
IMPROVEMENT OF WORKING CONDITION THROUGH A PARTICIPATORY ERGONOMICS APPROACH DECREASE LOW BACK PAIN COMPLAINTS AND INCREASE THE PRODUCTIVITY OF TAILORS

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ARTICLE INFO

ABSTRACT

Received:
September, 26th
2021

Revised:
October, 16th
2021

Approved:
October, 18th
2021

Tailors work in a static position and bend over with a relatively long duration of work. Postural muscle load on tailors results in the risk of complaints of low back pain which affects the productivity of tailor. The aim is to know the effect of improving working conditions through a participatory ergonomics approach to reduce low back pain complaints and increase tailor productivity. The method uses of experimental research with treatment by subject design, involving 9 samples selected by simple random sampling. Period 1 sample is working with conventional working conditions. Period 2 samples worked with improving working conditions through a participatory ergonomics approach. Washing out period and adaptation are given between the two periods. Complaints of low back pain were measured by the Oswestry Disability Index, while productivity was based on a comparison between the number of stitches/day and the score for complaints of low back pain per working time. The results showed that improving working conditions through a participatory ergonomics approach had a significant effect ($p < 0.05$). There was a decreasing in low back pain by 11.87% from an average of 48.67 ± 1.73 to 42.89 ± 1.76 and an increasing in productivity of 42.10%

Fadma Putri, I Putu Gede Adiatmika, I Made Krisna Dinata. (2021). Improvement of Working Condition through a Participatory Ergonomics Approach Decrease Low Back Pain Complaints and Increase the Productivity of Tailors. Journal Eduvest. 1(10): 1152-1162

How to cite:

E-ISSN: 2775-3727

Published by: <https://greenpublisher.id/>

from an average of 0.038±0.004 to 0.054±0.005.

KEYWORDS

Improvement of working condition, low back pain complaints, participatory ergonomics, productivity



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INTRODUCTION

In this era, society's interest in fashion is increasing, and the order consumer needs the businessman to improve their development of the garment industry. The development of the garment industry in one area gives a positive effect especially for increasing the labor, therefore it will support the economy and have the benefit to the public as well as to create a job. One of the garment industries that was productive is Putra Karmila Garment in Gianyar City, Bali. The development of the industry needs to require the owner to increase the quality of the product within managing it wiser. The occupational health and safety of the tailor in the garment industry is the most important to improve quality of the product.

The result of an observational study and interview with tailors at Putra Karmila Garment were they could make 15-18 products a day, but there were any symptoms of health problem that make their time off and decreased of daily production targets. This condition affected to loss of their focus and it could be some mistake or problem with their production. The health problem mostly they have is low back pain.

Low Back Pain (LBP), the symptoms felt by tailors at the Garment caused by lack of mobility and lack of time management. The tailors always cut their time off to break because of their target of production and they wanted to increase the production as much as they can. Long work duration is another risk factor for their symptoms, they worked 8 hours a day with a 1-hour break for 6 days per week. That means they have seated static with slouch posture (not properly as the physiological body) for a long time.

While sitting slouch position, there were decreasing in the lordosis lumbar angle. This condition made weakness of abdominal muscles and tightness of the postural muscle, there is a stretch of posterior ligament and if the condition duration for a long time affected to intradiscal pressure increased and constantly make a pain (Tjahyuningtyas, 2019; Wirgunatha & Adiputra, 2019).

The duration of work is the other risk factor that would affect to work position. Human-machine interaction in a sewing process needs to highlight because this is will have an important impact and this condition based on the table and the chair. The tailors at Putra Karmila Garment Industry used chairs (plastic material) height 41 cm, length 27 cm and width 27 cm. It was not appropriate with their anthropometry and the addition they used the chair without backrest and hard seat cushion below made the tailors sew-in a poor posture that will be affected to their physiological body. According to (Nag, Vyas, & Nag, 2016), a hard seat cushion below the chair is affected to increase the postural muscle load for postural control. The increased load of muscle have a big impact on fatigue and make them uncomfortable.

LBP felt by tailors have been decreased by a poor and not ergonomically work environment and caused an increase of the stress due to work, loss of motivation, and high risk of a work accident that will affect low the productivities and their welfare. (Dewi et al., 2018). The cold temperature affected metabolism and it will make the body slower, lack of nutrition to soft tissue and make the necrosis of some muscle's tissues therefore the contractility is not efficient cause pain. (Tarwaka, 2014).

A recent study in Putra Karmila Garment Industry showed six from thirteen tailors have musculoskeletal problems, five of them have LBP and the other has upper extremity pain. RULA (Rapid Upper Limb Assessment) was used to examine the problem of working position and they have a score of 5 which means their work position needs some intervention and changes. This problem has been concluded with the changes of working position approached with participatory ergonomic.

Changes of work position approached by participatory ergonomic including changing their chair, suggest of break time and core stability exercise before they work. All of those conditions need agreement from the owner and agreement by the tailors to make a good plan and solution for the problem. Ergonomic participatory gives them responsibility for their body and their problem shake the good result at the end (Suhardi, Citrawati, & Astuti, 2021). Using the ideal chair will decrease the load of hip muscle and as well as on the postural muscles. Therefore, working position will relax and reduce LBP complaints (O’Keeffe, Dankaerts, O’Sullivan, O’Sullivan, & O’Sullivan, 2013). Duration of break 5 minutes at 10.00 and 15.00 WITA and gave them exercise core stability before work aims to reduce off time work accumulation and activate deep muscle for weight-bearing more efficient because the deep muscles and global muscle balance contracted and synergy. Global muscle is a fatigue type muscle, while the deep muscle activates and caused the global muscle to slowly contracted therefore nutrition and oxygen at tissue enough and reduced of LBP complaints (Stuber, Bruno, Sajko, & Hayden, 2014).

One research in 2013 showed changes of the chair with the backrest more effective than using the chair without backrest and that affected LBP complaints (O’Keeffe et al., 2013). A break from the work time has been reported to reduce stress caused by work and that will reduce the musculoskeletal problems, stay focus and increase productivity (Sutapa, Sudiarsa, & Susila, 2017). The other study about core stability exercise in 2017, assess pain intensity in LBP using Visual Analog Scale (VAS) in 414 patients, the program core stability exercise is more effective to reduce the intensity of LBP complaints and increase functional capacity than the general exercise (Coulombe, Games, Neil, & Eberman, 2017).

This study aims to improve the working condition through an ergonomic participatory approach include of changes in the chair, suggest to increase of break and intervention with core stability exercise to reduce of low back pain complaints, and increasing the productivity from the tailors at Putra Karmila Garment Industry.

RESEARCH METHOD

This study is an experimental study which treatment by subject design and along with time period. The research in Putra Karmila Garment Industry at Gianyar, Bali. The intervention period started 1st February 2021 – 1st May 2021. There are nine samples randomized using simple random sampling. LBP complaints were assessed by Questionnaire Oswestry Disability Index that have 10 items and productivity of them was measured by comparing their product (product or shirt in one day), LBP complaints score per unit time that means 8 hours per day. Hypothesis test used SPSS (version 16.0) with value of $\alpha = 0.05$.

RESULT AND DISCUSSION

Category of age the sample was middle age that was a productive category (Primadi, 2020). The mean of work experience is 12 years that means sample if the samples of this study have good experience and good skills. Besides affected skill, age and work experience will affect LBP complaints. At 35 years old, there will be a decrease in functional capacity and will continue along with the aging and increase the risk factor to have LBP complaints (Nooryana, Adiatmika, & Purnawati, 2020; Tarwaka, 2014). Workers that have work experiences more than 4 years will have result better than the other but have a high risk of 11.71 times for having LBP syndrome (Riningrum & Widowati, 2016; Shafira & Listiara, 2017). In addition, worker's body mass index (BMI) more than 27 kg/m² (obesity) had a higher risk to have musculoskeletal problems than they with BMI normal and underweight especially on the lower extremity, hip, and pelvic. Due to posture changes the lordosis of the lumbar caused weakness on abdomen muscles, therefore make changes on the center of gravity of the body to anteriorly. The effect of this condition is to increase the load of paravertebral muscles and if it happens in a long period will have mechanical stress on the low back (Kaçuri, Murtezani, Rrecaj, Martinaj, & Haxhiu, 2015).

Data of samples characteristic in Table 1 below.

Table 1. Data Characteristic Samples

Variabel	Mean±SD	Range
Age (Year)	48±2.55	42-50
Height (Cm)	158.78±2.73	154-163
Weight (Kg)	57.78±5.29	50-64
Body Mass Index (Kg/m ²)	22.96±1.99	19.8-25.2
Work Duration (Year)	12±3.49	8-18

Normality test using Shapiro-Wilk test to show the distribution of data ($\alpha=0.05$) variable including work environment, LBP complaints pre and post, and the productivity in Period 1 and Period 2. The result of the normality test is shown in Table 2 below.

Table 2. Normality Test Work Environment, Low Back Pain and Productivity

Variable	Period 1	Period 2
	P value	P value
Temperature (°C)	0.804	0.167
Humidity (%)	0.660	0.505
Light Intensity (lux)	0.242	0.204
Noise (dBA)	0.049	0.198
Wind velocity (m/s)	0.089	0.101
Low Back Pain complaints (Pre)	0.364	0.208
Low Back Pain complaints (Post)	0.132	0.338
Productivity	0.000	0.000

Normality test of all variables distribute normally ($p>0.05$), except the noise data in Period 1 and productivity data all period ($p<0.05$). Comparability test for the work environment aims to show there are differences of condition on this research time period, while the test for LBP complaints pre and post-study aims to observe the difference after given the intervention of exercise and test for productivity data aims to prove there are an improvement or a derivation mean of their production after the intervention period. Comparability tests shown below in Table 3.

Table 3 Comparability test on Work environment, Low Back Pain and Productivity

Variabel	Period 1	Period 2	P value
	Mean±SD	Mean±SD	
Temperature (°C)	28.58±0.74	29.00±0.45	0.185 ^a
Humidity (%)	72.33±1.40	72.66±1.63	0.102 ^a
Light Intensity (lux)	990.33±45.01	1003.58±9.21	0.481 ^a
Noise (dBA)	74.16±4.08	73.41±4.15	0.066 ^b
Wind Velocity (m/s)	0.15±0.111	0.15±0.006	0.750 ^a
Low Back Pain complaints (Pre)	34.67±2.00	34.89±2.02	0.782 ^a
Low Back Pain complaints (Post)	48.67±1.73	42.89±1.76	0.000 ^a
Productivity	0.037±0.004	0.054±0.005	0.007 ^b

a. Paired sample test

b. Wilcoxon's test

In Table 3 showed that the temperature and humidity environment at Putra Karmila Garment Industry has an ideal value for industrial activity. This condition was similar to a study by (Lady & Wiyanto, 2019) that stated temperature in the industry environment around 18°C-30°C and mean the humidity is 65%-95%. Lighting during work activities in garment used sunlight that flows within the main door and air ventilation. Transportation is one of noise for the industry because of the location of this industry in center of the city. But this condition is categorized normally based on the standard of occupational health and safety according to the Indonesian Ministry of Manpower's regulation Number 5 about Occupational health and safety in the work industry (Menaker, 2018). In addition, wind velocity has mean and standard deviation 0.15±0.111 on Period 1 and on Period 2 is 0.15±0.006 which means ideal condition. Pandiangan et al (2013) stated standard of wind velocity in industry work activity range from 0.15-0.25 m/s. Comparability test of work environment along period showed that was not significant statistically ($p>0.05$), and the conclusion is along period of this study has similar work environment characteristic.

Before Period 2 started, the washing out period did aims to move out of the residual effect, therefore preconditions along period have similar characteristics. The result of data in Table 3 showed there were no significant statistically on LBP complaints pre and post within $p > 0.05$.

Samples of this study chosen by inclusion and exclusion criteria, they are having not deformity on their body and not disabilities. LBP complaints in the sample are not caused by trauma history on the spine, but its consequence of poor work position (not ergonomic position). There was unaware of work position, unideal of facility, overtime work duration, and lack of mobility from them. Mobility has an important part of the human body and lack of mobility due to static position for a long time made isometric contraction of postural muscles and caused of mechanical stress at muscle tissue. It will increase the nociceptor stimulation on muscle tissue active, therefore there are increasing of tightness muscle and will have local ischemic effect to decrease of nutrition and oxygen absorption and the residual of metabolism (Sugijanto & Bimantoro, 2008).

Residual of metabolism called Lactate Acid that gives an imbalance of aerobic energy within decreasing of oxygen capacity in tissue muscle and start the muscle activity using Adenosine Triphosphates (ATP) and Creatine Phosphate (CP) in limited stock. Maintaining the activity of muscle tissue energy supply will change to a carbohydrate called glucose. Carbohydrates are converted to glucose, restore in the pancreas and

muscles as glycogen is energy storage. Anaerobic Glycogen releases energy from glycogen molecules resulted in ADP and Pi to ATP, this process will release energy for the body and have lactate acid as the end part of the process anaerobic glycolysis which pain physiological in muscle tissue (Hidayah, 2018).

In addition, static sitting position using the unideal chair (not required as anthropometry) for long period caused neck compensation to forward head posture. Forward head posture affected the postural body especially the cervical spine and neck muscles. Isometric contraction of M. Extensor Cervical due to overuse flexion movement. Imbalance muscles affected postural problems such as posterior pelvic tilt and increase thorax's kyphosis curve and reduce lordosis curve of the lumbar. If this condition persists, degeneration will increase twice and the risk of injury in ligament caused pain (Talati, Varadhranjulu, & Malwade, 2018). LBP complaints also affected the productivity of the tailor on the day (Nooryana et al., 2020).

Table 3 showed that LBP complaints post on the second period have significant difference statistically $p < 0.05$ and there is the reduction of mean pre and post 48.67 ± 1.73 to 42.89 ± 1.76 or 11.87%. Mean of productivity along period showed significant difference with the increase mean of data 0.016 or 42.10% (0.038 ± 0.004 to 0.054 ± 0.005).

This happened because of improving the work condition use the ergonomic participatory approach, that all elements in the garment industry participated to have one solution to improve their quality of life and as well as their business (Tappin, Vitalis, & Bentley, 2016). A study by Susihono et al (2017) stated that the ergonomic participatory approach has an impact on decrease the LBP complaints by 12.91%, meanwhile, the other study from Guimaraes et al (2015) improvement of work condition used ergonomic participatory improve productivity 46%. Otherwise, ergonomic intervention without an ergonomic participatory approach increasing their productivity by 15.38% (Tunas, 2005). The ergonomic participatory approach has a chance and one of a good program of work condition, all elements in the entire industry participated actively from analyzing to solved the problem. This condition will give the participant a responsibility to challenge themselves. Ergonomic participation could be reliable and continuing for the work situation more effective, efficient, safe and pleasant (Limerick, 2018). In addition, this approach aims to not change extremely (Suhardi et al., 2021; Tappin et al., 2016).

Work condition improvement through an ergonomic participatory approach in this study including changes in the chair, suggests break time, and intervention core stability exercise. Change the chair by anthropometry measurement aims tailor to have better sitting position and designed new chair along with their body. All data anthropometry can see in Table 4 below

Table 4. Anthropometry

Anthropometry	Mean±SD	Percentage		
		5	50	95
Popliteal Height (Cm)	45.78±1.20	43.81	45.78	47.76
Popliteal Length-Buttock (Cm)	48.11±1.05	46.38	48.11	49.84
Hip width (Cm)	47.22±1.72	44.40	47.22	50.04
Shoulder width (Cm)	45.56±1.24	42.74	45.56	48.38
Shoulder height (Cm)	58.00±1.22	55.99	58.00	60.01

Table 4 showed the design plan of chairs for samples and it based on their proportion, required the smallest body (percentage 5%) from the height of popliteal to the

buttock, while the largest body dimension used (percentage 95%) of hip width, height, and width of the shoulder. This design was recommended from a recent study by (Carolina, Wibowo, & Rizqi, 2020; Suryatman & Ramdani, 2019). Changes on the chair's backrest were expected to facilitate posture samples, but that was not. According to samples in this study, the backrest was uncomfortable to them. They prefer to have a position nearest to the table to have focus when sewed, but their new chair has a height more comfortable than their old chair. It has been measured with anthropometry and now it had a cushion to make it more comfortable. That was stated in a study by (Yuliana, Yamtana, & Husein, 2019) there were decreased of LBP complaints by 26.62% after changes on a chair be more ergonomic. In addition, Manuaba (2003) showed work station's improvement and changes the equipment based on anthropometry will make the work situation better and increasing productivity.

In this study, there was suggested to enhance the break time of samples at 10.00 WITA and 15.00 WITA and tell them to have a glass of water. This is a great solution for them due to their lack of mobility and static sitting position for a long time. That will be habitual to change their old habit and it had a benefit for their body too, the most important that new habitual will make the new ergonomic situation in work. De Carvalho (2015) stated walking is one of dynamic activity had rhythm, and their break time for walking to drink is a good choice and it will minimize the effect of static position and reduce postural load. Similar to a study by Ding et al (2020), active rest is changing position and had stretched for 5 minutes give a better muscle performance 30-45 minutes better than passive intervention. In addition, they showed there was minimized of some mistakes in employees while writing or typing after took break time for 3 minutes every 20 minutes (Nakphet, Chaikumarn, & Janwantanakul, 2014).

Otherwise, improvement work conditions through the ergonomic participatory approach combine with core stability exercise. It started before samples of this study worked. Dose of the exercise is 3 times a week for 6 weeks period study. Core stability exercise is given by researcher before they started activity at garment supposed by the owner. Woods et al (2017) in their study used to exercise in the morning before all their samples activity did aims to prepare and increase their muscle capacity for decreased risk of injury. The temperature of the body increased during exercise caused vasocontraction of vessels and hemoglobin binding oxygen more than usually, increased oxygen in blood plasm at muscle tissues. Exercise before activity in the morning had the benefit to boost the metabolism process and reduce of viscosity to have muscle contraction effective.

Core Stability exercise targeted core muscle including traverses abdominis, Multifidus, paraspinal muscle, abdominal muscle, diaphragm, and pelvic floor muscle aims to increase neuromuscular control, endurance, the strength of muscle central, and stability of spine (Kisner & Colby, 2016). Core stability exercise activated deep muscle to load and movement body more efficiently due to the integration and balance of deep muscle and global muscles (Berbudi, Adiputra, & Sugijanto, 2014). A recent study that used core stability exercise showed a decrease in LBP complaints and increased endurance of abdominal muscles and pelvic floor muscles in patients who had chronic low back pain (Ebrahimi, Blaouchi, Eslami, & Shahrokhi, 2014). Core stability exercises is more effective than conventional exercise to reduce symptoms of nonspecific low back pain (Akhtar, Karimi, & Gilani, 2017). Another research used Mc Kenzie Exercise that had similar principal and program with core stability exercise showed effectiveness in increase the productivity of Kendang Tambur Carver (Hamzah et al., 2018).

A better result from the study by Meisatama et al (2018) there was work condition improvement with the other characteristic of labor in a static position with reducing LBP complaints about 37%. Their characteristic sample on work duration ± 24 hours per week,

meanwhile in this study is 48 hours per week. This condition affected increased muscle contraction and ligament strength. Sitting position for 5-8 hours in a day had 8.6 times risk to have symptoms low back pain than if had sat in 1-4 hours in a day (Wijayanti, Oktafany, Ramadhian, Saftarina, & Cania, 2019) differences in this study will affect differences in LBP complaints.

Improvement of work conditions used the ergonomic participatory approach had many benefits on the economic side. According to Hendrick (2001), the economy had better when the ergonomic system was within. This statement agreed by some research on increasing of salary tailors, they gained 25% more. Period 1 in this study showed production samples reach 16 pieces shirt in a day and after the intervention increased to 20 pieces of the shirt in a day. This is accumulated to their fee of Rp5.000,00 per piece, which means in Period 1 they got Rp2.400.000,00, and that increased in Period 2 to Rp3.000.000,00. Changes on the chair are an effort from the Owner and it is worth for accumulation of their profit because of productivity. The chair's worth and the economic usage of it is 4 months, but it will depend on the material of chairs and suggested to use wooden material because of good material and sturdier than plastic material which fragile. In this study, work condition improvement used an ergonomic participatory approach with changes the chair, increasing break time and intervention core stability exercise showed the effectiveness in reducing the LBP complaints and increased of productivity tailors in the garment industry.

CONCLUSION

Based on result and discussion, improvement of work condition through ergonomic participatory approach significantly affected decrease the low back pain complaints ($p < 0.05$) and result decrease of 11.87% and there are 42.10% increase of their productivity. Besides having an effect on decrease complaints of low back pain and increase productivity. Improving working conditions through ergonomic participatory approach as well as increase tailor's income.

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