analyzed by NRS obtained minor pain by 2 respondents (6.5%), moderate pain by 13 respondents (41.9%), and severe pain by 16 respondents (51.6%).

Table 5 shows a significance value of 0.001, where the value was less than the critical significance limit of 0.01, which could mean that there was a relationship between RULA analysis and complaints of neck pain. In addition, if you look at the correlation value, which is equal to 0.554, it indicates that the strength of the relationship between the two variables is in a strong category and has a unidirectional relationship, where the higher the RULA analysis category, the higher the neck pain category value in respondents.

Based on Table 6, a significance value of 0.000 was obtained, where the value was less than the critical significance limit of 0.01, which could mean that there was a relationship between physical activity and complaints of neck pain. In addition, judging from the correlation value, which is equal to 0.825, it indicates that the strength of the relationship between the two variables in the category is very strong and has a unidirectional relationship, where the higher the physical activity,

Table 1. Frequency of Respondent's Age (n=31)

Variable	Mean±SD	Min-Max
Age	37.23±6.510	26-47

Table 2. Frequency and Percentage of Ergonomics Risk Level (n=31)

Variable		Frequency	Percent (%)
RULA	Moderate	5	16.1
	High	18	58.1
	Very High	8	25.8
	Total	31	100.0

Table 3. Frequency and Percentage of Physical Activity (n=31)

Variable		Frequency	Percent (%)
IPAQ	Moderate Activity	12	38.7
	High Activity	19	61.3
	Total	31	100.0

Table 4. Frequency and Percentage of Musculoskeletal Pain Levels (n=31)

Variable		Frequency	Percent (%)
NRS	Minor Pain	2	6.5
	Moderate Pain	13	41.9
	Severe Pain	16	51.6
	Total	72	100.0

Table 5. RULA Variables on Complaints of Neck Pain Variables

Variable Correlation	Correlation	*P*-value
RULA Analysis with Complaints of Neck Pain (NRS)	0.554	0.001

Table 6. Physical Activity Variables on Neck Pain Complaints Variables

Variable Correlation	Correlation	*P*-value
Physical Activity with Complaints of Neck Pain (NRS)	0.825	0.000

the higher the level of neck pain in the respondent.

DISCUSSION

Woodcutters were chosen as the study population because they engage in specific work activities requiring intense upper limb use. In carving wood, they perform repetitive movements, handle heavy tools, and require high concentration. All of these can put pressure and strain on the neck muscles and bones, leading to complaints of pain. Gender is an essential factor related to muscle endurance between men and women. Previous research shows that physiological differences between male and female muscles can affect musculoskeletal complaints. In general, men have more significant and more robust powers than women.[9] According to research conducted by Helmina in 2019, men's muscle strength is estimated to be around two-thirds greater than women's. This is associated with differences in muscle structure and composition between the sexes. Differences in muscle strength between men and women can impact the musculoskeletal complaints experienced. Lower muscle strength in women can cause imbalance and excessive burden on muscles, bones and joints, which in turn can increase the risk of complaints of pain and musculoskeletal disorders.[10]

The research results found that there was a predominance of woodcarver employees who were respondents with working age of over 30 years. Respondents involved in this study were 31 people, who were on average over 25 years old. This is the same as the findings obtained by Helmina in 2019, where the dominant period of workers is over 30 years. Based on the research conducted, it was found that in this research sample there were 100% of respondents or 31 respondents who were male. This phenomenon can be explained by the influence of productive age on work processes. The older a person is, the higher the risk of muscle complaints. Older age and working hours can affect the risk of muscle complaints and decreased bone stability. The existence of a degenerative process that occurs with age and working for a long time can be a factor that affects the condition of a person's bones and muscles.[11] At entering age 30, individuals experience several physiological changes that can affect the health of muscles and bones. Research by Rossa in 2017 showed that at this age, there are setbacks such as tissue regeneration that turns into scar tissue, decreased fluid, and tissue damage. This process can contribute to reduced stability of muscles and bones. The study also highlighted that the older a person is, the risk of decreased bone elasticity increases. This can affect the structural integrity of the bones and increase the likelihood of bothersome symptoms, such as pain and discomfort.[12]

This study aligns with previous findings showing an association between age and the risk of muscle complaints in the working population. For example, a 2014 study by Järvholm found that muscle and joint complaints increased significantly in older age groups among industrial workers.[13] In addition, research by Andersen in 2016 also found that the risk of muscle complaints increased with age in service sector workers. Fourteen studies have also linked decreased bone and muscle stability to ageing and long work hours. A 2022 study by Fuggle identified a link between ageing and decreased bone density in the working population. This research shows that the older a person is, the higher the risk of reduced bone stability, contributing to muscle and bone pain complaints.[14] By understanding this relationship, companies and workers can take appropriate preventive measures, such as involving fitness and stretching programs, adjustments to workplace ergonomics, and education about the importance of maintaining healthy bones and muscles. This effort can help reduce the risk of muscle and bone complaints and improve the welfare and productivity of workers over 30 years of age.[15,16]

In this context, we need to develop an understanding and actions to help address the risks and grievances related to ageing in the work environment. Efforts needed include implementing appropriate health and fitness strategies, paying attention to ergonomics, providing time and opportunities to stretch and rest, and increasing education and awareness about the importance of maintaining health and reducing the risk of muscle and bone complaints.[17] Thus, companies can play an active role in creating a work environment that supports the welfare of older employees. An integrated strategy and attention to their unique needs will help reduce the risk of injuries and complaints related to muscles and bones, thus encouraging productivity and a better quality of life for employees of this age.[18] Based on the analysis of the questionnaire data, it was found that as many as 23 craftsmen, or around 31.9% of the total respondents, had worked for seven years. Tenure here refers to the length of time these individuals have performed from when they entered work until the research was conducted. Meanwhile, the duration of employment for woodcarving artisans reached 28 people who worked for 11 hours each day for a week or around 38.9%. The time of this work indicates the exposure experienced by each individual in their workplace.

The sample in this study involved workers who had worked for at least 5 years. Tenure here refers to the length of time these individuals have worked from the time they entered work until the time the research was conducted. Meanwhile, the duration of work for woodcarving craftsmen involves workers doing a minimum work duration of 6 hours in one day. The duration of this work is an indicator of the exposure experienced by each individual in their workplace.

Hardianto's research in 2015 linked the length of service with the risk of occupational diseases. The longer a person is exposed to working conditions involving physical stress, the higher the likelihood of health problems or complaints. Exposure to physical stress that lasts for a certain period can cause decreased muscle performance and disturbing symptoms.[19] Prolonged physical stress on muscles can damage joints, ligaments, and tendons. Muscles continuously subjected to static loads for a long time will experience detrimental changes, such as decreased flexibility and muscle strength. This can cause complaints and disorders, such as pain in the joints, damage to the ligaments, and inflammation of the tendons.[20] Thus, the length of the working period and exposure to physical stress that occurs during the work process can play an essential role in the risk of complaints and disorders of the musculoskeletal system. Attention to ergonomic working conditions and protection of workers' health can help reduce the risk of these complaints.[21]

One of the factors that can cause musculoskeletal complaints is an imbalance between intense physical activity and inadequate rest periods. Along with increasing physical activity, muscle complaints also tend to grow.[22] Research conducted by Manoppo in 2017 also supports the relationship between physical activity and musculoskeletal complaints. This research was conducted on fishermen and showed a close relationship between their physical activity and the musculoskeletal complaints they experienced.[23] Thus, these studies empirically support the relationship between physical activity and musculoskeletal complaints. This emphasises the importance of paying attention to the need for rest and recovery of the body after intense physical activity to prevent muscle and bone complaints that can potentially interfere with individual well-being. Through analysis of research data using the Rapid Upper Limb Assessment (RULA) method, it was found that the majority of workers in the study had a high ergonomic risk level, reaching 18 people or 58.1% and even 8 of the total sample or 25.8% had a very high ergonomic risk level. This is caused by non-ergonomic working conditions and work postures, which increase the level of danger at work. Unnatural body positions or staying in the same position for too long can cause certain muscles to work harder or tense up to maintain body balance. This can lead to gradual muscle fatigue. Tjahayuningtyas (2019) explains that the mismatch between the workplace and workers can cause complaints to the musculoskeletal system, including complaints to muscles and bones due to non-ergonomic body postures. These complaints are known as musculoskeletal complaints.[24]

Through analysis of research data using the Rapid Upper Limb Assessment (RULA) method, it was found that the majority of workers in the study had a high ergonomic risk level, reaching 18 people or 58.1% and even 8 of the total sample or 25.8% had a very high ergonomic risk level. This is caused by non-ergonomic working conditions and work postures, which increase the level of danger at work. Unnatural body positions or staying in the same position for too long can cause certain muscles to work harder or tense up to maintain body balance.[25] This can lead to gradual muscle fatigue. Tjahayuningtyas (2019) explains that the mismatch between the workplace and workers can cause complaints to the musculoskeletal system, including complaints to muscles and bones due to non-ergonomic body postures. These complaints are known as musculoskeletal complaints.[26]

The study also showed that the most common musculoskeletal complaints felt by woodcarvers in Ubud Village were pain in the lower neck, back and waist. This complaint is caused by the frequent work done in a static position. In addition, factors such as using tools such as chisels, carving, and cutting wood also contribute to musculoskeletal complaints. An unergonomic working position causes workers to bend over and move their bodies forward to achieve a comfortable but not ergonomic position. On the other hand, complaints with moderate and low levels were more often felt in the lower extremities, especially in the calves to the feet, where woodcarvers often felt tingling. Musculoskeletal complaints often occur due to increased excessive muscle contractions caused by high and long workloads. Several factors that can cause musculoskeletal complaints include extreme muscle stretching, repetitive activities, and adopting non-ergonomic work attitudes.[25] In this study, it was found that 58 respondents or around 80.6% of the total respondents, experienced severe pain, while 14 respondents or about

19.4%, experienced moderate pain. Most respondents who experienced severe pain reported that the pain was manageable. This shows that musculoskeletal complaints experienced by respondents tend to be more powerful and require serious attention to reduce their impact. The results of this study emphasise the importance of efforts to manage and prevent musculoskeletal complaints in the workplace.

Preventive measures that can be taken include adjusting natural work attitudes, reducing repetitive activities, and planning adequate breaks. In addition, it is also necessary to pay attention to the use of ergonomic work tools and the application of ergonomic principles in the work environment to reduce the risk of musculoskeletal complaints. Thus, understanding the causes of musculoskeletal complaints and implementing appropriate preventive measures can help reduce the risks and impacts of these complaints and improve workers' welfare and health in the workplace.[26] This study produced findings that align with research by Ibrahim and Hutabarat in 2021, where the RULA score for sanding and caulking operators before posture correction has a high-risk level with a value of 7. This indicates a high risk of musculoskeletal disorders and complaints of pain in other body parts. Therefore, it is essential to improve posture while working. After designing chairs and tables based on employee anthropometric data, analysis of the RULA score shows a decrease to 5, which indicates a moderate risk level.[27]

This finding is also supported by other studies using the RULA method. Salsa and Asy'ari, in 2020, researched worker posture in the activities of furniture workers in wooden shaving machines at UD Setia Usaha. Then, they processed the data using the RULA method and concluded that the work posture with the highest risk was the standing bent position with arms stretched forward. It received a score of 7 and needed to be corrected immediately. In addition, standing posture with the feet back and forth also has a moderate risk with a score of 6 which needs to be fixed shortly.[28] These results align with research conducted by Rahayu in 2020 on 103 employees at the Personnel Bureau of the Indonesian Ministry of Health, which found no significant relationship between physical activity and complaints of musculoskeletal disorders. In that study, 57 respondents (55.3%) reported having sufficient physical activity, while 46 respondents (44.7%) reported having insufficient physical activity.[29]

Based on bivariate analysis using Spearman's Rho non-parametric method on 31 respondents, a significant correlation was found between RULA analysis and complaints of neck pain with a correlation coefficient of 0.554. This value indicates that the relationship between physical activity and neck pain has strong strength.

The "Correlation Coefficient" value is positive (0.554), indicating that the two variables have a unidirectional relationship. This means that the higher the physical activity, the higher the number of neck pain complaints felt by respondents. Significance value or Sig. (2-tailed) of 0.000; which indicates a very significant relationship between physical activity and complaints of neck pain because 0.000 is smaller than 0.01. Thus, the first hypothesis or H1 namely "There is a relationship between RULA analysis and complaints of neck pain in woodcarving craftsmen in Ubud Village" can be accepted.

Based on bivariate analysis using Spearman's Rho non-parametric method on 31 respondents, a significant correlation was found between physical activity and complaints of neck pain with a correlation coefficient value of 0.825. This value indicates that the relationship between physical activity and neck pain has a very strong strength.

The "Correlation Coefficient" value is positive (0.825), indicating that the two variables have a unidirectional relationship. This means that the higher the physical activity, the higher the number of neck pain complaints felt by respondents. Significance value or Sig. (2-tailed) of 0.000; which indicates a very significant relationship between physical activity and complaints of neck pain because 0.000 is smaller than 0.01. Thus, the second hypothesis or H2 namely "There is a relationship between physical activity and complaints of neck pain in woodcarving craftsmen in Ubud Village" can be accepted.

Another study conducted by Soysal et al. (2013) regarding the "Assessment of Physical Activity in Patients with Chronic Low Back or Neck Pain," which found that physical activity had a more effect than sleep quality, depression, and quality of life on the incidence of low back pain and neck pain. Another study by Kroll et al. (2017) also found something similar, where the level of physical activity, well-being, stress, and self-assessed health had an effect on migraines and tension-type headaches and neck pain.[29]

Another study conducted by Soysal et al. (2013) regarding the "Assessment of Physical Activity in Patients with Chronic Low Back or Neck Pain," which found that physical activity had a more effect than sleep quality, depression, and quality of life on the incidence of low back pain and neck pain. Another study by Kroll et al. (2017) also found something similar, where the level of physical activity, well-being, stress, and seFlf-assessed health had an effect on migraines and tension-type headaches and neck pain.[30] Adequate physical activity significantly contributes to fitness levels and can help maintain body weight, improve physical fitness, and prevent cardiovascular disease. Regular physical activity should be done at least three times a week. In addition, stretching (stretching) in physical activity is essential to stretch the muscles used for a certain period. Lack of physical activity can reduce the oxygen supply to the muscles, which can cause muscle complaints. Generally, muscle complaints rarely occur in individuals who have sufficient rest time and do adequate physical activity.[31]

The limitations of this study are the small sample size and not measuring pain in other musculoskeletal complaints. This study only measured the level of pain in the neck, so other pain measurements such as wrist, back, and shoulder can be used as input in future studies.

CONCLUSION

Based on research findings, there were relationships between two variables of RULA analysis and physical activity, and neck pain in woodcarving craftsmen in Ubud Village.

ETHICAL CLEARANCE

This study has received approval from the Ethical Commission of Medical Faculty, Udayana University, and has obtained informed consent.

CONFLICT OF INTEREST

This study has no conflict of interest.

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AUTHOR CONTRIBUTIONS

NNRW prepared the research design, collected data, processed data, and wrote the manuscript. NLPGKS, NLNA, and NKAJA have directed data collection and revised the manuscript.

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REFERENCES

1. Dewi NMW, Wahyuni N, Sundari LPR. The relations between a working position with non-specific neck pain on laundry workers in Denpasar city. Majalah Ilmiah Fisioterapi Indonesia. 2019;7(1):10-14
2. Kementerian Kesehatan RI. Profil kesehatan indonesia tahun 2014. Kemenkes. 2015;199(9):1
3. Jusman N. Faktor-faktor risiko ergonomi dengan keluhan subjektif musculoskeletal disorders (msds) pada operator cutting bar di unit produjsi pt iron wire works indonesia tahun 2018. Energies. 2018;6(1):1-8
4. Scott P. Ergonomic checkpoints. Glob Ergon. 1998;1(2):47–50.
5. Adiprana IPG, Mahagangga IO. Dinamika perkembangan pariwisata di desa pakraman ubud. Jurnal destinasi pariwisata. 2013;10(1):34-43
6. Hidayat R, Hariyono W, Sutomo AH. Penyebab keluhan muskuloskeletal pada perajin mebel ukir di bantul. J Kedokt Masy (BKM J Community Med Public Heal. 2016;32(8):251-256
7. Belayana IBGB, Darmadi IGW, Mahayana IMB. Hubungan faktor waktu kerja, waktu istirahat dan sikap kerja terhadap keluhan nyeri tengkuk pada pengerajin ukiran kayu. J Kesehat Lingkung. 2014;4(1):6-15
8. Articles RBLOG. Is your workout giving you a stiff neck? Harvard Health. 2019;1(4):20-25
9. Wenur SJA, Kawatu PAT, Johan Josephus. Hubungan antara aktivitas fisik dengan keluhan muskuloskeletal pada pekerja bengkel di cv. kombos kota manado tahun 2013. J Kesehat Masy. 2013;3(1):1-6
10. Antyesti AD, Nugraha MHS, Griadhi IPA, Saraswati NLPGK. Hubungan faktor resiko ergonomi saat bekerja dengan keluhan muskuloskeletal pada pengrajin ukiran kayu di gianyar. Majalah Ilmiah Fisioterapi Indonesia. 2020;8(2):42
11. As-Syifa RM, Hutasoit R, Kareri DGR. Hubungan antara sikap kerja terhadap kejadian neck pain pada penjahit di daerah kuanino kota kupang. Cendana Med J. 2020;8(3):164-171
12. Puspitasari, EP. Analisis risiko sikap kerja dengan keluhan musculoskeletal disorder pada porter stasiun surabaya gubeng. The Indonesian Journal of Occupational Safety and Health. 2019;8(1):104–114
13. Aini N, Purwasari MD. Sikap dan perilaku pencegahan covid-19 di desa kemuningsari kidul kabupaten jember. J Kesehat. 2021;8(3):171-177
14. Evadarianto N. Postur kerja dengan keluhan musculoskeletal disorders pada pekerja manual handlingbagian rolling mill. Indones J Occup Saf Heal. 2017;6(1):97
15. Dharmansyah D, Budiana D. Indonesian adaptation of the international physical activity questionnaire (ipaq): psychometric properties. J Pendidik Keperawatan Indones. 2021;7(2):159-163
16. Artaya IP. Uji rank spearman. Metode Penelit. 2017;2(1):32-41.
17. Violetta VVV, Kawatu PA, Rumayar AA. Hubungan antara umur dan masa kerja dengan keluhan musculoskeletal pada pekerja petani di desa kanonang dua kecamatan kawangkoan barat kabupaten minahasa. J Kesmas. 2020;10(1):1-7
18. Helmina, Diani N, Hafifah I. Age, sex, length of service and exercise habits with complaint of musculoskeletal disorders (msds) on nurses. Caring Nurs Jounal. 2019;3(1):24
19. Rossa GU, Helmi ZN, Setyaningrum R, Marlinae L, Rosadi D. Correlation between individual and work factors with musculoskeletal. J Keselamat dan Kesehatan Kerja. 2017;1(4):1-6
20. Järvholm B, Stattin M, Robroek SJW, Janlert U, Karlsson B, Burdorf A. Heavy work and disability pension a long-term follow-up of Swedish construction workers. Scand J Work Environ Heal. 2014;40(4):335-342
21. Andersen LL, Fallentin N, Thorsen SV, Holtermann A. Physical workload and risk of long-term sickness absence in the general working population and among blue-collar workers: prospective cohort study with register follow-up. Occup Environ Med. 2016;73(4):246-253
22. Fuggle NR, Laskou F, Harvey NC, Dennison EM. A review of epigenetics and its association with the aging of muscle and bone. Maturitas. 2022;165:12-17
23. Hardianto, Elly Trisnawati IR. Faktor-faktor yang berhubungan dengan keluhan musculoskeletal disorder (msds) pada karyawan bank x. J Chem Inf Model. 2015;(9):1-20
24. Manoppo F, Malonda NSH, Kawatu PAT. Hubungan antara aktivitas fisik dengan keluhan muskuloskeletal pada nelayan desa kalinaun kecamatan likupang timur kabupaten minahasa utara. J KESMAS. 2017;6(3):1-5.
25. Tjahayuningtyas A. Faktor yang mempengaruhi keluhan musculoskeletal disorders (msds) pada pekerja informal. Indones J Occup Saf Heal. 2019;8(1):1
26. Djaali NA. Analisis keluhan musculoskeletal disorders (msds) pada karyawan pt. control system arena para nusa. J Ilm Kesehat. 2019;11(1):80-87
27. Ibrahim MA, Hutabarat J. Analisa ergonomi dengan pendekatan rapid upper limb assessment pada postur kerja statis karyawan produksi kerajinan kayu di ud . tohu srijaya , kota batu , jawa timur. Valtech. Jurnal Mhs Tek Ind. 2021;4(2):82-89
28. Salsa A, Asy'ari S. Analisa keluhan musculoskeletal pada postur tubuh pekerja penyerut kayu di mebel ud. setia usaha dengan menggunakan metode rapid upper limb assessment. JKIE Journal Knowl Ind Eng. 2020;7(1):38-45
29. Rahayu PT, Arbitera C, Amrullah AA. Hubungan faktor individu dan faktor pekerjaan terhadap keluhan musculoskeletal disorders pada pegawai. J Kesehat. 2020;11(3):449
30. Setiawan H, Munawwarah M, Wibowo E. Hubungan aktivitas fisik dengan kebugaran dan tingkat stres pada karyawan back office rumah sakit omni alam sutera dimasa pandemi covid-19. Physiother Heal Sci. 2021;3(1):1-10
31. Riskawati YK, Kania Aviandi Savitri, Putri Raessy Ramdani AFM. Correlation between physical activity level and body mass index of undergraduate students of medical doctor, faculty of medicine, universitas brawijaya. Maj Kesehat Univ Brawijaya. 2020;7(4):231–8.