The Influence of Ergonomic Risk on Work Performance: Low Back Pain as Mediator in Office Workers

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KEYWORDS

Work quality, work posture, lighting intensity, low back pain

ABSTRACT:

Introduction: In today's modern era characterised by rapid advances in technology and digital transformation, office workers are facing new challenges in their working patterns. They are increasingly trapped in a sedentary lifestyle, characterised by prolonged sitting during working hours. One of the most common ergonomic risks found in office workers is complaints of the lower back.

Objectives: The aim of this study was to look at the influence of ergonomic risks such as work posture and lighting intensity on work quality, with Low Back Pain (LBP) complaints as mediators.

Methods: Quantitative research with an analytical observational approach using a cross-sectional design. Data collection from 110 respondents used a work quality questionnaire, posture assessment using Rapid Entire Body Assessment, lighting measurement using a lux meter, and pain scale measurement using the Numerical Rating Scale.

Results: The results showed that there was a significant direct influence between work posture on work quality (p=0.000), (f=0.396) showing a high influence, while lighting intensity had no significant direct effect on work quality (p=0.058). Meanwhile, through the analysis of the indirect influence with LBP complaints as a mediator, there was a significant influence between work posture on work quality (p=0.000), (z-sobel= -3.644). Meanwhile, the intensity of lighting also had a significant influence on the quality of work with LBP complaints as mediator (p=0.042), (z-sobel= 2.185).

Conclusions:LBP complaints have a significant influence in mediating the influence of work posture and lighting intensity on work quality.

1. Introduction

In today's modern era, which is marked by rapid advances in technology and digital transformation, office workers face new challenges in their work patterns. They are increasingly trapped in a sedentary or inactive lifestyle, which is characterized by the habit of sitting for very long periods of time during working hours. This situation is exacerbated by the reliance on digital devices such as computers and laptops that require them to stay in front of the screen constantly [1]. Previous research has revealed the habit of prolonged sitting behavior that is consistent in various countries, several studies that have been conducted before have shown that the average office worker spends about 68-80% of their working time in a sitting position [2][3]. Work patterns that tend to be static have become a serious concern in occupational health studies. This is because this pattern can have a negative impact on the health of workers, which ultimately reduces the quality of their work [4][5].

One of the most common risks found in office workers due to prolonged sitting is complaints of the lower back [6]. According to the World Health Organization (WHO), LBP is the leading cause of disability worldwide with a prevalence of 7.2% and 4 out of 5 individuals will affect their lives in the world. The occurrence of LBP causes an increase in economic costs and a decrease in worker productivity [7][8]. The prevalence of LBP worldwide ranges from 15% to 45% [9]. Especially in office workers, the prevalence of LBP continues to increase, they spend 95% of their total working time in a sitting position [10].

The prevalence of LBP in Indonesia is a significant health problem, ranking second only to influenza in terms of prevalence. However, the exact data on the number of LBP sufferers has not been comprehensively identified. Government estimates show LBP prevalence range of between 18%. Meanwhile, LBP is

experienced by many office employees. With a prevalence of 23% to 38% annually [11]. Based on epidemiological data, the prevalence of musculoskeletal diseases in Indonesia reached 11.9% for diagnosed cases, with an additional 24.7% of the population experiencing related symptoms [12]

In addition to the long duration of sitting, there are several factors that can affect LBP complaints, including personal, work, and psychological factors. Personal risk factors such as age, gender, body mass index, physical activity level, and can be influenced by family history. Meanwhile, occupational risk factors such as bending over while working, lifting heavy weights, and being in the same position for a long time. Psychosocial factors such as depression and stress at work. Pain complaints that are left alone will affect the quality of workers' work, productivity will decrease, and cause sleep disturbances in workers [13][14].

In this study, the researcher focused on the worker's work posture and the intensity of lighting at the worker's desk. Based on the results of research conducted by Kusumaningrum, it was stated that there was a significant relationship between work posture and the incidence of LBP [15]. Several previous studies have shown a significant relationship between work posture and LBP complaints [16], [17], [18]. Another variable that has been studied is the intensity of lighting on workers' desks. Research findings indicate a significant relationship between lighting intensity and LBP complaints among workers [19]. which is supported by other studies reporting similar results [20], [21]. However, previous studies have not examined the impact of LBP complaints on workers' job performance.

Based on the description of the problem above, the risk factors for LBP are important to research, especially for office workers in today's digital era. The purpose of this study is to see the influence of ergonomic risk factors such as work posture, physical activity, and lighting intensity on the quality of workers' work, with LBP as a mediator in office workers.

2. Objectives

The aim of this study was to look at the influence of ergonomic risks such as work posture and lighting intensity on work quality, with Low Back Pain (LBP) complaints as mediators.

3. Methods

Research Design

This study is a quantitative research with an analytical observational approach using a cross-sectional design. This research was conducted for 30 days.

Participants

This study selected a professional service office in Makassar, Indonesia, with 110 office workers as participants. Pregnant women were excluded from the study. All participants provided informed consent before taking part. This research was conducted in accordance with the principles of the National Commission on Health Research Ethics and was approved by the ethics committee of Hasanuddin University, Indonesia. Upon completion of the study, individual results were provided to each participant.

Data collection

The data collection carried out in this study is secondary data and primary data. Secondary data was obtained from literature studies or relevant institutions. Primary data is data obtained directly from respondents (samples), including:

LBP Complaints: The instrument used in measuring the level of LBP complaints is the Numerical Rating Scale (NRS)

Work posture: The instrument used in measuring work posture is Rapid Entire Body Assessment (REBA), with the determination of angle degrees using the protractor application.

Lighting: Measurement of local lighting intensity in the work environment. The instrument used in this study is using a lux meter lighting intensity measuring instrument

Questionnaire

Quality of Work: The questionnaire consists of 15 statements related to the quality of workers' work, including discipline, work effectiveness, optimal work results, and employee skills. This questionnaire was prepared by the researcher and several related lecturers, and has been tested for validity and reliability before being given to respondents.

Data analysis

Data management is carried out using excel software and statistical analysis using the statistical software IBM SPSS ver. 22. Meanwhile, multivariate analysis is used to determine the two-way influence of variables by

controlling other variables with the SMART-PLS application, and determine how much net influence the variable is using the F-Square value for direct influence, and the Z-Sobel value for indirect influence.

4. Results

Characteristics Respondent

Referring to table 1 based on the age distribution of 110 respondents, the majority age group is 20-35 years old as many as 81 people (73.6%). Meanwhile, the distribution based on the gender of workers is dominated by 70 male workers (63.6%). Based on the distribution of working periods, workers are dominated by workers who have worked for less than 5 years as many as 49 workers (44.5%). Meanwhile, in the distribution of working time, based on the results of research, all workers work more than 8 hours/day.

Table 1. Distribution of Respondent Characteristics Based on Age, Gender, Length of Service, and Length of Service of Workers

Characteristics Respondent	Frequency (n)	Percentage (%)
Age Group (Year)		
20 – 35	81	73.6
36 – 45	19	17.3
46 – 55	10	9.1
Sex		
Male	70	63.6
Female	40	36.4
Work Experience		
≤ 5 Years	49	44.5
5 <X<10 Years	24	21.8
≥ 10 Years	37	33.6
Daily Working Hours		
≥ 8 Hours/Day	110	100.0
Total	**110**	**100.0**

Source: Primary Data, 2024

Univariate Analysis

Table 2: Frequency Distribution of Research Variables

Variable	Frequency (n)	Percentage (%)
Work Posture		
Low Risk	30	27.3
Medium Risk	61	55.5
High Risk	19	17.3
Lighting Intensity		
High	1	0.9
Normal	34	30.9
Low	75	68.2
LBP Complaints		
Mild	18	16.4
Moderate	55	50.0
Severe	37	33.6
Work Quality		
Good	76	69.1
Poor	34	30.9

Source: Primary Data, 2024

Work posture

In the distribution table above, the frequency of work postures from 110 respondents there are 30 respondents (27.3%) with a low risk level of work posture, the risk level with the most workers are in the medium category, which is 61 respondents (55.5%) and a high risk level of 19 respondents (17.3%).

Lighting Intensity

The results of lighting measurements on workers' desks showed that there were 1 worker (0.9%) withhigh lighting intensity on their desks, and as many as 75 workers (68.2%) with low lighting intensity on their desks. Meanwhile, as many as 34 workers (30.9%) had normal lighting intensity at their desks.

LBP Complaints

The results of the measurement of LBP complaints in workers showed that 18 workers with mild LBP complaints (14.4%), while workers with severe LBP complaints were 37 workers (33.6%). Meanwhile, workers with moderate LBP complaints are 55 workers (50%).

Work Quality

The frequency distribution of work quality above shows that workers with good work quality are 76 workers (69.1%), and workers with poor work quality are 34 workers (30.9%).

Path Analysis

This study uses hypothesis testing with multivariate analysis, especially path analysis which aims to test the direct and indirect influence between independent and dependent variables. An illustration of path analysis can be seen in the following figure:

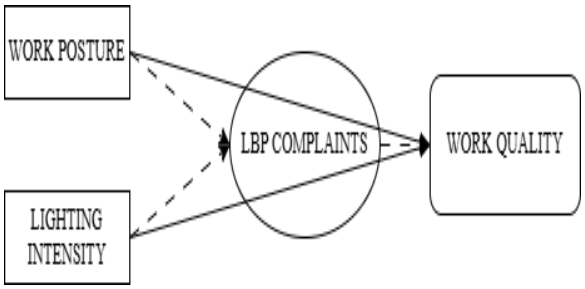

Figure 1: Path analysis

Hypothesis Testing of Direct Effects

Table 3 presents the results of the hypothesis testing for direct effects, analyzing the influence of working posture and lighting intensity on work quality. This analysis is based on the values of path coefficient, p-value, confidence interval, and f-square values. The f-square value indicates the direct effect of variables at the structural level, with criteria as follows: f-square 0.02 (low), 0.15 (moderate), and 0.35 (high) [22]. It can be observed that:

Table 3. Results of the analysis of the direct effect hypothesis test

Hypothesis	Path Coefficient	P-Values	95% Confidence Intervalof Path Coefficient		F-Square	Information
			Lower Limit	Upper Limit		
Work Posture → Work Quality	-0.477	0.000	-0.659	-0.318	0.396	High
Lighting Intensity → Work Quality	-0.105	0.058	-0.217	-0.001	0.029	Low

Source: Primary Data, 2024

*P-Value < 0.05: There is a significant influence

Based on the results of the analysis using the SMART-PLS application, there is a significant negative influence between work posture and work quality. It is proven by looking at the P-Value value (0.000 < 0.05) and the path coefficient value (-0.477). It has a significant negative effect, meaning that every change in work posture, whether there is an increase or decrease in posture value, it will have an inverse effect on the quality of work. In the 95% confidence interval the influence of work posture in influencing the quality of work in workers is between -0.659 to -0.318. The existence of work posture in influencing work quality has a high influence on the structural level (f-square = 0.396). Meanwhile, for the intensity of the analysis based on the results of the analysis, it was stated that there was no significant influence between the intensity of lighting on the quality of workers' work. Proven by looking at the P-Value (0.058 > 0.05).

Hypothesis Testing of Indirect Effects

Table 4 shows the results of the analysis of the hypothesis of indirect influence related to the influence of work posture and lighting intensity on work quality through low back pain complaints. Based on the value of path coefficient, p-value, confidence interval, and z-sobel value, it can be known that:

Table 4. Results of indirect effect hypothesis testing analysis

Hipotesis	Path Coefficient	P-values	95% Confident Interval of Path Coefficient		Z-Sobel	Information
			Lower Limit	Upper Limit		
Work Posture → LBP Complaints → Work Quality	-0.181	0.000	-0.269	-0.089	-3.644	Influential
Lighting Intensity → LBP Complaints → Work Quality	0.088	0.042	0.008	0.177	2.185	Influential

Source: Primary Data, 2024
*Z-Sobel>1,96 : There is a significant influence

Based on the results of the calculation above, the role of LBP complaints in mediating the indirect influence of work posture on work quality has a significant negative influence, as evidenced by the P-Value < 0.05 and the Z-Sobel value > 1.96. In the interval of 95% trust, if the best intervention is not immediately given to LBP complaints in workers, the role of this mediation will increase by -0.089.

As for the intensity of lighting, based on the results of the calculation above, the role of LBP complaints in mediating the indirect influence of lighting intensity on work quality has a significant influence, as evidenced by the P-Value of < 0.05 and the Z-Sobel value of > 1.96. In the interval of 95% trust, if the best intervention is not immediately given to LBP complaints in workers, the role of this mediation will increase by 0.177.

5. Discussion

Work posture

The results of this study show that there is a significant direct influence between work posture and work quality. With a path coefficient value of -0.418, it shows a negative influence between work posture and work quality. This indicates that any increase in the assessment of the work posture value will cause a decrease in the quality of work. Although the existence of work posture in influencing the quality of work is significant, it has a moderate influence at the structural level (f-square = 0.266).

The results of this study produced a very small p-value of 0.000 which indicates that the influence of work posture on work quality is very significant. The posture assessment in this study uses Rapid Entired Body Assessment, namely if the higher the risk assessment on the worker's work posture, then treatment must be given immediately. Therefore, the higher the risk assessment on the worker's work posture, the lower the quality of the worker's work. The results of this study are in line with the research that has been conducted by

Wang (2023) on "Quantifying the impacts of posture changes on office worker productivity: an exploratory study using effective computer interactions as a real-time indicator" The results of his research found that any changes in posture, be it changes in sitting or standing positions, which make workers feel comfortable in these positions, will increase their work productivity. Maintaining an unergonomic posture for a long time can result in a reduced ability to work optimally [23].

Researchers also want to prove the existence of mediators that can worsen the quality of work. Based on the results of the analysis, it was found that the indirect influence between work posture on work quality mediated by LBP complaints produced significant results. as evidenced by a P-Value of 0.000 < 0.05 and a Z-Sobel value of > 1.96. Negative value (Path Coefficient = -0.181) indicates that there is a reverse direction in influencing variables, the higher the LBP complaints and the assessment of work posture in workers, the more the quality of workers' work will decrease, and vice versa. In the 95% trust interval if the best intervention is not immediately given to LBP complaints in workers, the role of this mediation will increase by -0.089. In line with some previous research [24][25] stated that increased pain intensity and discomfort were negatively correlated with cognitive ability, particularly in terms of concentration, which in turn could result in a significant decrease in work output and work productivity efficiency. Unevenness due to complaints felt by workers is caused by holding a static posture and not being ergonomic for a long time during work [25].

Based on the results of this study, the researcher indicated that unergonomic work posture and increased LBP complaints were caused by a poor work environment, making it difficult to achieve good work quality. The more comfortable the work posture applied by the worker, the better the feeling of comfort in doing the work. Based on the results of the researcher's observations on the work environment, some of the desks and chairs used do not make workers comfortable because the desks do not have leg rests, some chairs do not have backrests, and some chairs cannot be adjusted to the height of the table. An ergonomically designed work environment can significantly improve the quality of workers' work [26]. Work equipment that is designed to be adjusted to the human body results in the risk of poor working posture can be minimized, because it makes workers always want to move to change positions that were previously static to be more dynamic [27][28].

An unergonomic sitting position equipped with a long sitting duration can worsen LBP complaints in workers so that the desire to work optimally will be reduced. The consequences that must be felt if this LBP complaint is not resolved immediately, especially for workers, is the increase in absenteeism at work and the loss of worker productivity due to pain [29].

Musculoskeletal disorders related to work activities, especially the manifestation of LBP in office workers, have strong associations with various ergonomic factors in the work environment. These factors include prolonged exposure to static and non-ideal postures, repetitive movement patterns, and workstation configurations that do not meet ergonomic principles. This condition can result in the accumulation of physical fatigue which has implications for a decrease in the productive capacity of workers Thus, the reduction of static behavior[30], implementation of ergonomic interventions in the workplace [28] and make good use of rest time [31] It is highly recommended as a necessary measure to reduce the discomfort/pain of LBP among office workers.

Lighting Intensity

Based on the results of the research that has been carried out, it was found that there was no significant influence between lighting intensity and the quality of workers' work. Proven by looking at the value of P-Value (0.139 > 0.05).

This research is in line with previous research [32] stated that creating a comfortable office environment fosters collaboration, concentration, and creativity. However, no effects were found on the dimensions of pleasure, enthusiasm, or dominance in emotional ranking by workers, nor was an effect found on worker performance. Although the results show no significant impact, the effects may not be acute but may manifest over time in the form of reduced stress or fewer sick leave days.

Based on the results of the analysis, it was stated that there was no significant influence between lighting and work quality. Based on the results of a short interview with several workers who were exposed to low lighting intensity, they felt uncomfortable with it but it did not hinder them in completing office work. Based on the results of measuring the lighting intensity using a lux meter, it was found that 3 rooms at the

research site with an average lighting intensity still did not meet the requirements with an average intensity of 146-172 lux. Meanwhile, only 1 room is eligible, namely a business support room with an average lighting intensity of 201 lux. If the lighting intensity is reviewed based on each worker's desk, the lowest lighting intensity is 38 lux and the highest intensity is 543 lux, such an incident must be followed up immediately.

The comfort of workers is greatly affected by the environment around the workplace, although this study states that it is not significant, but the intensity of lighting must still be considered. The better the work environment where workers work, the more the quality of their work will improve and thus the company's image will be more visible. Lighting is the most important factor of the physical work environment that can affect worker performance. So, lack of lighting in the workplace must be immediately overcome in order to improve the quality of workers' work [33]. Inadequate lighting is a trigger for discomfort that has an impact on decreased work performance. [34].

Researchers again want to prove that there are mediators who can worsen the quality of work. Based on the results of the indirect influence analysis, there is a role of low back pain complaints in mediating the indirect influence of lighting intensity on work quality and producing a significant influence, as evidenced by the P-Value (0 .042) < 0,05 and a Z-Sobel value > 1.96. In the interval of 95% trust if the best intervention is not immediately given to LBP complaints in workers, this mediation role will increase by 0.177.

This research is in line with previous research [21]stated that back and neck pain is mostly caused by poorly observed/unhealthy work environment conditions. This healthy building consists of several components including air quality, ventilation, lighting and all aspects of safety and security. Based on the results of the study, it was found that if the physical building/work environment deteriorates, the risk of back and neck pain also increases, and will also indirectly affect the quality of workers because of discomfort in the work environment [35].

The implementation of the lighting system must actually be in accordance with the standards of the requirements Occupational Safety and Health Administration (OHSA) is 250 Lux, and based on National Environmental Quality Standards (NEQS) is 300 Lux. Sufficient lighting quality can increase productivity by 10-50% and can reduce the error rate in work by 30-60%. Workers who work in office areas with standard light intensity (< 300 Lux) experience complaints of eye fatigue, 80% of complaints in the form of sleepy eyes and 63% of workers complain of pain in several parts such as the neck to back [36][37]

Occupational health and ergonomics are fundamental aspects in creating an optimal work environment and ensuring employee well-being. Improving the quality of the physical environment in the office environment is a very important aspect in creating an optimal working atmosphere, which aims to improve the psychosocial well-being and mental health of office workers. Various aspects of the physical environment that need to be considered include adequate lighting, good air circulation, ergonomic workspace layout, and the availability of supporting facilities such as rest rooms and clean sanitation areas. The implementation of a good work environment is expected to create a healthier, more productive work environment and support the overall welfare of employees [38].

6. Conclusion

This study provides evidence that poor work posture and poor lighting intensity can affect the quality of workers' work, especially when mediated by LBP complaints felt by office workers can worsen the quality of workers' work. The results showed that there was a significant direct effect between work posture and worker quality, but there was no direct effect between lighting intensity and work quality. But when mediated by LBP complaints, both work posture and lighting intensity have a significant influence on work quality.

For researchers in the future, it is better to use mixed methods (quantitative and qualitative) to deepen the information obtained. As well as adding other variables that can affect the quality of workers' work such as workload and work stress.

7. Acknowledgements

The researcher would like to thank the supervisors from the faculty of public health, department of occupational safety and health Hasanuddin University. To all participants who have participated in this study. As well as family and friends who have provided support during the research, so that this research can be carried out properly.

8. Conflict of Interest

There is no conflict of interest in this study

9. Funding

This study did not receive external funding

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