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Age and ergonomic position as determinants of musculoskeletal disorders among Batik workers: A cross-sectional study

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ABSTRACT

Background: Musculoskeletal disorders (MSDs) are complaints that occur in human muscles and bones, which are caused by several factors such as excessive work, lifting heavy loads, age, gender, and others. This study aimed to analyze the relationship between age and ergonomic working positions with the occurrence of MSDs across different divisions and types of batik production.

Methods: This study used a cross-sectional design with cross-divisional analysis based on the type of batik worked on. The study involving 60 respondents selected through purposive sampling from Laweyan Batik Village. Research data was collected using several instruments, including: Nordic body map (NBM), Oswestry disability index (ODI), work ergonomic risk assessment (WERA), and numeric rating scale (NRS).

Results: It was found that age was not related to the cause of changes in waist functional ability, with *p*-value= 0.342. There is a relationship between the level of waist ergonomics when working and the risk of lower back pain in batik makers, with *p*-value= 0.030.

Conclusion: There is a relationship between the level of waist ergonomics when working and the risk of lower back pain in batik makers, but age was not related with musculoskeletal disorders in batik workers.

Keywords: age, batik type, batik workers, ergonomic position, musculoskeletal disorders.
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INTRODUCTION

Batik makers are informal sector workers who manage a product in the form of cloth. Batik is an intangible cultural heritage that has been recognized by the united nations educational scientific and cultural organization (UNESCO) from the textile industry. One of the largest batik centers is in the Surakarta city area, namely the Laweyan batik village, which has been an icon of Surakarta batik since the 19th century and has owned patents for 250 batik motifs typical of the Laweyan batik village.[1] Batik makers are one of the workers who have the potential to experience musculoskeletal disorders (MSDs). Musculoskeletal disorders are complaints in the form of mild to severe pain due to joints, ligaments, tendons, and skeletal muscles disorders.[2] This complain can occur in any part of body.

Research stated that 70.4% of 44 batik makers in Lendah District, Kulon Progo Regency felt lower back pain.[3] This happens because the muscles experience fatigue due to ergonomic factors. This muscle fatigue is a characteristic of myogenic low back pain.[4] The increased risk of low back pain is also related to the frequency of back movement when the upper extremities perform manual handling tasks.[5,6] Repetitive movements in unnatural positions cause the muscles to not receive sufficient time to relax, causing fatigue and muscle tension.[7]

The risk of MSDs that often occur in batik makers is neck, shoulder, arm and back pain. Musculoskeletal complaints in the neck were found to be 40%.[8] Complaints of pain in the shoulders and arms showed a result of 30%.[9] Meanwhile, complaints of lower back pain are 75%.[10] Low back problems are one of the most common muscle complaints and are most often found in everyone, especially workers, and are one of the biggest contributors to global disability.[11] Complaints on the waist can cause limited worker activity and even result in absenteeism from work.[12] On the other hand, the most frequently encountered MSDs are in the knee arthritis accounts for the highest proportion of musculoskeletal cases, reaching up to 50%.[13]

Complaints that are often encountered in sufferers of low back disorders are discomfort, pain, and even stiffness that is localized in the area of the back to the buttocks.[14] Complaints on the waist can also be caused by several factors, namely individual factors (age, length of service, gender, smoking habits, increase in body

mass index (BMI) and environmental factors (work activities, work attitudes, workplace facilities, repetition, factors body movements).[15] Decreased lumbar flexibility, stiffness in the lumbar muscle area and decreased lumbar muscle strength and endurance are the main factors that can influence changes in lumbar functional ability.[16] Moreover, while age is commonly cited as a factor influencing musculoskeletal health, limited studies have assessed its interaction with specific ergonomic conditions in the context of traditional craftsmanship like batik production. The absence of comparative analysis between batik types and the combined role of age and ergonomics in predicting MSDs risk represents a significant gap in the occupational health literature.

A decrease in functional ability can be influenced by 3 main things, namely the range of motion of the joint, flexibility and the presence of pain.[17] Flexibility is the ability to maximally stretch a tissue or muscle so that the body is able to move without pain and with a full range of motion of the joints.[18] An unnatural working position, where the body moves away from the center of the body, causes muscle contractions to be inefficient in maintaining balance when the upper extremities move, resulting in fatigue.[3]

Musculoskeletal disorders are imbalances in the bones and muscles that result in pain or parasthesia, which consists of strains, sprains, fractures, tendinitis, dislocations and bursitis.[19] Muscoceletal disorders occur due to excessive use at work, such as lifting heavy loads, standing for too long, static postures and inappropriate postures that are carried out continuously for a long time.[20] According to the World Health Organization, musculoskeletal disorders are diseases that often occur in workers and are the main cause of malformations universally.[21] Data from non-communicable diseases in 2016 states that musculoskeletal disorders are illnesses that are often felt by people around the world and in Indonesia itself. In 2018, it showed that 7.9% of workers experienced MSDs (Ministry of Health of the Republic of Indonesia, 2018.[22]

Laweyan Batik Village is an micro, small, and medium enterprises (MSME) batik production center in Surakarta, which cannot be separated from the role of the Surakarta government.[23] Providing cultural programs can influence the amount of batik production for MSMEs so that there is the potential for batik makers to work overtime.[24] A good work duration per day is 6-10 hours, but this duration can be affected by overtime and almost no free time.[25] This condition can have an impact on the emergence of MSD complaints in batik makers.

METHODS

This study used a cross-sectional design to evaluate the relationship between age and ergonomic position on musculoskeletal complaints in batik workers, with cross-divisional analysis based on the type of batik worked on. This research was carried out in Laweyan Batik Village, which is the center of the batik industry in Surakarta. The total sample was 60 batik respondents who met the criteria selected using a purposive sampling technique.

The inclusion criteria for the sample used were myogenic back pain complaints, so questions were asked regarding pain symptoms and specific tests to determine them. The Slump Test is used to identify nerve root compression in the lumbar area and can indicate lumbar disc herniation.[26] Another exclusion criterion is batik makers who have a history of injury (such as accidents and falls) or a medical diagnosis of musculoskeletal disorders (such as osteophytes, rheumatism, hyperlordosis, kyphosis, scoliosis, osteoporosis, tumors, etc.) in the lower back area.

This study uses validated and reliable instruments and enumerators or data collectors so that standard procedures are followed consistently to avoid research bias. The questionnaire used in this research is the Nordic Body Map with a specificity value of 71-88% and validity of 0.297. The Nordic body map questionnaire maps the parts of the body that experience musculoskeletal complaints which are divided into 28 body regions.

Low back functional ability uses the Indonesian version of the Oswestry disability index (ODI) modified questionnaire to measure impaired low back functional ability and includes 10 points that have been validated with a validity value of 0.722 and a reliability value of 0.890.[27]

Decreased functional ability of the neck will be evaluated with the Neck Disability Index with a validity value of 0.61 and a reliability value of 0.81. The Neck Disability Index consists of 10 questions with interpretations of 0-20% (minimal or mild disability), 20-40% (moderate or moderate disability), 40-60% (severe or severe disability), 60-80% (crippled or paralyzed), 80-100% (cannot be defined).

Evaluation of work posture is taken by taking a picture of the working position and calculating repetitions of that position for one minute on samples that meet the criteria whose waist ergonomics level will then be measured using the work ergonomics risk assessment (WERA) back point. WERA is an ergonomics measuring tool whose validity has been tested with a p-value = 0.002 (< 0.05) with a reliability value of K = 0.41 (moderate).[5] Next, pain intensity was measured using the Numeric Rating Scale (NRS) through interviews, NRS was tested as valid ($r > 0.8$; $p < 0.01$) with a reliability value (ICC) = 0.801 (very strong) for measuring pain intensity with a validity value.

Data collection was carried out by enumerators after the sample agreed to become respondents through informed consent. This research has an ethical clearance permit with number 870/EC/IV/2024 from the Ethical Committee Military Hospital of Dr. Soedjono Magelang, Indonesia.

RESULTS

Data analysis was carried out using a normality test, then a bivariate test of age group variables with ODI categories. Then, the percentage of distribution of ergonomic levels and pain levels based on Batik maker and the test of the relationship between waist ergonomics level at work and the risk of lower back pain.

Based on table 1, it shows that from research conducted on 60 respondents who were divided into of 32 men (53.3%) and 28 women (46.7%) with 34 people in the written batik group (56.7%) and 26 people in the stamped batik group. (43.3%). The age variable is categorized into 3 groups according to WHO, namely the adult group (30-44 years) as much

as 36.7%, middle age (45-59 years) as much as 38.3%, and elderly (60-74 years) as much as 25%, and it is known that 54 people (90%) fall into the mild disability category in the ODI score group.

As shown in Table 2, the results of the Kolmogorov-Smirnov normality test show that the age variable has a significance value of p= 0.200, which indicates that the age data is normally distributed. In contrast, the ODI score variable has a significance value of p= 0.000, so it is concluded that the ODI score data is not normally distributed. There was no significant relationship between age and disability level based on ODI score in batik workers in this study (r= 0.125; p= 0.342). Although there was a tendency for ODI score to increase with age, the relationship was not strong enough and not statistically significant.

Table 3 presents the results of the physical workload distribution analysis based on the WERA method show that 100% of stamped batik workers are in the high workload category, while canting batik workers are dominated by medium (15 people, 51.7%) and high (4 people, 13.8%) workloads. In the NRS category, 43.8% of stamped batik workers experience a high risk of musculoskeletal disorders, while in canting batik workers, the majority are at moderate risk (13 people, 44.8%).

All workers in the lorod section (3 people) are recorded as being in the high risk category, both according to WERA and NRS, indicating significant ergonomic risk potential. Meanwhile, workers in the coloring sections have a varied distribution of workload and NRS risk, with around 50% of coloring workers at moderate to high risk. In contrast, workers in the pattern section show a relatively low to moderate physical workload, with 2 out of 3 workers at low to moderate NRS risk, reflecting the lightest level of musculoskeletal risk compared to other types of work.

Based on the data in Table 4, a significant relationship was found between the ergonomics of waist posture during work and the occurrence of lower back pain in batik makers, with a p-value= 0.030. The correlation coefficient value of 0.283 indicates that the strength of the relationship is weak with the direction of the relationship being unidirectional or positive.

Table 1. Characteristics of 60 Batik makers

Variable	Mean ± SD or n (%)
Age (years)	49.1 ± 12.2
Adult	22 (36.7)
Middle Age	23 (38.3)
Elderly	15 (25)
Age Group	1.9 ± 0.8
Gender	
Male	32 (53.3)
Female	28 (46.7)
Types of Batik Makers	
Stamp	26 (43.3)
Canting	34 (56.7)
Jobdesk Stamp Batik maker	
Ngiseni	18 (30)
Coloring	6 (10)
Lorod	2 (3.3)
Jobdesk Canting Batik maker	
Ngiseni	28 (46.7)
Mola	1 (1.7)
Nyolet	3 (5)
Coloring	1 (1.7)
Lorod	1 (1.7)
ODI Score	11.5 ± 7.8
Mild disability	54 (90)
Moderate disability	6 (10)
ODI Score Group	1.1 ± 0.3

N, frequency of participants; ODI, Oswestry disability index; SD, standard deviation

Table 2. Normality test and bivariate analysis of age group with Oswestry disability index (ODI) score

Variable	Kolmogorov-Smirnov		Spearman's rho	
	Statistic	*p*-value	*r*	*p*-value
Age	0.093	0.200	0.125	0.342
ODI Score	0.177	0.000		

Table 3. Distribution of ergonomic levels and pain levels based on batik maker

Jobdesk	WERA			NRS		
	Low	Moderate	High	Low	Moderate	High
Batik Stamp	0	0	16	4	5	7
Batik Canting	8	15	4	9	13	5
Lorod	0	0	3	0	0	3
Nyolet	0	1	3	1	2	1
Coloring	0	0	6	2	3	2
Pattern	0	1	1	0	2	0

NRS, numeric rating scale for pain level; WERA, waist ergonomics level when working

Table 4. The relationship between waist ergonomics level at work and the risk of lower back pain

Variable	NRS			Correlation Coefficient	*p-value*
	Low	Moderate	High		
	n (%)				
WERA					
Low	5 (8.5)	3 (5.1)		0.283	0.030
Moderate	3 (5.1)	10 (16.9)	4 (6.8)		
High	8 (13.6)	12 (20.3)	14 (23.7)		

NRS, numeric rating scale for pain level; WERA, waist ergonomics level when working

DISCUSSION

The Nordic body map questionnaire results revealed that the most frequently reported complaint among batik artisans was lower back pain, affecting 83.3% of those using the handwritten technique and 92.3% of those using the stamped method. Statistical analysis showed no significant association between age and waist function. However, there was a significant correlation between ergonomic working posture and the risk of lower back pain. Inadequate ergonomic practices were found to increase the risk of musculoskeletal disorders (MSDs), regardless of the batik-making technique used.

According to the respondent characteristics in Table 1, musculoskeletal complaints among written batik workers were predominantly reported by female participants, while in stamped batik workers, they were more frequently reported by male participants. Physiologically, men's muscle strength is stronger than women's, therefore gender is closely related to the emergence of musculoskeletal complaints.[13] This was also explained in the research of which states that the prevalence ratio of symptoms in women is about 50% higher than in men, regardless of the type of task performed by the worker.[28]

Based on the characteristics of the respondents, the lowest age was 30 years and the highest was 73 years. In accordance with the results above, it was found that for written batik the average age of respondents was 45-59 years old, whereas for stamped batik makers the average age of respondents was 30-44 years old. Musculoskeletal complaints do not recognize age ranges, but as you get older the risk of developing musculoskeletal complaints increases. At the age of 30 years there is a decrease in stability in muscles and bones due to decreased fluid, tissue damage and tissue regeneration.[29] Increasing age in a person can indeed cause a decrease in the stability and strength of the waist muscles, but when the batik maker is in an ergonomic position during work, has sufficient rest time, endurance and has good nutritional intake and physical activity, fatigue in the waist muscles can be minimize.[30] Aging is a natural process that cannot be avoided, where a decrease in muscle strength in a person will appear more significant at the age of 60 years, with an average decrease of up to 20% which will trigger low back complaints.

Increasing age is not the only factor that causes changes in a person's waist functional ability. According to research conducted stated that the physiological health of the elderly is also one of the factors that can influence their physical functional abilities, the better the physiological health, the better the functional abilities of the elderly, and vice versa.[31,32] To achieve good physiological health, one way to achieve this is to do good physical activity, because it can increase the flexibility of muscle tone in the elderly, so that the level of muscle complaints will decrease.[33]

Based on the explanation above, the probability of changes in waist functional ability may decrease, so that the majority of batik makers in this study have ODI scores in the low category. For batik makers with a mild disability category, this means that the batik maker can still carry out most of his life activities, without any indication of taking medication, and is more focused on being given education regarding how to sit or lift objects correctly so as not to worsen the level of disability. Based on the job desk division, each batik making process is dominated by the stamping and stamping processes. Complaints arising from inappropriate work positions are generally caused by task characteristics, tools used in work, work places that do not match the workers' abilities.[34]

In research with tailor respondents, it was stated that there was a significant relationship between unergonomic posture and repetitive movements and complaints of lower back pain, with a strong category of relationship for the non-ergonomic posture variable and movement repetition variable.[10] In his research, it was explained that respondents worked sewing in a bent position accompanied by repeating this position repeatedly during working hours so that the muscles were overused and lower back pain occurred. This research was in line with research where there is a relationship between the level of waist ergonomics when working, which includes position and repetition of work, and the risk of lower back pain in batik making.[10] From the results of the correlation test carried out, the correlation coefficient value in this study is in the weak category because this study presents data on the relationship between the level of waist ergonomics when working with the level of pain from myogenic back pain through carrying out specific tests to obtain samples. inclusion. In previous research, distinguishing variables of unergonomic posture and repetitive movements from the presence or absence of back pain complaints without carrying out specific tests to select the type of low back pain.[10]

The relationship between waist ergonomic factors and the risk of lower back pain occurs because repetitive body position away from the neutral position, if it lasts for a long time, can cause continuous muscle contractions, causing the muscles to experience fatigue and causing lower back pain.[13] This is in line with statistical tests where the majority of respondents are written batik makers (45.8%) and stamped batik makers (27.1%) are in second place,

where the two job desks have different ergonomic tendencies. Writing batik works in a sitting position, back leaning forward, with few repetitions, while stamping batik works in a standing position, back leaning forward, with many repetitions. Repetitive movements can increase MSDs complaints in industrial workers, as they lead to continuous strain on the same muscle groups and joints, potentially causing inflammation, fatigue, and long-term musculoskeletal damage.[35] These results are in line with research with respondents who were batik makers, where the majority of batik makers had a moderate level of risky ergonomics with a moderate level of pain.[36] Research with stamped batik making respondents stated that the majority of batik makers have a high level of risky ergonomics with a high level of pain.[37]

Physical ergonomics when working can be a factor in the occurrence of piriformis syndrome as a result of lifting weights accompanied by repeated forward-leaning back postures which cause continuous contraction of the piriformis muscle resulting in muscle tension.[38] This ergonomic condition can also cause lower cross syndrome where the hip flexor muscles (iliopsoas) and erector spine become tense while the hip extensors and abdominal muscles experience weakness.[39] Work positions and repetitions where the lower back is bent and then lifted repeatedly are ergonomic factors that have the potential to cause lower back pain The study found a significant positive correlation between work posture and musculoskeletal pain complaints among laundry workers in Denpasar, Bali, indicating a moderate-strength relationship in the same direction.[40] Statistically, the majority of batik makers have a level of waist ergonomics in the high-risk category, while the level of pain felt by the majority of batik makers is in the moderate category. These results could be caused by the conditions of the research location so that it is a consideration not to carry out other tests that could indicate complaints of back pain. Apart from that, there are other ergonomic factors such as work duration and length of service as well as individual factors such as gender, age, smoking, alcohol consumption and exercise habits can influence the pain level of back pain.[41]

The limitations of this study are that it was only conducted at one point in time, so it cannot ascertain the causal relationship between the independent and dependent variables and because it was only conducted once, this study cannot monitor changes or developments in variables over time. Additionally, the study was limited to a specific geographic location laweyan batik village so the findings may not be generalizable to batik workers in other regions with different environmental, cultural, or ergonomic working conditions. Furthermore, the reliance on self-reported data from questionnaires may have introduced response bias, as participants may underreport or overreport symptoms due to recall difficulties or social desirability.

CONCLUSION

This study found that there was no significant association between age and changes in waist function. However, there was a significant relationship between ergonomic working posture and the risk of lower back pain. These findings explained that the urgent need for targeted ergonomic interventions and age-appropriate workplace modifications to enhance occupational health in traditional batik industries.

ETHICAL CONSIDERATION

Data collection was carried out by enumerators after the sample agreed to become respondents through informed consent. This research has an ethical clearance permit with number 870/EC/IV/2024 from the Ethical Committee Military Hospital of Dr. Soedjono Magelang, Indonesia.

CONFLICT OF INTEREST:

The authors declare that they have no conflicts of interest regarding the publication of this paper.

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AUTHOR CONTRIBUTIONS

AP led the study's conceptualization, data acquisition, literature research, and manuscript writing; AFN, MWD, RS, WAA, and AT assisted with data collection; MSA, NRL, and ASB contributed to literature reviews; S and MNS participated in manuscript revisions.

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