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Articles

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The Effectiveness of the Rule of Twenty Method in Reducing the Musculoskeletal Complaints among Educational Staffs

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Abstract

Educational staff at the University of Darussalam Gontor sit in front of the computer screen for quite a long time, causing musculoskeletal complaints. Applying the Rule of Twenty (RoT) method is one way to minimize the risk of musculoskeletal disorders. This study aimed to measure the effectiveness of the Rule of Twenty methods in reducing the risk level of complaints of musculoskeletal disorders for the educational staff of the University of Darussalam Gontor. This study was a pre-experimental research with one group pre-test – post-test design. The population in this study was the entire 68 educational staff of the University of Darussalam Gontor. Twenty-one (21) staff involved as a sample in this study and selected by purposive sampling method. The Nordic Body Map instrument was used to measure musculoskeletal complaint levels before and after the rule of twenty methods applied. Data were analyzed using the SPSS program version with autocorrelation test and paired t-test (CI: 95%). The measurement results of musculoskeletal disorders among 21 respondents before and after the application of RoT were the level of action 1 (low-risk level). The result of the autocorrelation measurement showed that the value of Durbin Watson (DW) was 1.958 and DW (1.968) > DU (1.8116), indicates that there was no autocorrelation between variables. The paired t-test showed the value of t=5.760 and p=0.0001, indicates a significant difference between musculoskeletal disorders before and after the application of the Rule of Twenty Method ($p<0.05$). Based on the result, this study found that the Rule of Twenty Method is effective in reducing the musculoskeletal disorders of the Educational Staffs, and potentially reduce 9.4% of musculoskeletal complaints among workers.

Keywords: educational staff, musculoskeletal disorders, the rule of twenty method

Effektivitas Metode Rule of Twenty Menurunkan Keluhan Muskuloskeletal pada Staf Kependidikan

Abstrak

Staf kependidikan di Universitas Darussalam Gontor bekerja di depan layar monitor komputer dengan posisi kerja duduk dalam waktu yang lama sehingga dapat menyebabkan timbulnya keluhan muskuloskeletal. Metode Rule of Twenty (RoT) merupakan salah satu cara yang dapat diterapkan untuk mengurangi tingkat risiko keluhan muskuloskeletal. Penelitian ini bertujuan untuk menganalisis keefektivan metode Rule of Twenty dalam mengurangi tingkat risiko keluhan muskuloskeletal staf kependidikan Universitas Darussalam Gontor. Penelitian ini merupakan penelitian pra eksperimen dengan rancangan one group pretest posttest. Populasi dalam penelitian ini yaitu staf kependidikan Universitas Darussalam Gontor berjumlah 68 orang. Teknik pengambilan sampel dengan purposive sampling dengan jumlah sampel yaitu 21 orang. Pengambilan data menggunakan kuesioner Nordic Body Map. Analisis data dilakukan menggunakan program SPSS versi 20.0 dengan uji autokorelasi

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dan uji t berpasangan. Hasil pengukuran keluhan muskuloskeletal pre dan post RoT yaitu tingkat aksi 1 (tingkat risiko rendah) sebanyak 21 orang. Hasil pengukuran uji autokorelasi diketahui bahwa nilai Durbin Watson (DW) sebesar 1,958 maka DW (1,968) > DU (1,8116) sehingga dinyatakan tidak ada autokorelasi antar variabel. Hasil uji beda yaitu nilai t=5,760 dan nilai p=0,0001 yang menunjukkan adanya perbedaan signifikan antara keluhan muskuloskeletal sebelum dan sesudah penerapan metode Rule of Twenty (p<0,05). Metode Rule of Twenty efektif mengurangi keluhan muskuloskeletal Staf Kependidikan, karena terjadi penurunan keluhan sebesar 9,4% antara sebelum dan sesudah penerapan RoT.

Kata kunci: metode rule of twenty, keluhan muskuloskeletal, staf kependidikan

INTRODUCTION

Occupational Health and Safety (OHS) is an important aspect of global development, especially in all industrial sectors. The implementation of OHS is one of the efforts to create occupational safety so it is good for health aspects and free from environmental pollution. The proper management of OHS will reduce occupational accidents, minimizing health disorders, and also increase work efficiency and productivity. One of the pillars of implementing OHS is to perform ergonomics in the workplace.

Ergonomics is the alignment of work with the workforce to provide efficiency and effectiveness in the workplace to increase the worker's comfort and productivity (Rahma, 2012). Poor application of ergonomics aspects in the workplace will potentially cause several health problems, especially Musculoskeletal Disorders (MSDs) that become the major effect of the ergonomics problem. Musculoskeletal Disorders (MSDs) are skeletal muscle disorders caused by a non-ergonomic work attitude that potentially accelerate the onset of fatigue and muscle pain among workers. The non-ergonomic activity which is done frequently for a long time (chronic) could impact permanent pain and becomes potential damage to the joints, muscles, tendons, ligaments, and other tissues. Working with such conditions continuously will result in disability and could causing job loss among workers (Aprico et al., 2019).

Adhyatma reported that the prevalence of Musculoskeletal Disorders (MSDs) based on symptomatic diagnosis reached 24.7% in Indonesia (Aprico et al., 2019. The results showed that the MSDs problem is one of the most occupational disease cases in various countries. In America, there are about 6 million cases per year or 300-400 of average cases per 1000 people in the workforce. Based on research on 9,482 workers in 12 districts or cities in Indonesia, the disorders experienced by most workers are MSDs (16%), cardiovascular (8%), nervous disorders (5%), respiratory disorders (3%), and ENT disorders (Prawira, et al., 2017).

One of the strategies to reduce musculoskeletal complaints initiated by Rosenfield and the American Optometric Association (AOA) is the Rule of Twenty methods (Aprico, et al., 2019). This method is one of the methods used to reduce the risk level of musculoskeletal complaints that are often experienced by workers. This method does not only focus on musculoskeletal complaints but also considers the disorders that effect eye health among workers (Rosenfield, 2013).

The visual symptoms experienced by computer users shows the most obvious expression of deficiencies in workplace ergonomics and the visual character of workers. Several studies show that visual symptoms occur in 75% to 90% of the people who work with computers. Research on the effectiveness of the Ergonomic Rule of Twenty methods in reducing the risk of MSDs among educational staff at the University of Darussalam Gontor can be a preliminary study to reduce the risk of MSDs in the workplace.

Based on research by Tofan, et al. (2016), there were musculoskeletal complaints among educational staff at the University of Darussalam Gontor. Most of the educational staff (12

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people) had low-grade of musculoskeletal complaints. The educational staff at the University of Darussalam Gontor work in front of a computer with a various sitting posture that leads to musculoskeletal complaints if it is done frequently for long periods. This study aimed to analyze musculoskeletal complaints before and after the application of the Rule of Twenty and analyze the effectiveness of implementing the Rule of Twenty methods to reduce musculoskeletal complaints among educational staff at the University of Darussalam Gontor (UNIDA Gontor).

METHOD

This research is a pre-experimental study with *one group pre-test post-test* design. The research was conducted at the University of Darussalam Gontor (UNIDA Gontor), Ponorogo. The population in this study was 68 educational staff at the UNIDA Gontor. The sampling technique used was purposive sampling and involved 21 respondents as a sample. Research variables, instruments, and data collection techniques are shown in Table 1.

Table 1
Research Instrument Variables and Data Collection Techniques

Variable	Operational Definition	Instrument	Technique	Data Scale
Musculoskeletal complaints	Complaints in the skeletal muscle ranged from mild to very fatal complaints felt by the patient	NBM Questionnaire	Observation and interview	Nominal
Rule of Twenty (ROT) Method	A method to reduce eye health and musculoskeletal complaints	Android application	Instruction every 20 minutes and 2 hours	Nominal
Age	The lifespan of the educational staff in years from birth to the present	Questionnaire	Interview	Ratio
Years of service	Years of service of the educational staff from the start of working at UNIDA Gontor until the research was carried out	Questionnaire	Interview	Ratio
Sitting Duration	Sitting duration of educational staff when working from the beginning to the end of work per day	Questionnaire	Interview	Ratio
Screen time	The duration of staring at the computer screen from the beginning to the end of the work per day	Questionnaire	Interview	Ratio

Data were analyzed using SPSS program version 20.0 with autocorrelation test and paired t-test (dependent t-test).

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RESULTS AND DISCUSSION

The univariate analysis in this study described the characteristics of the respondents (educational staff) such as age, gender, years of service, sitting duration, and screen time. The results of the questionnaires from 21 educational staff at the University of Darussalam Gontor is shown in Table 2.

Table 2
Distribution of the Educational Staff Characteristics

Variable	Amount (n)	Percentage (%)
Age (year)		
<30	17	81
>30	4	19
Total	21	100
Gender		
Male	7	33.3
Female	14	66.7
Total	21	100
Years of Service (year)		
1–3	16	76.2
>3	5	23.8
Total	100	100
Sitting duration (hour)		
<6	5	23.8
>6	16	76.2
Total	21	100
Screen time (hour)		
<6	9	42.9
>6	12	57.1
Total	21	100

Based on Table 2 that described the distribution of educational staff characteristics, it is known that: the age of educational staff was mostly <30 years old (81%) with the average age was 27 years old. The youngest staff was 24 years old and the oldest was 39 years old. People aged less than 30 years have a productive age where someone is still well-energized and able to do work optimally. Most of the educational staff were female (66.7%). This is because the educational staff of the central campus of UNIDA Gontor was predominantly female. The most working period of educational staff was 1 to 3 years (76.2%). The average years of service for educational staff were 2 years with the shortest work period was 6 months and the longest was 5 years. This is because UNIDA Gontor is a new university that requires a lot of educational staff to support the development process. The longest duration of sitting activity in the office in a day was 72.8%. It is caused by many jobs that required them to sit for a long time in front of computer screens. The most screen time-frequency was > 6 hours per day (57.1%) because the main task of the staff is to work in front of a computer screen for 8 working hours in a day.

The measurement of pre-post of musculoskeletal complaints experienced and required action level 1 both before and after RoT intervention by educational staff at UNIDA Gontor is shown in Table 3.

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Table 3
Distribution of Musculoskeletal Complaints Measurement Results (Pre and Post RoT)

Musculoskeletal Complaints						
Action Level	Individual Total Score	Risk level	Respondent amount			
			pre	(%)	post	(%)
1	28-49	Low	21	100	21	100
2	50-70	Moderate	0	0	0	0
3	71-91	High	0	0	0	0
4	92-112	Very high	0	0	0	0
Total			21	100	21	100

The measurement of musculoskeletal complaints based on the subjective body part complaint showed in Table 4.

Table 4
Results of Pre and Post RoT Musculoskeletal Complaints Measurement Percentage of the Educational Staff

No	Complaints	Respondent amount	Pre RoT Prevalence		Post RoT Prevalence	
			Pre	(%)	Post	(%)
1	Upper neck	21	10	47.6	6	28.6
2	Nape	21	10	47.6	4	19
3	Left shoulder	21	5	23.8	2	9.5
4	Right shoulder	21	12	57.1	4	19
5	Left upper arm	21	1	4.8	0	0
6	Back	21	11	52.4	5	23.8
7	Right upper arm	21	6	28.6	2	9.5
8	Waist	21	14	66.7	12	57.1
9	Hip	21	9	42.9	7	33.3
10	Buttocks	21	4	19	0	0
11	Left elbow	21	5	23.8	0	0
12	Right elbow	21	6	28.6	1	4.8
13	Left forearm	21	4	19	0	0
14	Right forearm	21	8	38.1	3	14.3
15	Left wrist	21	3	14.3	2	9.5
16	Right wrist	21	9	42.9	5	23.8
17	Left hand	21	2	9.5	2	9.5
18	Right hand	21	5	23.8	2	9.5
19	Left thigh	21	3	14.3	1	4.8
20	Right thigh	21	3	14.3	0	0
21	Left knee	21	6	28.6	1	4.8
22	Right knee	21	5	23.8	3	14.3
23	Left calf	21	6	28.6	4	19
24	Right calf	21	7	33.3	6	28.6
25	Left ankle	21	2	9.5	1	4.8
26	Right ankle	21	4	19	0	0

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27	Left Foot	21	2	9.5	1	4.8
28	Right foot	21	2	9.5	1	4.8
Maximum value			14	66,7	12	57,1
Minimum value			1	4,8	0	0
Average			5,85	19	2,7	6,3
Modus			5	22,8	0	0

Subjective body part complaints were measured before (pre) and after (post) RoT by NBM instrument. The respondents were asked to describe the musculoskeletal pain they felt in each 28 part of the body as shown in Table 4. It was a subjective measurement in NBM so the quality of assessment highly depends on the situation and conditions being experienced by the workforce as well as the expertise and experience of the observer (Tarwaka, 2010).

Based on Table 4, the average score of musculoskeletal complaints all over the body part before RoT is 5.85 (19%) and decreased to 2.7 (6,3) after RoT intervention. Besides the average, there was also a mode value indicates how often the score is appeared in the measurement (the value was 5). Next, the mode value in the post RoT assessment column was 0. Based on Table 4, there are 5 body parts that experience the highest complaints on the pre-RoT assessment: waist (14 people/66.7%), right shoulder (12 people/57.1%), back (11 people/52.4%), upper neck (10 people/47.6%), and nape (10 people/47.6%).

To ensure the significant effect of RoT intervention in musculoskeletal complaints reduction, repeated measurement is required. In this section, respondents were asked to do RoT again and the musculoskeletal complaint was re-measured. The autocorrelation and paired t-tests are required to find out other variables that potentially affect the musculoskeletal complaints among the educational staff. Furthermore, the comparison of musculoskeletal complaints between before and after RoT treatment is tested using paired t-test to find out if there's a significant difference.

The autocorrelation test is a statistical test to determine the correlation between confounding variables and dependent variables. Based on the results of the data analysis involving variables such as age, years of service, sitting duration, and screen time, there was no autocorrelation between these variables and the results of the SPSS test. The details can be seen in Table 5.

Table 5
Confounding Autocorrelation Test Results

Model	R-value	R^2 Value	Durbin Watson Value
1	0,886	0,785	1,958

Based on Table 5, it is known that the Durbin Watson score (1.958) is higher compared to the Durbin Watson Table with n=21 and k=4 (DW=1.86), (DW>DU). Based on this result, it can be concluded that there was no autocorrelation between variables. The results of data processing with SPSS version 20.0 using the paired t-test can be seen in Table 6.

Based on Table 6, it can be seen that the value of t=5.760 and the value of p=0.0001. This showed a significant difference between musculoskeletal complaints before and after the application of the Rule of Twenty Method ($p<0.05$).

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The job demands of educational staff require them to sit in front of a computer screen for a long time every day. This condition potentially caused complaints at various parts of the body due to the static and monotone activity. Based on the result, there were 5 parts of the body experienced the highest musculoskeletal complaint and the felt by the most of respondents (educational staff): waist (15 people/66.7%), right shoulder (12 people/57.1%), back (11 people/52.4 %), and neck (10 people/47.6%). Rahma (2012) stated that body parts or body segments measured in work posture (neck, body, arms, wrists, and feet) have a very high percentage of musculoskeletal complaints (±99.43%) compared to other body segments whose percentages are below 90%.

Table 6
Difference Test Results between Musculoskeletal Complaints, Before and After Application of the Rule of Twenty Method

	n	t Value	p-Value
Musculoskeletal Complaints *pre* and *post* RoT	21	5,760	0,0001

Many previous studies had examined the relationship between variables that can affect the level of musculoskeletal complaints. This study had conducted the same topic on the respondents (education staff). These results were used to decrease the risk level of musculoskeletal complaints among the respondents by applying RoT intervention.

The results of the initial measurement of the risk level of musculoskeletal complaints compared to the results of the final measurement (posttest) or after being given RoT treatment among educational staff showed that there was a significant decrease in musculoskeletal complaints by 9.4% ($p<0.05$). Based on the MSDs category, it is known that the musculoskeletal complaints among staffs were low. This result occurs because the work activity of the educational staff is static. The same thing was also reported by other researchers. Rahma (2012) in her research on the relationship between work posture of crane operators and complaints of musculoskeletal disorders at the Steel Slab Factory 1 Krakatau Steel Ltd. Cilegon, Banten found that musculoskeletal complaints among crane operator workers showed most equally score between low and moderate level complaints.

CONCLUSION

Based on the results and discussion, it can be concluded that there is no autocorrelation between the factors of age, years of service, sitting duration, and screen time. The Rule of Twenty methods is effectively reducing musculoskeletal complaints among educational staff. There was a decrease in musculoskeletal complaints by 9.4% after RoT implementation.

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Improvement Mechanism of Work Oriented by Ergonomic Increase Health Quality and Productivity

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Abstract

The aim of this research is to reduce musculoskeletal disorders, work stress, and increase productivity of workers *piranti upakara* makers by work mechanism improvement using ergonomic work oriented. Through a quasi-experimental using treatment by subject design and randomized pre and post-test group design assessed: (a) improvement mechanism of work oriented by ergonomic reducing musculoskeletal disorders, was recorded by Nordic Body Map Questionnaire; (b) improvement mechanism of work oriented by ergonomic reducing work stress, was recorded by Work Stress Questionnaire; (c) improvement mechanism of work oriented by ergonomic increase the productivity of workers, assessed by output (product produced) divided by input (pulse) multiplied by time. Data collection was done at 10 (ten) days before and after working, in Period I and Period II on 14 samples. Data obtained were analyzed using paired t-test at a significance level of 5%. The result showed that improvement mechanism of work oriented by ergonomic, reducing musculoskeletal disorders of workers to 44.45%, reducing the work stress of workers to 29.90%, and increasing productivity of workers to 53.93%. It can be concluded that improvement mechanism of work oriented by ergonomic reducing musculoskeletal disorders, work stress, and improving productivity of workers *piranti upakara* makers.

Keywords: ergonomic, *piranti upakara*, ergonomic work mechanism

Perbaikan Mekanisme Kerja Berorientasi Ergonomi Meningkatkan Kualitas Kesehatan dan Produktivitas

Abstrak

Penelitian ini bertujuan untuk membuktikan dan mengimplementasikan perbaikan mekanisme kerja berorientasi ergonomi mengurangi keluhan muskuloskeletal dan stres kerja serta meningkatkan produktivitas pekerja pembuat piranti upakara. Penelitian ini berupa eksperimental semu (quasi experimental) dengan rancangan sama subjek dan pola randomized pre and posttest group design, dilakukan penilaian berupa: (a) perbaikan mekanisme kerja berorientasi ergonomi mengurangi keluhan muskuloskeletal pekerja pembuat piranti upakara didata dengan kuesioner Nordic Body Map; (b) perbaikan mekanisme kerja berorientasi ergonomi mengurangi stres kerja pekerja pembuat piranti upakara didata dengan Kuesioner Stres Akibat Kerja; (c) perbaikan mekanisme kerja berorientasi ergonomi meningkatkan produktivitas pekerja pembuat piranti upakara dinilai berdasarkan output

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(produk yang dihasilkan) dibagi dengan input (denyut nadi) yang dikalikan dengan time (waktu). Pendataan dilakukan sebelum dan sesudah kerja pada Periode I dan Periode II terhadap 14 sampel selama 10 (sepuluh) hari. Data yang diperoleh dianalisis dengan paired t-test pada taraf signifikansi 5%. Hasil penelitian menunjukkan bahwa perbaikan mekanisme kerja berorientasi ergonomi mengurangi keluhan muskuloskeletal pekerja pembuat piranti upakara sebesar 44,45%, mengurangi stres kerja pekerja pembuat piranti upakara sebesar 29,90%, dan meningkatkan produktivitas pekerja pembuat piranti upakara sebesar 53,93%. Dengan demikian dapat disimpulkan bahwa perbaikan mekanisme kerja berorientasi ergonomi dapat mengurangi keluhan muskuloskeletal dan stres kerja serta meningkatkan produktivitas pekerja pembuat piranti upakara.

Kata kunci: mekanisme kerja ergonomi, ergonomi, piranti upakara

INTRODUCTION

Home industries have an important role in the Indonesian economy such as to reduce unemployment. Home industries can develop because they still use a local resource such as local human resources, local raw materials, and local equipment. Home industries of *piranti upakara* makers have progress rapidly especially in Bali. Balinese women spend more time in their work until they decide to buy ceremonial equipment. The working mechanism of *piranti upakara* makers in Peliatan Village involves physical activities. The working mechanism has the potential to cause musculoskeletal disorder, fatigue, and the feasibility of work accidents.

Work mechanism is a combination of several work processes involving several workers in the work cycle (Sutajaya, 2018). Conducive work mechanism will improve quality products and the quality of a worker's health (Manuaba, 2003). Conducive work mechanism refers to ergonomic principles (Manuaba, 2003; Hsieh, et al., 2013; Agyemang, et al., 2014). Work system of p*iranti upakara* makers without ergonomic principles. Ergonomic problems of workers *piranti upakara* makers such as (a) complex of workload demands due to the large orders of ceremonial equipment; (b) workstations incompatible with anthropometry causes non-physiological position and posture of work; (c) muscle overuse due to non-physiological position and posture of work; and (d) static motion is dominated in the work. These problems resulted in: (a) work stress due to complex workload and working intense conditions; (b) uncomfortable working; (c) fatigue occurs more quickly; (d) more mistake in work; (e) increase workload; (f) energy required for the same cooperative effort is higher; (g) cause musculoskeletal disorders especially in the musculoskeletal system; and (h) reduce productivity (Sutajaya, 2018).

Improvement condition of work should use systemic, holistic, interdisciplinary, and participatory (SHIP) approach, so that workplaces and work processes are designed to be technically suitable for workers and physiology does not result in too heavy a workload. These conditions can avoid the emergence of work stress, do not cause musculoskeletal disorders, decrease fatigue of work, and increase job satisfaction (Bahari, et al., 2013; Tanjung, 2015; Mokaya, et al., 2013). The working mechanism of workers *piranti upakara* makers consist of three parts: (a) the process of making *jaja upakara*; (b) the process of making *jejahitan*; and (c) the process of *metanding piranti upakara*. The process of making *jaja upakara* consists of milling the flour, shaping, and frying then ready to be assembled during the *metanding* process. The process of making *jejahitan* consists of cutting the leaves, assembling, and ready to assemble during the *metanding* process. The *metanding* process is a combination of several materials such as flowers, *jejahitan*, and *jaja upakara* to form a *piranti upakara* (offerings). The work process is carried out sequentially to produce the *piranti upakara*.

The working mechanism of *piranti upakara* makers is usually carried out every day in a monotonous condition. The complex workload due to the large order of *piranti upakara* also

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causes fatigue to *piranti upakara* makers. Workers generally do one job only, so it becomes monotonous. Static motions are often performed in the process of making *jaja upakara*, making *jejahitan*, and *metanding piranti upakara*. The static motion means a sitting or standing position with more than two or three hours of duration. The process of making *jaja upakara* and making *jejahitan* usually takes more than two hours. Meanwhile, the process of *metanding piranti upakara* usually takes more than three hours. If it is not corrected immediately, various complaints will arise such as musculoskeletal disorders, increased fatigue, workload, and work stress due to monotonous work.

Based on the results of a preliminary study to 12 workers *piranti upakara* makers in Peliatan Village, Ubud, Gianyar, Bali there were musculoskeletal disorders of workers increase to 39.72%, the work stress of workers increases to 46.66%, and the workload of workers increase to 16.49%. The workload of workers who made *jaja upakara* increase to 16.09%, the workload of workers who made *jejahitan* increase to 15.94%, and the workload of workers who made *piranti upakara* increase to 17.41%. Work organization (remuneration system, work methods, and work processes), work instrument (work tools, work stations, personal protective equipment), characteristics of worker (age, male gender, weight, height, health, anthropometry), and environmental factors (temperature, relative humidity, lighting intensity, wind speed, noise) also affect musculoskeletal disorders of workers and stress due to the work of *piranti upakara* makers.

Apart from monotonous work, workers also work in the wrong position and posture. Workers sit with their waist twisted and their legs hanging for more than two hours on the house floor's edge. This work methods causes non-physiological posture such as (1) the muscles that work statically due to unchanged (static) work posture for more than two hours; (2) forward inclination of the neck and head due to the low work station and not using the worktable; (3) bent posture due to the low work station and not using the worktable; (4) hanging legs due to the seat too high (48.00 cm), so that it is not in accordance with anthropometry of the popliteal height in 5 percentile (43.00 cm); (5) twisting posture effect in differences of the load on both sides on the spine. Related to this research, Sutajaya (2018) explains that the wrong posture in work methods such as static posture, repeated circular, and bowing motions can affect musculoskeletal disorders. Monotonous work with a demanding workload such as the large order of *piranti upakara* can trigger stress on workers.

To improve the working mechanism of *piranti upakara* makers which does not refer to ergonomic principles, necessary to (a) repair work stations to improve non-physiological work posture; (b) providing seats for *majejahitan* activities and making *jaja upakara* activities; (c) changing the work system from static to dynamic. That improve it should be done so that workers are always safe, comfortable, healthy, and free from the stressful condition. So that workers can increase productivity. Ergonomic improvement should be considered with local wisdom. Ergonomic principles that prioritize comfort, health, safety, efficiency, effectiveness, and productivity are closely related to the Tri Hita Karana. In addition, the concept of *desa kala patra* also to be a reference to improving working conditions in home industries.

The applied of Tri Hita Karana in this research are (1) praying before working as a being devotion to God; (2) discarding unused ceremony facilities in their place as a being to preserving the environment; (3) keep the relationships between workers in the workplace as a being of love with others. This research also refers to *desa* (place), *kala* (time), *patra* (habit) such as (1) workers must use cloth (*kamen*) when making *piranti upakara*; (2) workers come from the local village to avoid differences perceptions how to made of *piranti upakara*. This concept is useful for the success of an ergonomic intervention in an area (Sutajaya & Ristiati, 2011).

Problem formulation can be made based on the background are (a) does improvement mechanism of work oriented by ergonomic reducing musculoskeletal disorder of *piranti*

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upakara makers? (b) does improvement mechanism of work oriented by ergonomic reducing work stress of *piranti upakara* makers? (c) does improvement mechanism of work oriented by ergonomic increase the productivity of *piranti upakara* makers?

METHOD

This research was inspected by quasi-experimental with the same subject design (treatment by subject design) and randomized pre and posttest group design. The subjects in this research are workers who made *piranti upakara* in Peliatan Village, Ubud District, Gianyar Regency, Bali Province. The target population in this study is all workers who made *piranti upakara* in Peliatan Village. The accessible population is all workers who made *piranti upakara* spread over in 10 banjar that fulfil the inclusion criteria. The sample in this study is all workers *piranti upakara* makers who selected in determining the number of samples and were involved in this study. The number of samples involved in this study is 14 people of workers *piranti upakara* in randomly selected stratified (multistage random sampling).

The independent variable in this study is the improvement mechanism of work oriented by ergonomic. The improvement mechanism of work such as (a) repair of work stations for standing position by adding the height of the table (19 cm) and adding the height of the table (18 cm) for sitting position; (b) providing seats for *majejahitan* activities and making *jaja upakara* activities; (c) changing a static work system to dynamic system with job rotation. Repairing work station for standing, according to the height of the table for light work must be reduced by 5 cm from elbow height in the 5th percentile standing position. Therefore, the height measurement of *metanding* table (standing position) was added from 69 cm to 88 cm. For *majejahitan* and making *jaja upakara* activities (sitting position) were added from 48 cm to 66 cm. It was obtained from the addition of elbow height on sitting position in the 5th percentile (21 cm) with seat height (45 cm).

Dependent variables in this study are musculoskeletal disorders was recorded by Nordic Body Map Questionnaire, work stress was recorded by the Work Stress Questionnaire, and productivity assessed based on output (product produce) divided by input (pulse) multiplied by time. Control variables are (a) subject characteristics (age, weight, height, sex, health status, and work experience); (b) work organization (organization structure, remuneration system, and nutrition); (c) instruments (work tools and personal protective equipment); (d) environmental conditions at work (temperature, relative humidity, lighting intensity, wind speed, and noise). Data collection is carried out before and after work in Period I (without intervention) and Period II (with intervention) for ten days. Data collection in Period I is carried out for 3 three days then followed by one day of washing out period, three days of adaptation, and data collection in Period II is also carried out for 3 three days.

The data obtained were analyzed by (a) characteristics subject data were analyzed descriptively by calculating mean and standard deviation; (b) environmental conditions data were analyzed descriptively by calculating mean and standard deviations then followed by paired t-test to determine the comparability of environmental conditions in Period I and Period II; (c) the worker's anthropometric data were analyzed using the 5th and 50th percentile tests; (d) the data musculoskeletal disorders, work stress, and productivity were analyzed by paired t-test at a significance level of 5%.

RESULTS AND DISCUSSION

The result of environmental conditions data analysis between Period I and Period II showed in Table 1.

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Table 1
The Result of Environmental Conditions Data Analysis

Variable	Period I		Period II		t	p
	Mean	SD	Mean	SD		
Dry Temperature (°C)	30.07	1.308	30.26	1.483	1.053	0.323
Wet Temperature (°C)	27.22	1.787	27.46	1.272	0.852	0.419
Relative Humidity (%)	74.04	7.402	75.79	8.079	0.856	0.417
Light Intensity (lux)	580.78	101.092	564.11	86.693	1.200	0.265
Wind Speed (m/s)	0.17	0.063	0.17	0.061	0.503	0.629
Noise dB(A)	60.16	3.091	60.37	3.132	0.433	0.677

Dry temperature, wet temperature, relative humidity, light intensity, wind speed, and noise were measured in this research. The environmental conditions between Period I and Period II are comparable ($p>0.05$). Environmental conditions in this research have the same effect on determining changes in worker's health conditions. Musculoskeletal disorders, work stress, and productivity changes are fully influenced by the improvement mechanism of work oriented by ergonomic.

Result of the hypothesis on musculoskeletal disorders between before and after working in Period I and Period II showed in Table 2.

Table 2
Result of the Hypothesis on Musculoskeletal Disorders

Variable	Period I		Period II		t	p
	Mean	SD	Mean	SD		
Musculoskeletal Disorders (Before Working)	29.52	0.884	30.00	1.922	0.990	0.340
Musculoskeletal Disorders (After Working)	58.58	2.829	32.54	1.461	30.593	0.000 1

Based on Table 2 it was revealed that musculoskeletal disorders of workers *piranti upakara* makers have decreased between Period I and Period II by 44.45%. That showed the mechanism of work oriented by ergonomic can improve the health of workers. It showed on musculoskeletal disorders of the workers *piranti upakara* makers were reduced. This research can be used as a reference to explain that the mechanism of work without ergonomic design must be improved with ergonomic design. It can be spared of musculoskeletal disorders as an effect of improper technology transfer. The mechanism of work without ergonomic design result in (1) statically motion due to working posture has not changed for more than two hours; (2) forward inclination of the neck-head and bending posture due to the low work station and not using the worktable; (3) hanging legs due to the seat too high; and (4) asymmetrical posture (twisting).

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The workers with activities to make *jejahitan* and *jaja upakara* in a sitting position for more than two hours. It showed in the mechanism of work without an ergonomic design. The work tools and materials will be placed by a worker near their workplaces when the activity started. Worker's health is also compounded by non-physiological position and posture of work. The activities of making *jejahitan* and *jaja upakara* are carried out in a bent sitting position due to not using the worktable. The worker's hips also twisted due to sitting on the edge of the floor. The same thing happens to *metanding* activities. Workers are in a standing position for more than three hours. *Metanding* activities carried out in a standing position with bent work posture. It happens because the worktable is too low. It can increase the risk of musculoskeletal disorders.

Grandjean (2007) explains that forced posture for too long can increase the workload on the musculoskeletal system. So that it has a negative impact on health. A forced posture will attack the muscle so that causing stretching and pressure on the tendons, nerves, and blood vessels. It can cause inhibiting blood circulation to the active muscles and increasing the accumulation of lactic acid and body temperature. This problem can cause muscle fatigue which is felt as muscle pain. Biomechanically, the further apart of the limbs from the fulcrum it can cause the greater of force produced. So that the muscles contract more strongly to produce more force. If the muscles contract more strongly, the muscle tends will lose a lot of energy to contracting again.

This research was in accordance with other researchers such as (a) Purnamawati (2013) explained that ergonomic interventions in the process of making *banten ngaben pranawa* reduce musculoskeletal disorders to 37.98%; (b) Dinata, et al. (2013) revealed that the alternating sitting-standing posture reduced musculoskeletal disorders of ironing women worker in household to 13.15%; (c) Putri & Griadhi (2015) explained that repairing the workstation for wood carving reduced electrical activity of the trapezius muscle to 17.44% and the electrical activity of the erector spinae muscles to 12.28%; (d) Mindhayani & Purnomo (2016) explained that improving the work system with ergonomic approach reduced musculoskeletal disorders to 10.91%; (e) Rosanti & Wulandari (2016) revealed that repairing work chairs for tailors reduced musculoskeletal disorders to 36.6%; (f) Ferdyastari, et al. (2018) explain that workstation improvement and stretching for employee in the silver industry reduced musculoskeletal disorders to 21.61%; (g) Dhari (2019) explained that providing active recovery for *pembatik cap* reduced musculoskeletal disorders to 31.6%.

Result of the hypothesis on work stress between before and after work in Period I and Period II showed in Table 3.

Table 3
Result of the Hypothesis on Work Stress

Variable	Period I		Period II		t	p
	Mean	SD	Mean	SD		
Work Stress (Before Working)	41.24	1.610	41.68	1.231	0.777	0.451
Work Stress (After Working)	86.28	2.737	60.48	1.260	36.144	0.0001

In this research, the mechanism of work oriented by ergonomic was improved. So that workers are always safe, healthy, comfortable, free from work stress, and increase productivity. The mechanism of work oriented by ergonomic was able to reduce work stress by 29.90% between

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Period I and Period II. This shows that the mechanism of work oriented by ergonomic can improve worker's health. It showed on work stress of the workers *piranti upakara* makers are reducing.

The monotonous process of making *jaja upakara*, making *jejahitan*, and *metanding* happened for more than three hours. The workers have to do these activities every day without getting enough rest. It is due to the large orders of ceremonial equipment. If it is not corrected immediately, various complaints will arise such as musculoskeletal disorders, increased fatigue, workload, and psychological disorders especially work stress. Widyastuti (2017) explains that stress is a disorder in which the body overproduces stress hormones such as cortisol. The brain responds to high levels of cortisol as an external threat that needs to be fought or avoided (fight or flight response). To prevent running out of energy, the brain will order the body to take a rest. If workers continue to work, it can cause muscle fatigue.

Bachroni & Asnawi (2015) explain that work stress sources are the workload that is too light or too heavy and time pressure when doing the job. Work stress also arises from the inability to control an uncertain or unpredictable situation. The types of workers who are prone to stress are workers who have an obsession with time because they want to finish the work. This happens to workers *piranti upakara* makers with high demand for orders. When orders for ceremonial equipment boomed, workers would be pressed the time to complete these orders.

The work of making *piranti upakara* is one of the most complex jobs. So that it is required to have adequate expertise. The work is considered complicated so that workers tend to get frustrated and stressed out quickly. Stress on workers will cause various physical and emotional reactions. Emotional reactions that often occur in *piranti upakara* workers are anger and fear. Musculoskeletal disorder is one of the physical reactions in work stress. Related to this research, the mechanism of work oriented by ergonomic was improved. The improvement mechanism of work there are (1) repairing work stations; (2) providing seats for workers with *majejahitan* activities and making *jaja upakara*; (3) and changing the static work system to dynamic. Improved work mechanisms will increase work comfort and reduce work stress due to boredom caused by monotonous working.

This research is synergized with other researchers such as (a) Sutrisno (2010) revealed that the contribution of organizational culture, work stress, and commitment to employee performance is 83.50%; (b) Purnawati (2014) explained that an ideal work stress management program includes primary, secondary, and tertiary prevention refers to the workers and employer's need; (c) Noor, et al. (2016) explained that workers must be free from stressful conditions because job stress and job satisfaction have a simultaneous and significant effect on employee performance; (d) Susetyo & Ratnaningsih (2016) explained that the perception of K3 had an effective effect of 13.6% on the work stress of production employees; (e) Wartono (2017) explained that job stress affects magazine employee performance by 77.44%.

Result of the hypothesis on productivity in Period I and Period II showed in Table 4.

Table 4
Result of the Hypothesis on Productivity

Variable	Period I		Period II		t	p
	Mean	SD	Mean	SD		
Productivity	26.12	0.949	40.73	0.816	47.853	0.0001

Based on Table 4, it was found that productivity increased by 55.93% between Period I and Period II. It shows that improving mechanism of work oriented ergonomic make workers

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more safe, healthy, and comfortable so that productivity will increase. It showed that improvement mechanism of work oriented by ergonomic can reduce musculoskeletal disorders to 44.45%, reduce work stress to 29.90%, and consequently increase the productivity to 53.93%.

Productivity measurement has an important role to determine the suitability between work productivity and the productivity were expected. Improvement mechanism of work with ergonomic principles are able to increase productivity of workers such as (a) good organized make the work is easier; (b) improvement the mechanism of work oriented by ergonomic principle can decrease musculoskeletal disorders, work stress, and workload so that a larger number of result are obtained with the best quality; (c) improvement the mechanism of work oriented by ergonomic principle can produce more products; (d) efficient use of raw materials and equipment that is not too expensive without reducing the quality of product.

This research is in accordance with other researchers such as (a) Purnamawati (2013) explained that ergonomic interventions in the process of making *banten ngaben pranawa* are able to increase the productivity by 78%; (b) Mindhayani & Purnomo (2016) revealed that improving the work system with a macro ergonomic approach was able to increase employee productivity by 36.96%; (c) Sutajaya (2019) explained that improving condition of work based on local wisdom with ergonomic principle increased productivity of sculptors by 14.85%; and (d) Nooryana, et al. (2019) explained that dynamic stretching exercises and active rest were able to increase the productivity of garment industry workers by 31.25%.

CONCLUSION

The conclusion that improvement mechanism of ergonomic work oriented reducing musculoskeletal disorders of workers to 44.45%, reducing the work stress of workers to 29.90%, and increasing the productivity of workers to 53.93%.

The suggestions of this study are: (a) to the workers of *piranti upakara* makers should use the mechanism of ergonomic work oriented; (b) to the employer of *piranti upakara* makers should always pay attention of the work mechanism who at risk for health; (c) to village authority should facilitate the efforts of work mechanism improvement in home industries, particularly those making ceremonial equipment.

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Analisis Tingkat Postur Kerja Dan Musculoskeletal Disorders pada Pekerja di Pabrik Roti Latansa Gontor

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Abstrak

Industri pabrik Roti La Tansa merupakan sebuah sektor industri formal yang membuat roti, beberapa proses kegiatan masih dilakukan secara manual. Kondisi tersebut yang akan menyebabkan terjadinya prevalensi keluhan MSD's karena posisi tubuh pekerja dalam kondisi membungkuk. Tujuan penlitian ini untuk menilai tingkat risiko cedera dengan menggunakan kuesioner *Quick Exposure Check* (QEC) dan menilai keluhan dampak dari postur janggal tersebut dengan menggunakan kuesioner *Nordic Body Map* (NBM). Jenis penelitian ini secara deskriptif yang dilaksanakan pada Pabrik Roti Latansa, Gontor, Ponorogo pada bulan Mei 2020 dengan jumlah 9 responden. Hasil penelitian akan di analisis menggunakan program Excel. Berdasarkan hasil penelitian pada sebaran kuesioner yang dilakukan oleh peneliti maupun pekerja itu sendiri, menunjukkan bahwa tingkat risiko cedera pada 7 pekerja dari 9 pekerja berada pada level 72,8% - 82,7% yang artinya harus dilakukan penelitian dan perubahan secepatnya. Hasil penilaian keluhan MSD's pada pekerja menunjukkan bahwa seluruhnya di kategorikan mengalami keluhan sedang. Saran yang diberikan untuk Pabrik Roti Latansa yakni membuat rancangan berupa kursi dan meja bagi pekerja sehingga dapat meminimalisir risiko cedera dan tercipta kondisi kerja yang efektif, aman, nyaman, dan efisien.

Kata kunci: informal, Nordic Body Map, postur janggal

Analysis of The Level of Work Posture and Musculoskeletal Disorders (MSD's) in Workers at the Latansa Gontor Bakery

Abstract

The La Tansa bakery industry is a formal industrial sector that makes bread, some process activities are still repeated manually. This condition will cause the prevalence of MSD complaints because the worker's body position is bent. The purpose of this study was to assess the level of risk of injury using the Quick Exposure Check (QEC) questionnaire and to assess complaints about the impact of this awkward posture using the Nordic Body Map (NBM) questionnaire. This type of research was descriptively carried out at the Latansa Bread Factory, Gontor Ponorogo in May 2020 with a total of 9 respondents. The research results will be analyzed using the Excel program. Based on the results of research on the distribution of questionnaires conducted by researchers and the workers themselves, it shows that the level of risk of injury to 7 out of 9 workers is at the level of 72.8% - 82.7%, which means that research and changes must be carried out as soon as possible. The results of MSD's complaint assessment among workers showed that all were categorized as having moderate complaints. The advice given to the Latansa Bread Factory is to design a chair and table for workers so as to minimize the risk of injury and create effective, safe, comfortable and efficient working condition.

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Keywords: awkward posture, informal, Nordic Body Map

PENDAHULUAN

Sektor industri saat ini merupakan sektor yang memberikan dampak positif bagi perkembangan Negara terutama bagi Negara yang sedang berkembang, karena dapat menyerap banyak tenaga kerja dan meningkatkan pula pendapatan Negara salah satunya adalah industri informal. Pendiri Pondok X mendidirikan unit usaha mandiri, salah satunya adalah Pabrik Roti Latansa yang merupakan sebuah sektor industri formal yang didalam proses pekerjaanya memiliki risiko terhadap kesehatan pekerja salah satu nya adalah faktor ergonomic, yaitu pekerja dapat mengalami keluhan MSD's karena dalam beberapa proses pekerjaanya masih dilakukan secara manual.

Musculoskeletal Disorders (MSD's) adalah keluhan yang akan di rasakan oleh pekerja jika menerima beban statis dalam waktu yang cukup lama secara berulang-ulang. Keluhan otot yang di rasakan oleh pekerja sangatlah bervariasi mulai dari keluhan yang ringan hingga keluhan yang sangat parah yang berkaitan dengan jaringan otot, tendon, system kartilago, system saraf, struktur tulang, dan pembuluh darah (Tarwaka, 2010). Mayoritas yang di rasakan adalah keluhan *Low Back Pain* (LBP) atau nyeri pinggang, jika pekerja mengalami keluhan otot dalam jangka waktu yang lama akibatnya pekerja akan mengalami ketidakmampuan dalam bekerja. Namun, keluhan tersebut di rasakan karena banyak faktor yang berperan. Hal tersebut disampaikan oleh (Tarwaka, 2010) bahwa terjadinya keluhan otot skeletal pada pekerja banyak faktor yang dapat mempengaruhi yakni aktivitas berulang, sikap kerja tidak alamiah, gerakan otot berlebihan, beban, postur janggal, durasi, getaran dan suhu.

Data dari berbagai penelitian yang telah dilaporkan, menunjukkan bahwa MSD's adalah salah satu kasus kesehatan kerja yang paling tinggi di beberapa negara. menurut *Health and Safety Authority* (HSA), menyebutkan bahwa angka Penyakit Akibat Kerja (PAK) yang terjadi pada tahun 2012 terus meningkat, data menunjukkan bahwa 27,1% dari 1000 telah menimpa pekerja. Diketahui pula bahwa sekitar 32% merupakan cedera *muskuloskeletal* akibat aktivitas kerja seperti mengangkat beban (43%). Kondisi tersebut akan dapat diperparah apabila posisi atau sikap pekerja berada pada posisi janggal secara terus menerus tanpa adanya bentuk pengendalian yang di lakukan.

Berdasarkan hasil Riset Kesehatan Dasar (Riskesdas, 2013) pada tenaga kesehatan di Indonesia, prevalensi Keluhan MSD's yakni 11,9% dan berdasarkan gejala yaitu 24,7%. Prevalensi berdasarkan diagnosis tenaga kesehatan tertinggi di Bali (19,3%), diikuti Aceh (18,3%), Jawa Barat (17,5%) dan Papua (15,4%). Keluhan MSD's yang paling tinggi di temui pada petani, nelayan, buruh baik yang didiagnosis tenaga kesehatan (15,3%) maupun diagnosis tenaga kesehatan atau gejala[5] (31,2%) (Balitbang Kemenkes RI, 2013).

Industri pabrik Roti La Tansa yang merupakan sebuah sektor industri formal yang menyediakan roti berbagai jenis rasa dan kemudian akan di distribusikan ke pondok cabang. Target pembuatan roti dalam sehari mencapai 1000 pcs dan jika pekerja lembur bisa mencapai 3000 pcs. Namun, dalam pemenuhan target pembuatan roti setiap hari nya hanya di kerjakan oleh 9 karyawan dan bekerja selama 6 jam/hari. Setiap kegiatan yang dilaksankan oleh karyawan sebagian besar masih dilakukan secara manual dan dilakukan secara berulang serta belum terdapat pembagian kerja yang jelas, jadi beberapa proses produksi akan di kerjakan oleh 1 karyawan. Hal ini akan dikhawatirkan dapat mempengaruhi produktivitas pekerja karena akan mengalami keluhan MSD's.

Meskipun belum dilaporkan secara detail terkait dengan keluhan MSD's pada Pabrik roti latansa, namun sudah terdapat hasil penelitian yang telah dilakukan sebelumnya, yakni hasil penelitian Khusyaini di Pabrik Roti La Tansa bahwa terdapat 10 pekerja atau 83% yang

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memperoleh nilai *exposure level* antara 51-70% dengan *action level* 3 dimana harus dilakukan investigasi lebih lanjut dan dilakukan penanganan dalam waktu dekat. Berdasarkan hasil observasi sebelumnya, pekerja mengalami keluhan pada bagian pinggang dan bahu karena berdiri dalam waktu yang lama serta membungkuk ketika membuat toping roti.

Berdasarkan latar belakang tersebut, maka peneliti tertarik untuk melakukan penilaian Postur janggal pada pekerja menggunakan *Quick Exposure Check* dan keluhan MSD's dengan metode *Nordic Body Map* pada pekerja Pabrik Roti La Tansa.

METODE

Penelitian ini menggunakan metode pendekatan secara deskriptif dengan tujuan untuk menjawab permasalahan postur kerja dan keluhan MSD's pada pekerja serta variabel lain dengan pendekatan desain *cross sectional* (potong lintang). Penelitian ini dilakukan di Pabrik Roti La Tansa Gontor yang merupakan *home industry* pembuatan roti yang terletak di desa Gontor, Kecamatan Mlarak, kabupaten Ponorogo, Jawa Timur dan penelitian ini berlangsung pada bulan Mei 2020. Populasi yang diteliti adalah seluruh karyawan yang bekerja pada Pabrik Roti La Tansa Gontor sebanyak 9 responden dengan pengambilan sampel menggunakan teknik total populasi. Pengumpulan data menggunakan lembar kuesioner *Nordic Boy Map* untuk mengetahui keluhan MSD's pada pekerja serta pengukuran tingkat risiko cedera otot menggunakan metode QEC. Pengamatan postur kerja pada pekerja dengan terlebih dahulu melakukan pemetaan stasiun kerja. Hasil pemetaan stasin kerja pada kegiatan penyedian bahan, pengadukan bahan, pembuatan adonan dan pembuatan toping, pemanggangan roti serta packing, untuk pengamatan postur kerja dapat di ambil melalui gambar dan video.

Kuesioner terdiri atas dua kuesioner, kuesioner pertama yaitu diisi oleh pengamat dan kuesioner kedua di isi oleh operator pada satu stasiun kerja di pabrik roti latansa. Data kuesioner yang telah diambil dan kemudian akan dilakukan perhitungan *exposure score* pada setiap anggota tubuh yang diamati yaitu pada bagian punggung, bahu/lengan, pergelangan tangan, dan leher. Selanjutnya dilakukan perhitungan *exposure level* untuk menentukan tindakan apa yang yang perlu dilakukan untuk pengendalian berdasarkan perhitungan *exposure level*.

HASIL DAN PEMBAHASAN

Di bawah ini merupakan hasil distribusi karakteristik individu yakni faktor usia, masa kerja, indeks masa tubuh, dan riwayat merokok pada pekerja dan faktor pekerjan yaitu beban kerja sebagai berikut.

Tabel 1
Distribusi Faktor Individu dan Faktor Pekerjaan Pada
Pekerja Pabrik Roti latansa Ponorogo

Faktor individu		
Usia pekerja (thn)	Frequency (n)	Persen (%)
<35 tahun	6	66,7
≥35 tahun	3	33,3
Total	9	100
Masa kerja pekerja	Frequency (n)	Persen (%)

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<2 tahun	6	66,7
≥2 tahun	3	33,3
Total	9	100
Indeks masa tubuh pekerja	Frequency (n)	Persen (%)
Normal	5	55,6
Gemuk	3	33,3
Obesitas	1	11,1
Total	9	100
Riwayat merokok pekerja	Frequency (n)	Persen (%)
Perokok ringan	3	33,3
Perokok sedang	4	44,4
Tidak merokok	2	22,2
Total	9	100
Beban kerja pekerja	Frequency (n)	Persen (%)
Sangat berat	8	88,9
Berat	1	11,1
Total	9	100

Berdasarkan Tabel 1, di ketahui bahwa karakteristik subjek penelitian pada pekerja Pabrik roti Latansa Gontor ini meliputi: umur, masa kerja, indeks masa tubuh, riwayat merokok dan beban kerja. Pekerja pada Pabrik roti Latansa Gontor yang menjadi subjek penelitian dalam penelitian ini berjumlah 9 responden dan semua responden berjenis kelamin laki-laki.

Hasil analisis pada Tabel 1 menunjukkan bahwa umur responden mayoritas berada pada kelompok umur kurang dari 35 tahun sebanyak 6 responden sebesar (66,7%) dibandingkan dengan kelompok umur lebih sama dengan 35 tahun sebanyak 3 responden sebesar (33,3%). Masa kerja responden dikategori menjadi 2 kelompok yaitu masa kerja kurang dari dua tahun dan masa kerja sama dengan lebih dari dua tahun. Mayoritas menunjukkan bahwa responden memiliki masa kerja kurang dari dua tahun sebanyak 6 responden sebesar (66,7%). Mayoritas Indeks mata tubuh pekerja di kategorikan normal sebanyak 5 responden sebesar (55,6%) namun, diantaranya terdapat 1 respoden yang di kategorikan obesitas sebesar (11,1%).

Pekerja di Pabrik Latansa ternyata sebagian besar memiliki kebiasan merokok dalam keseharianya, mayoritas di kategorikan sebagai Perokok sedang sebanyak 4 responden sebesar (44,4%) dan terdapat pula responden yang dikategorikan sebagai perokok ringan sebanyak 3 responden sebesar (33,3%) serta hanya 2 responden sebesar (22,2%) yang di kategorikan tidak merokok.

Salah satu beban yang di angkat oleh pekerja dalam membuat roti diantaranya adalah karung terigu yang mayoritas dikategorikan sebagai beban sangat berat sebanyak 8 pekerja (88,9%) sisanya di kategorikan beban berat. Setelah seluruh pekerja diberikan kuesioner pada stasiun kerja masing-masing, maka diketahui hasil rekapitulasi jawaban dari kuesioner pengamat dan operator. Bagian tubuh pekerja yang di amati yakni bagian punggung, bahu, Pergelangan tangan dan leher menunjukkan bahwa 9 pekerja pembuat roti mayoritas memiliki tingkat risiko ergonomi tinggi.

Berdasarkan hasil pengisian kuesioner QEC oleh pengamat dan pekerja, di simpulkan bahwa bagian punggung dan bahu/lengan memiliki tingkat risiko yang paling tinggi (*very high*)

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yang di rasakan oleh semua pekerja termasuk pada bagian leher, namun pada bagian leher hanya di rasakan oleh pekerja 5,6, dan 7. Pada bagian pergelangan tangan, mayoritas pekerja memiliki tingkat risiko ergonomi tinggi (Tabel 2).

Tabel 2
Total Nilai *Exposure* pada Pekerja di Pabrik Roti Latansa, Ponorogo

Pekerja	Exposure Level (%)	Tindakan
1	70,3	Dilakukan penelitian dan perubahan secepatnya
2	72,8	Dilakukan penelitian dan perubahan secepatnya
3	70,3	Dilakukan penelitian dan perubahan secepatnya
4	70,3	Dilakukan penelitian dan perubahan secepatnya
5	82,7	Dilakukan penelitian dan perubahan secepatnya
6	82,7	Dilakukan penelitian dan perubahan secepatnya
7	72,8	Dilakukan penelitian dan perubahan secepatnya
8	69	Dilakukan penelitian dan perubahan secepatnya
9	55,5	Dilakukan penelitian dan perubahan secepatnya

Disimpulkan bawah pekerja di Pabrik Roti Latansa memiliki risiko ergonomi yang sangat tinggi pada bagian punggung dan bahu karena pekerja pada pabrik roti sering bekerja dengan postur janggal berupa punggung yang terlalu membungkuk pada saat membuat toping roti dan dijanjutkan dengan packing roti. Postur janggal terjadi karena tidak terdapat tempat duduk yang nyaman bagi pekerja pada saat memberikan toping roti.

Pada bagian leher dan pergelangan tangan juga di nilai dengan kategori postur tinggi, berdasarkan hasil obervasi bahwa pada saat pekerja memasukkan roti ke mesin panggang dengan posisi leher yang tidak ergonimis atau posisi tubuh dan leher sedikit memutar. Hasil menunjukkan bahwa pekerja 8 dan 9 menunjukkan hasil dengan nilai exposure 69% dan 55,5% hal ini perlu dilakukan penelitian lebih lanjut dan dilakukan perubahan. Sementara pekerja 1,2,3,4,5,6 dan 7 menunjukkan hasil dengan nilai exposure 70,3%-82,7% dengan hasil tersebut perlu dilakukan penelitian dan perubahan secepatnya karena kemungkinan besar pekerja akan mengalami keluhan otot jika di perparah dengan faktor- faktor yang mendukung.

Lama waktu yang di perlukan pekerja untuk menyelesaikan pekerjaanya dalam sehari, rata-rata jika lembur yakni 6 jam per hari dan waktu kerja di mulai pada pukul 07.00 pagi. Meskipun jam kerja pekerja tidak melebihi 8 jam kerja perhari namun pekerjaan tersebut di lakukan secara manual tanpa adanya istirahat sejenak, diperparah dengan stasiun kerja yang tidak egonomis. Menurut (Humantech, 2003) bila postur janggal tersebut dipertahankan selama lebih dari 10 detik hal tersebut akan berisiko tinggi pada pekerja. Berdasarkan hasil penelitian oleh (Icsal, dkk., 2016) dapat dilihat secara statistik dengan menggunakan uji korelasi spearman diperoleh hasil p=0,013 (p>0,05) yang berarti ada hubungan antara durasi kerja dengan *muskuloskeletal disorders* pada penjahit wilayah pasar panjang. Pekerjaan fisik yang berat dan dilakukan secara manual akan mempengaruhi kerja otot, kardiovaskular, system pernapasan dan lainnya. Jika pekerjaan berlangsung dalam waktu yang lama tanpa istirahat, kemampuan tubuh akan menurun dan dapat menyebabkan kesakitan pada anggota tubuh.

Berat beban juga sangat mempengaruhi postur janggal, rata-rata setiap harinya, pekerja pada Pabrik Roti Latansa mengangkat beban (karung terigu) seberat 20-40 kg dengan kategori beban sangat berat. Beban yang terlalu berat akan berdampak pada pekerja karena beban merupakan salah satu faktor yang mempengaruhi terjadinya gangguan otot rangka yang akan menimbulkan keluhan MSD's. Departemen Kesehatan beban yang diperbolehkan untuk laki-laki dewasa yaitu 15-20 kg dan untuk perempuan (16-18 th) yaitu 12-15.

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Penjelasan mengenai hasil penilaian keluhan MSD's berdasarkan kuesioner *Nordic Body Map* pada pekerja pada Pabrik Roti Latansa dapat dilihat pada lampiran Tabel 3. Metode QEC yang tujuannya untuk menilai postur tubuh pekerja yang telah di jelaskan sebelumnya, berbeda dengan *Nordic Body Map* (NBM) yang di gunakan untuk melihat tingkat keparahan yang dirasakan oleh pekerja atas terjadinya keluhan system *musculoskeletal*. NBM ini adalah tindak lanjut setelah di lakukan observasi postur pada pekerja.

Hasil kuesioner pada 9 pekerja memberikan tanggapan terhadap 28 kuesioner *Nordic Body Map* menunjukkan bahwa pekerja dalam membuat roti ternyata mengalami keluhan baik itu keluhan agak sakit (AS), keluhan sakit (S), maupun keluhan sangat sakit (SS) meskipun keluhan yang di rasakan oleh pekerja semuanya di kategorkan sebagai keluhan sedang.

Di bawah ini merupakan penjelasan lebih rinci bagian tubuh yang paling dirasakan oleh pekerja berdasarkan *Nordic Body Map.*

Tabel 3
Ringkasan Bagian Tubuh Yang Mayoritas Banyak Mengalam
Keluhan MSD's Berdasarkan NBM Pada Pekerja Pada Pekerja
Pabrik Roti Latansa.

Bagian tubuh	Penyebab
Leher bagian atas	Posisi leher pada saat mengambil atau memasukan roti yang akan di panggang
Punggung	Posisi punggung pada saat memberikan toping roti yang terlalu membungkuk tanpa duduk.
Pinggang	Posisi punggung pada saat memberikan toping roti yang terlalu membungkuk, dan setiap hari nya mengangkat beban.
Bokong	Tempat duduk yang tidak ergonomis pada saat packing roti.
Pergelangan tangan kanan	Posisi pergelangan tangan pada saat mengaduk adonan toping kue secara manual dan membentuk adonan menjadi roti.
Pergelangan kaki kiri dan kanan	Membentuk adonan menjadi kue dengan posisi berdiri secara terus-menerus tanpa adanya tempat yang di sediakan.

Meskipun keluhan MSD's pada pekerja dikategorikan mengalami keluhan sedang, namun postur janggal yang di alami pekerja dikategorikan sangat tinggi. Hal ini di sebabkan karena rata-rata masa kerja pekerja masih tergolong baru yakni <2 tahun sebanyak 6 responden. Menurut Guo dalam (Octaviani, 2017) apabila semakin lama masa kerja seorang, maka semakin sering orang akan mengalami risiko *musculoskeletal disorders* (MSD's). Keluhan MSD's terjadi tidak secara langsung, namun akan di rasakan secara bertahap sampai pada kemampuan tubuh manusia mulai merespon adanya rasa sakit. Hasil penelitian (Maijunidah, 2010) mengatakan bahwa terjadinya *Musculoskeletal Disorders* (MSD's) pada pekerja membutuh waktu yang lama hingga menimbulkan rasa sakit karena bersifat kronis. Namun, pada penelitian ini menunjukkan hasil bahwa mayoritas masa kerja pekerja pada Pabrik Roti Latansa rata-rata tegolong baru sehingga pekerja mengalami keluhan MSD's kategori sedang.

Tampak pada Tabel 3 menunjukkan bahwa ringkasan bagian tubuh terhadap aktivitas kerja membuat roti berdasarkan hasil kuesioner dan hasil observasi menunjukkan bahwa bagin tubuh yang paling cenderung mengalami keluhan yaitu leher bagian atas karena posisi leher pada saat mengambil atau memasukan roti yang akan di panggang, pekerja juga mengalami keluhan pada bagian punggung dan pinggang karena posisi punggung dan pinggang pada saat memberikan toping roti yang terlalu membungkuk tanpa duduk dan pekerja setiap hari nya mengangkat beban karung terigu yang dikategorikan sangat berat. Bagian bokong juga terasa sakit karena tempat duduk yang tidak ergonomis pada saat packing roti, serta pada bagian pergelangan tangan dan kaki juga dialami oleh pekerja karena posisi pergelangan tangan pada saat mengaduk adonan toping roti secara manual dan membentuk adonan menjadi roti dengan posisi berdiri secara terus-menerus karena tidak disediakan tempat duduk yang nyaman. Menurut penilitian Habib juga menunjukkan bahwa terhadap 504 tokoh roti di Libanon yang di ambil secara acak menunjukkan bahwa 23% pekerja pada tokoh roti tersebut melaporkan mengalami keluhan exstremitas atas. Di bawah ini salah satu dokumentasi pekerja dengan postur janggal.

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Gambar 1. Postur tubuh memberikan toping roti

SIMPULAN

Berdasarkan penelitian yang dilakukan pada Pabrik Roti Latansa, menunjukkan bahwa penilaian Postur kerj menggunaka QEC pada pekerja pembuat roti di dapatkan hasil yaitu mayoritas pekerja berada pada level Exposure 72%-82% dengan keterangan harus dilakukan penelitian dan perubahan secepatnya. Namun hasil penilaian keluhan MSD's berdasarkan *Nordic Bodi Map* (NBM) pada pekerja menunjukkan bawah keluhan tersebut dikategorikan sebagai keluhan ringan. Mayoritas anggota badan yang mengalami nyeri pada saat bekerja yakni leher bagian atas, pada bagian punggung, pinggang, bokong, pergelangan tangan dan Pergelangan kaki Kiri dan kiri

SARAN

Saran yang diberikan untuk Pabrik Roti Latansa yakni membuat rancangan berupa kursi dan meja bagi pekerja sehingga dapat meminimalisir risiko cedera keluhan sehingga tercipta suasan kerja yang nyaman.

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The Improvement of Working Posture and Ergonomic Workplace Stretching Decreased Musculoskeletal Complaint and Fatigue and Increased Productivity of Nurses

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Abstract

General fatigue complaints and musculoskeletal disorders are two of the most common symptoms experienced by dialysis nurses, as the products of the poor ergonomic working poses. Ergonomic intervention and stretching in the workplace are needed to reduce the symptoms. Unnatural pose has a potential to develop general fatigue and musculoskeletal disorders in hemodialysis room where each nurse in every shift is in charge to take care of four patients. The study aims to investigate the improvement of poses of work ergonomically by using *ergonomic workplace stretching* to reduce complaints in musculoskeletal and general fatigue which in turn can expectedly improve work productivity in hemodialysis room. This study is an experimental study with *treatment by subject design*. The study was conducted in hemodialysis unit in Wangaya Regional Public Hospital (WRPH) Denpasar from October until December 2019 with 11 people as the participants. As the result, there is no significant difference in the average of musculoskeletal complaints before working with p=0.350 (p>0.05). Meanwhile, the average of musculoskeletal complaints of nurse after working shows a significant difference that is p=0.001 (p<0.05). The analysis result indicates that there is a significant decrease in musculoskeletal complaints, which is 36.18%. The average of general fatigue before working shows no significant difference in score, that is p=0.350 (p>0.05). In the other side, there is a significant difference in score after working with p=0.001 (p<0.05). The analysis result reveals that there is a significant decrease in general fatigue for 66.97%. A significant improvement is shown in the productivity average with p=0.001 (p<0.05). The conclusion of this study is the improvement in poses of work and *ergonomic workplace stretching* have reduced the complaints in musculoskeletal and general fatigue and also improve nurses' working productivity in hemodialysis unit.

Keywords: ergonomic workplace stretching, general fatigue, musculosceletal

Perbaikan Sikap Kerja dan Ergonomic Workplace Streching Menurunkan Keluhan Muskuloskeletal dan Kelelahan serta Meningkatkan Produktivitas Kerja Perawat di Unit Hemodialisis RSUD Wangaya Kota Denpasar

Sebagai upaya untuk meminimalkan keluhan kelelahan dan gangguan muskuloskeletal perawat hemodialisis akibat sikap kerja yang kurang ergonomis, diperlukan intervensi ergonomi terhadap perawat selama melakukan pekerjaannya melalui penggunaan kursi kerja dan workplace stretching setelah melakukan aktivitas. Sikap yang tidak alamiah berpotensi menimbulkan kelelahan dan gangguan muskuloskeletal di ruang hemodialisis RSUD Wangaya dimana perawat yang bekerja setiap shift adalah satu perawat melayani empat pasien. Tujuan penelitian adalah membuktikan

perbaikan sikap kerja secara ergonomi menggunakan ergonomic workplace stretching untuk mengurangi keluhan muskuloskeletal dan kelelahan agar dapat meningkatkan produktivitas kerja perawat di ruang hemodialisis. Penelitian yang digunakan adalah penelitian ekperimental dengan menggunakan rancangan sama subjek. Penelitian dilaksanakan di unit Hemodialisis RSUD Wangaya Kota Denpasar, awal Oktober 2019 sampai dengan akhir Desember 2019 dengan jumlah sampel 11 orang. Hasil penelitian menunjukkan rerata keluhan muskuloskeletal sebelum kerja pada Periode I dan II tidak berbeda bermakna dengan nilai t=0,980 dan nilai p=0,350 (p>0,05). Rerata keluhan muskuloskeletal perawat sesudah kerja berbeda secara signifikan antara Periode I dan II dengan nilai t=75,922 dan nilai p=0,0001 (p<0,05). Hasil analisis menunjukkan bahwa terjadi penurunan keluhan muskuloskeletal yang signifikan antara Periode I dan II sebesar 36,18%. Rerata kelelahan sebelum kerja pada Periode I dan II tidak berbeda bermakna dengan nilai t=0,980 dan nilai p=0,350 (p>0,05). Rerata kelelahan perawat sesudah kerja berbeda secara signifikan antara Periode I dan II dengan nilai t=75,933 dan nilai p=0,0001 (p<0,05). Hasil analisis menunjukkan bahwa terjadi penurunan kelelahan yang signifikan antara Periode I dan II yaitu 66,97%. Rerata produktivitas perawat meningkat signifikan antara Periode I dan II dengan nilai t=7,206 dan nilai p=0,0001 (p<0,05). Hasil analisis tersebut menunjukkan bahwa terjadi peningkatan produktivitas yang signifikan antara Periode I dengan II sebesar 9,09%. Simpulan penelitian adalah perbaikan sikap kerja dan ergonomi workplace stretching dapat mengurangi keluhan muskuloskeletal dan kelelahan serta meningkatkan produktivitas kerja perawat di unit hemodialisis RSUD Wangaya Kota Denpasar. Penelitian ini diharapkan menjadi acuan perawat terutama dalam mengurangi keluhan muskuloskeletal dan kelelahan.

Kata kunci: kelelahan, muskuloskeletal, ergonomic workplace stretching, RSUD Wangaya.

INTRODUCTION

Health services can be conducted in groups which is a service managed by private or government at the hospital. Wangaya Regional Public Hospital (WRPH) is a type B government hospital which provides specialist health services for inpatient or outpatient with various service units, one of those is hemodialysis service. Hemodialysis service is provided in the hemodialysis unit/room for patients who needs dialysis therapy, such as kidney failure patient. Hemodialysis (HD) occurs in a long period and permanent to substitute the decreased kidney's function (Brenner & Lazarus, 2012). Ideally, HD is proceeded for 10 – 15 minutes/week, which means the patients need 4 – hours/week and about 2 – 3 times of HD in a week (Suwitra, 2009).

Hemodialysis Unit in WRPH has fulfilled the minimum service standard in the regulation of Minister of Health of the Republic of Indonesia and provides the minimum service to the patients who need dialysis therapy. Hemodialysis Unit has been operating since August 18th of 2006 and currently, there are 20 hemodialysis machines with 800 treatments. The patients who need hemodialysis will have two times hemodialysis treatment based on the schedule. The age range of patients who get hemodialysis treatment is from 18 – 75 years old with the most etiology, such as diabetes mellitus (DM), hypertension, pyelonephritis chronic (PNC), glomerulonephritis chronic (GNC). The health workers who involved in giving hemodialysis treatment are one consultant doctor of kidney hypertension, one internist who is responsible in hemodialysis unit, two general professional practitioners as the executive doctors, 13 certificated nursing staffs, administration staff, and electromedical staff. The nursing staff is responsible in providing nursing care in pre, intra and post level of hemodialysis treatment. Each nurse has 6 hours/day (2 shift) and is responsible to 3 – 4 patients.

The activities in providing nursing care to patients are: preparing the environment, such as comfortable bed, bulkhead for patient's privacy, light and temperature with operational standard; preparing dialysis machines which are ready used with rinse process (disinfectant

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and machine cleaning) and soaking (machine temperature, the dialyzer or artificial kidney humidification process); preparing patients, such as prior assessment in weight, vital sign measurement and take *anamneses* of patient complaints. Then, puncture in the patient's large blood vessels (arteries and veins) is done as the access of vascular in dialysis treatment. After the blood vessel access is complete, then the hemodialysis process is taken over by the machine until the target (time, weight and so on) is accomplished while nursing staffs observe the patients and machines continuously. There is no specific resting time while in charge in providing nursing care and nursing staff only use free time to take a break. Hemodialysis process is ended by taking off the vascular access, ensuring that there is no bleeding and the condition of the patients is stable.

Poses of work which is done by nursing staff in hemodialysis unit of WRPH is mostly unnatural. Standing position while working tends to bend their body for a long time is done when doing puncture of vascularizing access and taking off the vascular access and preventing bleeding. From the observation result, one series of puncture is occurred for the time average 6 minutes 64 seconds in one patient and continue to the other patients. The bending in poses of work is done to find the appropriate position due to the height of bed is lower than the reach of nursing staff's height (the bed is not adjustable) and the patients are frequently changing their position. To assess the nurses' working pose, Rapid Entire Body Assessment (REBA) is used which resulted in the final score of 8, which means that the position has a high risk to cause musculoskeletal disorder and thus needs the improving treatments.

If the treatment is not provided, the nurses will remain suffer from discomfort, general fatigue and musculoskeletal complaints. Musculoskeletal Disorders (MSDs) is a complaint in skeletal muscles, which has a low until high complaints when the muscles experienced pressure for a long time (Kirkhorn, et.al., 2010). MSDs can cause complains which is caused by muscles damage, ligament, joints, bone, tendon, cartilage and spinal cord. MDSs is occurred on nursing staff who work in hemodialysis room. The interview results to 5 nursing staff shows that they experienced pain in the neck, shoulder, elbow and waist, however the observation used *Nordic Body Map* questionnaire and the lowest score is 71 and the highest is 96. It can be interpreted that nurse staff has a high risk to experience musculoskeletal and improvement treatment needs to be immediately conducted.

Fatigues is related to physical and mental general fatigue which cause a decrease in physical performance, feeling tired, decreased in motivation and productivity (Setyawati, 2010). The fatigue level of 5 nursing staff in working after and before in hemodialysis room is assessed by using 30 item of rating scale questionnaire which cause the increase in nursing about 80%. The average of resting pulse is 80 x/minute and working pulse is 100 - 140 beat/min, which shows medium-high workload. Base on those condition, nursing staff who work in hemodialysis room experiences several ergonomic problems and need intervention to reduce problems, the risk to musculoskeletal disorder, prevent work accident and improve working productivity.

In order to achieve the optimal work result, tools, work place design, procedure and work environment based on needs, anthropometric measures, natural poses of works and the maximum capacity of individual workers are needed, among those the priority for the improvement are poses of work and workplace stretching. The improvement of poses of work can be fixed with the adjustments between the anthropometric size of the nurse and the bed, the position of the patient and the field of work for nurse. The use of ergonomic working chair while doing puncture and other procedures is used compared doing the procedure while bending the body. Moreover, the intervention by giving ergonomic workplace stretching to hemodialysis nurse in before, during and after doing hemodialysis treatments can be applied to improve flexibility and help to relax the muscles after doing the treatment. Providing

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intervention will be built-in with standard operational procedure of nurse in hemodialysis room.

METHOD

The method of this study is experimental with *treatment by subject design*, where all subjects were assigned as control and treatment subjects at the different time period. The study was conducted in Hemodialysis Unit of WRPH on October until December 2019. Total sampling techniques is used in choosing the participants. Eleven of nurses who work during the puncture process of vascularization access has fulfilled the inclusion criteria. *Nordic Body Map* in 4 scales is used to measure body musculoskeletal experience of nurses. The 30 item of rating scale fatigue questionnaire is used to measure fatigue. Stopwatch is used to measure the duration of activity needed. *Lux meter* is used for measuring the light intensity in work place. *Sound level meter* used for measuring the noise intensity in work place. *Humidity meter* is used for measuring the room humidity in the work place, and camera is used to document the activity during research. Data obtained was analyzed using SPSS version 16.0 to test the set hypothesis with significant level p=0.05.

RESULTS AND DISCUSSION

The age average of subject is 33.27±4.047 years old. The age average in this study which include productive age while working (Depkes RI, 2015). Number of studies has stated that the range of productive age in ergonomic is around 31 – 44 years old with the average is 37.11 years old (Yusuf, 2016), and this study states the average age is 34.89 years old (Dinata, et.al., 2015). This study show that average of age can be categorized as productive and has the ability to work in optimal way.

The average weight was 65.36±16.070 kg, the average height was 163.45±7,06 cm and Body Mass Index (BMI) is 24.17±4.207kg/m^2 with similar condition as the previous study which has been conducted in ergonomic about providing seat covers and stretching movements on drum carvers in Gianyar (Hamzah, 2018). It is supported with the number of BMI that shows the category nurse's body condition is normal and indicates the healthy physical condition while doing research (Depkes RI, 2015). The average result in work experience was 11.18±5.82 years and the range about 5 – 17 years. This indicates that the subject was extremely experienced.

The data of research subject condition and environment condition in nurse working place that is in hemodialysis room can be seen in Table 1 and Table 2.

Table 1
The Data Result of Research Subject Condition(n=11)

Variable	Average±Standard Deviation
Age (years)	33.27±4.047
Height (cm)	163.45±7.062
Weight (kg)	65.36±16.070
IMT (kg/m^2)	24.17±4.207
Work Experience (years)	11.18±5.810

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Table 2
The Data Result of Environment Condition in Working Place of Hemodialysis Nurse (n=11)

Variable	Perioe I	Period II	t value	p value
	Average±SB	Average±SB		
Temperature (^{0}C)	22.43±0.081	22.45±0.083	0.415	0.695
Relative Humidity (%)	54.70±1.204	55.40±0.219	1.204	0.282
Light Intensity (lux)	100.83±2.041	201.67±4.082	50.243	0.000
Noise (dB)	52.00±2.450	51.67±2.065	0.284	0.788

The compatibility test between Period I and Period II with p=0.365 (p>0,05) means that the temperature in Period I and Period II is comparable or provide the similar effect to the change of variable. The compatibility test between Period I and Period II with p=0.282(p>0.05) shows that the humidity is similar to the change of related variable. The compatibility test between Period I and Period II with p=0.695(p>0.05) indicates that the light intensity is similar to the related variable change. The compatibility test between Period I and Period II with p=0.788 (p>0.05) means that it is comparable or provide the similar effect to the change of related variable.

Table 3
The Analysis Result of Nurse's Musculoskeletal Complaint, Fatigue and Work Productivity (n=11)

Variable	Period I	Period II	Changes
	Rerata±SB	Rerata±SD	
Musculoskeletal Complaints (Before Working)	28.91±0.539	29.27±0.786	1.25%
Musculoskeletal Complaints (After Working)	41.73±1.104	39.36±0.505	-5.68%
Musculoskeletal Complaints (Difference)	12.82±1.168	10.10±0.700	-21.22%
Fatigue (Before Working)	30.11±0.151	30.27±0.467	0.50%
General fatigue (After Working)	66.09±1.578	42.18±0.603	-36.18%
Fatigue (Difference)	35.98±1.554	11.91±0.700	-66.90%
Productivity	4.84±0.336	4.63±0.305	-4.34%

Based on the analysis result above in Table 3, the difference of musculoskeletal complaints in Period I and Period II is decreased for -21.22%. The difference of fatigue is also decreased for -66.90%, in the other side nurse' productivity level in the time duration is decreased for -4.34%.

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Table 4
Normality Test in Nurse's Musculoskeletal Complaints, Fatigue and Work Productivity (n=11)

Variable	Average±SD
Musculoskeletal Complaints Before Working (Period I)	28.91±0.539
Musculoskeletal Complaints After Working (Period I)	41.73±1.104
The Difference of Musculoskeletal Complaints (Period I)	12.82±1.168
Musculoskeletal Complaints Before Working (Period II)	29.27±0.786
Musculoskeletal Complaints After Working (Period II)	39.36±0.505
The Difference of Musculoskeletal Complaints (Period II)	10.10±0.700
Fatigue Before Working (Period I)	30.11±0.151
Fatigue After Working (Period I)	66.09±1.578
The Difference of Fatigue (Period I)	35.98±1.554
General fatigue Before Working (Period II)	30.27±0.467
General fatigue After Working (Period II)	42.18±0.603
The Difference of Fatigue (Period II)	11.91±0.700
Productivity (Period I)	4.84±0.336
Productivity (Period II)	4.63±0.304

Based on the analysis above, it shows that the data before, after and difference in musculoskeletal complaints, general fatigue and productivity in Period I and Period II is normally distributed ($p>0.05$), and continued with paired t-test with 5% significance.

Table 5
Hypothesis Test Result in Nurse's Musculoskeletal Complaints, General fatigue and Work Productivity (n=11)

Variable	Period I	Period I	t value	p value
	Average±SB	Average ±SD		
Musculoskeletal Complaints (Before Working)	28.91±0.539	29.27±0.786	1.491	0.167
Musculoskeletal Complaints (After Working)	41.73±1.104	39.36±0.505	6.500	0.000
General fatigue (Before Working)	30.11±0.151	30.27±0.467	0.980	0.350
General fatigue (After Working)	66.09±1.578	42.18±0.603	75.922	0.000
Productivity	4.84±0.336	4.63±0.305	7.206	0.000

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Table 5 shows the average of nurse's musculoskeletal complaints is comparable. It is used to decide the decrease of musculoskeletal complaints between Period I and Period II based on hypothesis test after working, the average of musculoskeletal complaints is significantly different between Period I and Period II with t=6.500 and t=0.000 ($p<0.05$). The result also shows a significant decrease in musculoskeletal complaints between Period I and Period II for -21.22%. The nurse's general fatigue average is comparable. It is used to decide the decrease of fatigue between Period I and Period II based on the result of hypothesis test in fatigue average. The average of nurse's fatigue after working is significantly different between Period I and Period II with t=75.922 and p=0.000 ($p<0.05$). It indicates the significant decrease between Period I and Period II, that is -66.90%. The nurse's productivity average is decreasing in duration, but increasing in work productivity, this improvement is significant between Period I and Period II with t=7.206 and p=0.000 ($p<0.05$). It indicates that there is a significant improvement in productivity between Period I and Period II or decreasing in time duration for -4.34%.

Ergonomic workplace stretching is a stretching exercise that workers can do to prevent musculoskeletal pain, neck and shoulder injuries. This stretch is done after the nurse has finished doing punctures with ten movements twice in 20 seconds (Anderson, 2010). Related with this study, several researchers reported that the complaints about respondents' muscle disorders occurred in the lower part of the waist muscles (Nuryaningtyas & Martiana, 2014). This is due to conditions of bending the body for 20-60° while working. This situation results in an increased risk of musculoskeletal disorders (Wicaksona, 2012). Another study states that a large reduction in musculoskeletal complaints in nurses who are given workplace stretching exercise (WSE) interventions can provide relaxation to muscles and joints to increase blood flow and reduce pain or musculoskeletal complaints in nurses (Syafrianto & Zulfa, 2019).

In principle, the stretching movement is located in the neck to the leg muscles, part of muscles that experience spasm cause a shortening of the muscle fibers because the myofilaments webbing overlaps one another. When the resistance stretching is done with several seconds duration and the position of muscle is long, the structure of the muscle fiber, especially the sarcomere, is stretched because of the overlapping is less than usual, which affect the structure of the muscle fiber to lengthen and muscle spasm is reduced. Related to this, the cause of fatigue at work are the length of work, physical and mental burdens, environment condition, such as working weather, noise and lighting, psychological responsibilities, worry and illness, and nutrition condition. Several researchers state that the subjective fatigue use a method or parameter IFRC which is experienced to the tired nurses while working (Perwitasari & Tualeka, 2018).

In general, productivity can be defined as the relation between certain value of input and output. Working productivity shows how the nurse do their job. The productivity of work is caused by the body attitude and paying attention to the condition and situation of burden on the body, the scope and the type of work. The use of a working chair when doing a puncture and ergonomic workplace stretching while breaks in this study was reduce the fatigue of the muscles. Other study state that the environment of the workplace including external factors that can affect a person's motivation and environmental factors, such as training equipment, work facilities and infrastructure for employees who are carrying out their own work (Kawarimi, 2012). The result of examining the coefficient parameter of workload on the nurse's work productivity prove the positive impacts with the score 0.203, and t-statistic is 2,091. Those scores are above the critical score that is 1,96 (Wahyudi & Gunarto, 2019). This assessment shows that the increased workload also causes the increase in productivity.

CONCLUSION

It can be concluded that the improvement of poses of work and ergonomic workplace stretching can reduce musculoskeletal complaints, fatigue and improved the nurse's working productivity. The result of this study is expected to be a reference for the nurse, especially in reducing musculoskeletal complaints and fatigue, and as a guideline to prevent and manage the risk.

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Ergonomic-Based Redesign of Broomsticks Reduces the Physiological Burdens of Street Sweepers in Denpasar City, Indonesia

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Abstract

The equipment, such as broomsticks used by street sweepers are not appropriate based on anthropometric aspects, with a potency to induce inconvenience among them. Working with equipment that is not ergonomics, in addition to non-physiological work posture can cause fatigue, musculoskeletal disorders, and increased workload. This study aims to determine whether redesign an ergonomic-based broomstick may reduce the physiological burden of street sweepers in Denpasar city, Indonesia. This research is a pure experiment using a cross-design (two-period crossover design). The sample was 16 female street sweepers, divided into two groups: 8 as the control group and 8 treatment groups. Data analysis were performed using a paired t-test with significance level of 5%. The results showed significant difference ($p<0.05$) on the variables of workload, musculoskeletal complaints, and fatigue. In the first period, the mean of the street sweeper working heart rate was 118.96 ±2.26 beats per minutes (bpm), the mean musculoskeletal complaint score was 91.63 ±2.70 and the average fatigue was 77.69 ±2.96. In Period II, the mean heart rate was 98.49 ±2.22 bpm, the mean musculoskeletal complaint score was 63.56 ±2.73 and the average fatigue was 57.56 ±2.94. Redesigned stem brooms turned out to reduce workload, musculoskeletal complaints, and fatigue by 17.21%, 30.6%, and 25.91%, respectively. It can be concluded that the redesign of an ergonomic-based broomstick can reduce workload, musculoskeletal complaints, and fatigue.

Keywords: broomstick, ergonomics, redesign, street sweeper

Redesain Sapu Lidi Berbasis Ergonomi Mengurangi Beban Fisiologis Pada Penyapu Jalan Di Kota Denpasar

Abstrak

Alat atau sarana yang digunakan oleh para pekerja penyapu jalan belum mengacu pada aspek antropometri sehingga dapat menimbulkan ketidaknyamanan dalam melakukan pekerjaan. Sapu lidi yang digunakan pekerja masih terdapat beberapa kekurangan yang menjadikan pekerjaan menjadi kurang efektif dikarenakan ketidaknyamanan dari peralatan kerja. Bekerja dengan peralatan yang tidak sesuai dengan kaidah ergonomi serta sikap kerja yang tidak fisiologis dapat menyebabkan kelelahan, gangguan otot muskuloskeletal dan beban kerja meningkat. Penelitian ini bertujuan untuk mengetahui apakah dengan redesain sapu lidi berbasis ergonomi mengurangi beban fisiologis penyapu jalan di Kota Denpasar. Metode Penelitian adalah eksperimen murni dengan menggunakan rancangan silang (two-period cross over design). Sampel yang dilibatkan dalam penelitian ini adalah penyapu jalan wanita yang berjumlah 16 orang, selanjutnya dibagi menjadi dua kelompok yaitu 8 orang sebagai

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kelompok kontrol dan 8 orang kelompok perlakuan. Analisa data menggunakan uji t-paired dengan taraf signifikasi 5%. Hasil penelitian menunjukkan adanya perbedaan bermakna (p<0.05) terhadap variabel beban kerja, keluhan muskuloskeletal dan kelelahan. Pada periode I rerata denyut nadi kerja penyapu jalan adalah 118.96±2.26 dpm, rerata skor keluhan muskuloskeletal adalah 91.63±2.70 dan rerata kelelahan adalah 77.69±2.96. Sedangkan pada Periode II rerata rerata denyut nadi kerja penyapu jalan adalah 98.49±2.22 dpm, rerata skor keluhan muskuloskeletal adalah 63.56±2.73 dan rerata kelelahan adalah 57.56±2.94. Redesain sapu lidi jenis bertangkai ternyata menurunkan beban kerja sebesar 17.21 %, keluhan muskuloskeletal sebesar 30.63% dan kelelahan sebesar 25.91 %. dapat disimpulkan bahwa redesain sapu lidi berbasis ergonomi dapat menurunkan beban kerja, keluhan muskuloskeletal dan kelelahan.

Kata kunci: ergonomi, penyapu jalan, redesain, sapu lidi

INTRODUCTION

One of the problems faced by big cities is garbage. Garbage is a classic problem in big cities, including Denpasar. In maintaining a clean and healthy environment, the city government carries out environmental care movement under the Hygiene and Gardening Service. All activities related to the maintenance of the city environment are under the supervision of the Sanitation and Gardening Department. This agency consists of several divisions, including the road cleaning department. The job of sweeping the streets has been performed using a broomstick that has been modified by adding a wooden stalk. The equipment used by the street sweepers have not yet referred to the anthropometric aspects, so that some of the workers perform their work in a lordotic posture. These workers, working from morning and evening if it is done continuously and for long hours can cause discomfort. The broomsticks used by workers still have shortcomings that make work less effective due to the inconvenience of the work equipment provided.

Based on field observations, the diameter of the broomstick stalk is too small about 2.23 cm and is made of hard material so that the workers developed blisters and calluses. The average length of the broomsticks is 42 cm with a weight of approximately 519.06 grams. The broomstick has a length of about 53 cm. By interviewing several workers, we found that they felt physical pain and complaints after work, namely, pain in the neck to the back, sore and hot palms, even often accompanied by cramps and numbness, as well as and thirst. These workers sweep in a bent posture toward. Sideways and the head lowered, which made fatigue develops quickly. If it happens over a long period of time, it will affect the skeletal muscles of the body which are more at risk if neglected.

Working with equipment that is not in accordance with ergonomic principles and non-physiological work attitudes can cause fatigue, musculoskeletal disorders and increased workload. Work that is not done with an ergonomic work posture for a long duration of time without stretching will cause excessive muscle contraction due to the load on several parts of the body such as neck muscles, shoulder muscles, arm muscles, hand muscles, finger muscles, back muscles, muscles waist and lower muscles (Tarwaka, 2015).

Palilingan (2017) showed that the high value of musculoskeletal complaints in *bendi* coachmen was due to the fact that the chairs did not match the workers' anthropometry. When the load rests on the spine, spasms will occur in the muscles around the back and waist which spontaneously force the posture of the worker to bend, then the back muscles will be stressed and tense to compensate for the body, resulting in lower back pain (Sengadji, 2015). According to Guyton and Hall (2014), strong and prolonged muscle contractions result in muscle fatigue. Muscle fatigue is caused by the inability of the contraction and impaired metabolism of the muscle fibers to continue the same work.

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Types of work tools and facilities that are less comfortable often cause ergonomic problems for workers, and if this work is carried out continuously, negative impact on health will develop, which triggers occupational diseases (Cris, 2012). Manuaba states in Palilingan (2017) that when the work tool is not designed properly, various problems will arise in workers, such as fatigue, musculoskeletal complaints, high workloads, which ultimately results in poor productivity and worker health. This is also in line with the results of observations on street sweepers. Various symptoms are complained because the design of the work tool is not ergonomic, thus caused discomfort in working.

Ergonomic aspects and technological accuracy must be considered in creating a work tool. There are six criteria that must be met to create a work tool in accordance with an appropriate technological approach. These criteria are that these work tools must be considered from a technical, economic, ergonomic, accountability, as well as, not wasting of energy and environmentally friendly (Manuaba 2004).

METHOD

This is a pure experimental research that utilizes the same subject method but is developed in a cross method. In this study, it took a time span *(washing out)* for each team to provide a pause so that the effect of the first treatment given by the researcher disappeared and only then was given the next treatment. The population is street sweeping cleaners in the Niti Mandala Renon area, Denpasar City, Bali.

The number of samples was determined by using *Pocock* method with total sample size was 16 people. This type of research was a cross-design, the 16 samples were divided into control and treatment groups (n=8 for each group). The measuring instruments in this research are; 10 pulse technique, *Nordic Body* questionnaire and subjective fatigue questionnaire. These instruments aim to measure the workload as well as the, subjective and musculoskeletal fatigue of street sweeping cleaners in Denpasar City. Data were processed with SPSS version 20 (IBM, USA). To determine the statistical significance, a paired t-test was carried out with the significance level is set at 0.05.

RESULTS AND DISCUSSION

Sixteen female subjects who worked as street sweeping cleaners in Denpasar, Bali were included in the study. The 16 subjects were divided into two different groups. The first group consisted of 8 subjects using old broomsticks, and the second group consisted of 8 people using new broom stalks. Table 1 shows the age, weight and height and working period of the subjects.

Table 1
Characteristics of Subjects

No	Variable	N	Mean	SD	range
1	Age (yrs.)	16	38.56	3.58	32 - 43
2	Weight (kg)	16	60.06	6.61	45 - 72
3	Height (cm)	16	156.00	5.73	145 - 165
4	working period (yrs.)	16	9.56	1.41	8 - 13

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Normality tests on the three variables of workload, musculoskeletal fatigue and pre-post work fatigue were performed using the *Shapiro Wilk Test (n<50).* The results of the normality test obtained a p score of more than 0.05, which means that the three variables in this study were workload, musculoskeletal fatigue and fatigue before working on the control team and treatment were normally distributed. Homogeneity testing, was carried out using the *Levine's Test* which obtained a p score of more than 0.05. Based on this score, it can be concluded that the sample of this study has a homogeneous variation.

The subjects were divided into two groups: control and treatment groups. Each group consists of 8 subjects. All of the subjects were subjected to a non-dependent t test to determine the conditions for differences in each variable that might occur in each team. The results of these tests are shown in Table 2.

Table 2
Comparability Test Results on Workload, Musculoskeletal Complaints and Fatigue
Variable Group I (control-treatment) Group II (treatment-control)

Variable	Group I			Group II			t	p
	n	Mean	SD	n	Mean	SD		
Workload	8	65.25	2.12	8	66.75	3.69	-0.996	0.336
Musculoskeletal Complaints	8	45.25	2.96	8	45.63	2.50	-0.273	0.789
Fatigue	8	47.63	1.77	8	47.13	1.55	0.601	0.557

Based on the data obtained, it is revealed that the scores of the three variables are p>0.05 which means that there is no significant difference. In other words, the three variables studied in this study, workload, musculoskeletal complaints and work fatigue, both in team I (control-before broom handle repair) and team II (treatment-after broom handle repair) did not have a significant difference. It can be said that the decline score that occurred was due to the intervention provided by the researcher alone.

The score is *period effect* obtained from the sum of the mean of the variable team I (control) period one with the average results of the variable team II (treatment) in the second period. In table 3, the results of the period effect test on street sweeping cleaners will be presented on the three research variables.

Table 3
Period Effect Test Results on Workload, Musculoskeletal Complaints and Fatigue

Variable	Group I			Group II			t	p
	n	Mean	SD	n	Mean	SD		
Workload	8	21.11	3.89	8	22.21	3.92	-0.57	0.58
Musculoskeletal Complaints	8	29.00	3.78	8	25.75	4.28	1.61	0.13
Fatigue	8	19.87	5.17	8	20.25	4.20	-0.16	0.88

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As can be seen on the p score in Table 3, the p values are >0.05, it can be concluded that there is no significant difference between Team I (control-with old broom) and Team II (treatment - with a new broom). In other words, it can be interpreted that team I (control) has no influence on Team II (treatment) and vice versa. As well as workload, increased musculoskeletal complaints and fatigue were only caused by differences in the treatment given by the researchers.

The calculation for the residual effect is done by subtracting the average of the first period (control) team I (control) variables from the mean of the second period (treatment) team II variable. In table 4, the results of the residual effect test on street sweeping cleaners will be presented on the three research variables.

Table 4
Results of the Residual Effect Test on Workload, Musculoskeletal Complaints and Fatigue

Variable	Group I			Group II			T	p
	n	Mean	SD	n	Mean	SD		
Workload	8	86.34	4.90	8	87.44	6.11	-0.40	0.70
Musculoskeletal Complaints	8	26.75	6.30	8	28.00	4.04	-0.47	0.64
Fatigue	8	18.63	4.07	8	21.50	6.05	-1.12	0.28

Judging by the p score in Table 4 which shows a number >0.05, it can be concluded that no significant difference occurred. It can be interpreted that the residual treatment does not have any effect on further treatment. As well as workload, increased musculoskeletal complaints and fatigue were only caused by differences in the treatment given by the researchers.

The calculation for the treatment effect was carried out by comparing the mean of the variable team I (control) period one with the average result of the variable team II (treatment) in the second period. In Table 5, the results of the treatment effect test on street sweeper cleaners will be presented on the three research variables. Latest was also *paired t carried out* because the data had a normal spread.

Table 5
Results of the Treatment Effect Test on the Workload of the Street Sweeper

Variable	n	Control		Treatment		t	p
		Mean	SD	Mean	SD		
Resting Rate	16	64.69	3.24	65.88	3.22	-1.50	0.154
Work Rate	16	118.96	2.26	98.49	2.22	28.69	0.001
Work pulse	16	54.27	3.46	32.61	3.25	21.58	0.001

Referring to Table 5, it can be seen that the p score in the condition before work is >0.05. This score implies that there is no meaningful result or a decrease in workload that may occur simply because of differences in treatment performed by researchers. However, the p score after work shows a result <0.05, which means a change in the new broom handle has an effect on reducing the workload of the street sweeper.

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Table 6 describes the differences in musculoskeletal complaints between Team I (Control) and Team II (Treatment):

Table 6
Results of the Treatment Effect Test on Musculoskeletal Complaints on Street Sweepers

Variable	n	Control		Treatment		t	p
		Mean	SD	Mean	SD		
Musculoskeletal Complaints (before)	16	46.13	2.45	45.44	2.34	0.87	0.397
Musculoskeletal Complaints (after)	16	91.63	2.70	63.56	2.73	24.98	0.001
Ratio	16	45.50	2.92	18.13	3.79	21.36	0.001

In the conditions before work, a score of p>0.05 means that in Team I (control) and team II (treatment), there was no significant difference in terms of musculoskeletal complaints before work. Meanwhile, in the post-work condition, it can be seen that the p score is <0.05, which means that in the post-work condition, there is a significant difference in terms of musculoskeletal complaints between Team I (control) and Team II (treatment). In other words, the use of a broomstick that has been newly designed with the ergonomic method has a positive effect on reducing musculoskeletal complaints in street sweeping cleaners.

The different conditions of fatigue tested on Team I (Control) and Team II (Treatment) can be seen in Table 7.

Table 7
Results of the Test Results of the Fatigue Treatment of Street Sweepers

Variable	n	Control		Treatment		t	p
		mean	SD	Mean	SD		
Fatigue (before)	16	46.50	2.45	46.44	2.34	0.85	0.934
Fatigue (After)	16	77.69	2.96	57.56	2.94	21.95	0.001
Ratio	16	31.19	3.66	11.13	3.12	15.45	0.001

Based on the exposure in Table 7, it can be seen that the p score in the condition before work shows a number >0.05, this means that there is no significant difference in the condition of the street sweepers' fatigue before working, or in other words it can be assumed that the differences that might occur are due to the effect of differences in treatment that the researchers did. While the p score after work shows the result <0.05, which means that there is a significant difference in the fatigue condition of street sweepers after doing their job. It can also be interpreted that the use of a broom stick with a new design can reduce the fatigue of working on street sweepers.

DISCUSSION

The subjects involved in this study ranged from 32 to 37 years with an average age of 38.56 ±3.58 years, which can be categorized into the productive age range. In general, it is known that some physical capacities such as sight, hearing and reaction speed decrease after 40 years of age (Suma'mur, in Aziz 2018). Based on research from Guo et al (in Tarwaka 2011) states that in general, skeletal muscle complaints are felt between the ages of 35-65 years. The first complaint is usually felt at the age of 35 years and the level of complaints will continue to

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increase with age. This can be because at the age of over 35 years, degeneration process starts, causing reduced stability of muscles and joints. As a person ages, bone elasticity decreases and complaints will increase. In addition, this complaint will appear more quickly if it occurs in workers who do work related to muscle and joint activity with excessive workload. This is in line with the results of research that many respondents experienced skeletal muscle complaints in the 36-55 years age category.

Betti'e, *et al* (1989) as quoted by Tarwaka (2011) have conducted a study on muscle static strength for men and women aged between 20-60 years. Their research was focused on the arms, back and legs. The results showed that the maximum muscle strength occurred between the ages of 20-29 years, then it continued to decrease with age. By the time people reach 60 years of age, the mean muscle strength decreases by 20%. Compared to our subjects of street sweepers from Denpasar, our subjects are still in the category of being able to do their activities optimally.

It is known from the measurements taken, the subject's elbow had an average height of about 100.17 ±6.25 cm, with an average palm length of 17.09 ±1.04 cm, the width of the palms had an average of approximately 7.94 ±0.80 cm and the average diameter of the handheld was 3.12 ±0.39 cm. The average hand grip diameter of the research subjects is used as a reference to determine the diameter of the broom handle that will be designed by the researcher.

Based on the rules of the anthropometric design process, the researcher determined the 95th percentile for the redesign of the ergonomics-based broomstick. The 95th percentile is used to determine the diameter of the broom handle, which is 3.5 cm, the height of the broom is 130 cm high and the weight is ±456 grams. After the researcher observes the process of sweeping the road, the researcher concludes that the limb that moves the most in this sweeping process is the upper body part. To facilitate the sweeping process, the researchers designed the broom handle to be 18 cm above the standing elbow. From the results of the interview, the street sweeper said that she felt comfortable using it.

Work pulse will describe the workload conditions felt by individuals. Santosa (2013) states that an individual's heart rate indicates the condition or activity that the individual is doing. When individuals are actively working, angry, or even scared, their pulse rate will also increase. In addition, from the total pulse of a person, it can be seen that their capacity or ability to complete work will also have an impact on their productivity. In this current study, it was found that the pulse rate decreased between the use of an old broom handle (from the mean score of 118.96 ±2.26 bpm) and the use of a new, redesigned broom handle (to 98.49 bpm). This means that there has been a decrease in pulse rate of 17.21%.

Based on Grandjean (2000) work rate category, if an individual has a pulse rate of around 75-100 bpm, it can be said that the individual has a light workload. Then for the number of beats 100-125 bpm, it can be said that the individual has a moderate workload. Finally, if the number of beats reaches 125-150 bpm, it will enter into a heavy workload condition. From this explanation, the we conclude that the workload resulting from the use of the old broom handle, for the workload variable is in the medium category, while the new broom handle which has been redesigned based on ergonomics gives the workload score in the light category. Therefore, providing design modifications to the broom handle with the ergonomic method, can reduce the workload of road sweepers.

Similar research has also proven that ergonomic interventions can reduce workload and increase worker productivity. Research by Rasna (2015) with a modification of ergonomics-oriented weighting on female rice thresher farmers in Subak Denpasar, showed that the workload score can be reduced by 42.3% ($p<0.05$). Likewise, Haryawan (2016) modification of handle shaft *roller* the paint can reduce the workload of 10.77%, on a painter ceiling

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shophouse in Denpasar.

In the old broom form, musculoskeletal complaints were found in all parts of the body starting from the neck to the calves. This complaint was caused by the sweeping process which involved a long bowing (lordotic) posture accompanied by a repetitive swinging motion. After using the newly designed broom handle, musculoskeletal complaints only occurred in the arms, shoulders, knees and calves. Manuaba (1998) states that musculoskeletal complaints at work can occur because of inefficient posture during work.

The results of the research that had been conducted showed that the scores of musculoskeletal complaints that occurred in the first team (control) were 91.63 ±2.70 and in the second team (treatment) around 63.56 ±2.73. The muscle complaints that occurred in the first team (control) were quite large due to the sweeping process that involved the performance of the body muscles (from the neck to the calves) in a standing and bowing position for a long time.

Surata's research in 2011 stated that the reduction in muscle complaints experienced by workers could be reduced by redesigning the tools used by workers. The decrease obtained can reach 56.15%. Suarjana (2018) stated that the application of ergonomics in the redesign the coconut grater reduces musculoskeletal complaints by 28.07%, among workers dough (industry melting in the satay) in Kaba-kaba Village, Kediri Tabanan. Subsequent research conducted by Yasa (2018) shows that the redesign of sanding and tools *hand stretching* can reduce musculoskeletal pain. 53.8% ($p<0.05$) of motorbike paint sanders in Tabanan.

In this current research, there was a decrease in musculoskeletal complaints in street sweeping cleaners by 30.63% with an ergonomic approach method with a score of $p<0.05$, which means that design changes on broom handles with ergonomic and anthropometric approaches can reduce musculoskeletal complaints and create better work convenience.

A tired condition in the body is an early warning that the body is not in good condition and needs a rest to prevent a worse effect in the future, which ultimately results in a decrease in work productivity. This study found a significant difference between fatigue in Team I (control) and Team II (treatment) with a score of $p<0.05$. The fatigue that occurred in Team I (control) could occur due to several factors, both internal (less than optimal body energy) or external (temperature and working environmental conditions). The decrease in fatigue can occur due to the ergonomics application of the new broom design which has been adapted to the anthropometric conditions of the road sweeper during the work process.

In line with this study, the results of by Santosa (2013) who also used ergonomics applications in the design of *dodol* mixer work equipment in Penglatan Buleleng village reduced the level of work fatigue by 22.09%. Research by Rasna (2015) with ergonomically-oriented *gebotan* modification on female rice thresher farmers reduced the level of fatigue in workers by 28.57% ($p<0.05$). Research by Susanta (2017) revealed that the use of an X-ray tube handle that has been redesigned based on ergonomics can significantly reduce general fatigue by 22.38% ($p<0.05$) in radiographers at Sanglah Hospital. And finally, research from Suarjana (2018) states that the application of ergonomics in the redesign of coconut grater reduced fatigue by 25.98%.

In this study, the design of work tools based on ergonomic aspects and anthropometric conditions has succeeded in reducing the level of work fatigue by 25.91% with a score of $p<0.05$. This decrease is the result of the novel broom designs that have succeeded in providing more comfort to workers through the new form of brooms, with designs that encourage the formation of a natural working posture so that the energy required is not too large. Based on this explanation, it can be concluded that the application of ergonomics with consideration of anthropometric aspects and the addition of a sponge to the broom handle is proven to reduce the level of workload, musculoskeletal complaints, and work fatigue experienced by street sweeping cleaners in Denpasar City.

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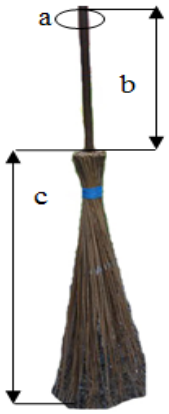

Weight	: 519.06 ± 32.52 gram
Girth (a)	: ± 2.23 cm
Shaft length (b)	: ± 42 cm
Broom length (c)	: ± 53 cm

Figure 1. Broomsticks before redesign with ergonomics applications

Weight	: 456 ± 32.39 gram
Girth (a)	: ± 3.5 cm *(percentile 95)*
Shaft length (b))	: ± 70 cm
Broom length (c)	: ± 60 cm

Figure 2. Broomsticks after Redesign with ergonomics applications

Figure 3.
The work posture of street sweeper cleaners before the broomstick is designed with ergonomics applications.

Figure 4.
The work posture of street sweeper cleaners before the broomstick is designed with ergonomics applications.

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CONCLUSION

The results of the redesign the broomstick with ergonomics applications, with dimensions of 130 cm high, 3.5 cm in diameter and 456 grams of weight can significantly reduce the workload, by 17.21% ($p<0.05$). The redesign of the broomstick with the application of ergonomics was able to significantly reduce musculoskeletal complaints, by 30.63% ($p<0.05$). The redesign of the broomstick with the application of ergonomics significantly reduced work fatigue, by 25.91% ($p<0.05$).

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bengkel bagian proses pengamplasan di desa Tengkudak Tabanan. *Jurnal Ergonomi Indonesia* Vol. 4(2).

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Giving Active Breaks and Snack Reduced Fatigue and Improved Motivation of Work and Productivity of *Jaja Gipang* Employee

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Abstract

The production of *jaja gipang* to packaging is done manually. *Jaja gipang* employee do monotonous work for a long time approximately four hours of work and are accompanied by heat exposure of approximately 29.1^{0}C. Providing active rest and snacks in a participatory manner is very much needed. This study aims to prove and apply active resting and snacking to reduce fatigue and increase work motivation and productivity of *jaja gipang* employees in Sading village. This research is quasi-experimental using treatment by subject design and pre and posttest group design patterns, carried out an assessment in the form of: (a) giving active breaks and snacks to reduce fatigue *jaja gipang* employees measured using a 30 Items questionnaire of Rating Scale; (b) the provision of active breaks and snacks increases the work motivation of *jaja gipang* employees recorded with work motivation questionnaires; (c) giving active breaks and snacks increases the productivity recorded based on the output (the product produced) divided by the input (pulse) multiplied by time. Data collection was carried out before and after work in Period I and Period II of 13 samples for 10 (ten) days. The data obtained were analyzed by t-paired test at a significance level of 5%. The results showed that giving snacks and active breaks reduced fatigue by 27.27%, increased work motivation by 28.20%, and increased the productivity of *jaja gipang* employee by 23.31%. The conclusion is the provision of active breaks and snacks can reduce fatigue and increase work motivation and productivity of *jaja gipang* employee.

Keywords: active breaks, *jaja gipang* employee, snacks

Pemberian Istirahat Aktif dan Kudapan Mengurangi Kelelahan dan Meningkatkan Motivasi Kerja serta Produktivitas Pembuat Gipang

Abstrak

Pembuatan jaja gipang dari proses produksi hingga pengemasan dilakukan secara manual. Pekerja pembuat jaja gipang melakukan pekerjaan secara monoton dalam waktu yang relatif lama kurang lebih empat jam kerja dan disertai dengan paparan panas kurang lebih 29,1^{0}C. Pemberian istirahat aktif dan kudapan secara partisipatori sangat diperlukan. Penelitian ini bertujuan untuk membuktikan dan mengaplikasikan pemberian istirahat aktif dan kudapan mengurangi kelelahan dan meningkatkan motivasi kerja serta produktivitas pembuat jaja gipang di desa Sading. Penelitian ini merupakan quasi experimental dengan model rancangan sama subjek dan pola pre and posttest group design, dilakukan penilaian berupa: (a) pemberian istirahat aktif dan kudapan mengurangi kelelahan pembuat jaja gipang diukur menggunakan kuesioner 30 Items of Rating Scale; (b) pemberian istirahat

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aktif dan kudapan meningkatkan motivasi kerja pembuat jaja gipang didata dengan kuesioner motivasi kerja; (c) pemberian istirahat aktif dan kudapan meningkatkan produkivitas yang didata berdasarkan output (produk yang dihasilkan) dibagi dengan input (denyut nadi) yang dikalikan dengan time (waktu). Pendataan dilakukan sebelum dan sesudah kerja pada Periode I dan Periode II terhadap 13 sampel selama 10 (sepuluh) hari. Data yang diperoleh dianalisis dengan uji t-paired pada taraf signifikansi 5%. Hasil penelitian menunjukkan bahwa pemberian kudapan dan istirahat aktif mengurangi kelelahan sebesar 27,27%, meningkatkan motivasi kerja sebesar 28,20%, dan meningkatkan produktivitas pembuat jaja gipang sebesar 23,31%. Adapun simpulannya adalah pemberian istirahat aktif dan kudapan dapat mengurangi kelelahan dan meningkatkan motivasi kerja serta produktivitas pembuat jaja gipang.

Kata kunci: istirahat aktif, kudapan, pekerja jaja gipang

INTRODUCTION

Sading Village is one of the villages which is famous for its snacks making industrial village. *Jaja gipang* made from rice that is served without preservatives. The process of making *jaja gipang* is still classified as traditional, which is still using a wick stove. The ingredients used in making *jaja gipang* is rice, sugar, and coconut oil. *Jaja gipang* are packed with plastic. The manufacture of *jaja gipang*, from the production process to the packaging, is done manually using muscle power and is done monotonously. The production process starts at 09.00 WITA, preparing equipment such as a frying pan, stirrer, rice that has been developed, sugar, oil, *sentir*, plastic, ruler, and knife. The manufacturing process begins by mixing rice, oil, and sugar from 09.15 am to 09.30 am with a standing position and a bent work attitude. The mixed dough is poured into the mold for 20 minutes of grinding in a standing and bending position. The tool used to press and grind is made from pipe, then the snacks are cut to size using a ruler for 10 minutes. Ummi, et al. (2017) stated that the need for *gipang* cake in the community is greatly increased because it is used as a snack or snack.

Workers carry out the packaging process for a long time, from 10.00 am to 12.00 pm with a bent work attitude while sitting down. The rest period starts from 12.00 pm to 13.00 pm. The production process was continued until 17.00 pm. The packaging process is still done manually using a *sentir, a* traditional lamp. The temperature at the *jaja gipang* production is made is a dry temperature of 29.1^{o}C and a relative humidity of 64.4% and a light intensity of 210 lux. Manuaba (2015) described that the comfortable temperature for Indonesians is between 22^{o}C s.d. 28^{o}C and the relative humidity is between 70 to 80%. The workers are not provided with drinking water, so during work the workers drinking water intake is only approximately 460 ml. This condition can cause workers to experience thirst. The dominant workers who make *jaja gipang* average age is 47 years. Nutrition that are not balanced in the body causes a decrease in the resistance of the human body to work, resulting in fatigue and decreased work productivity. This problem was found in workers who made *jaja gipang*, is the tired condition often experienced by workers after carrying out activities. The average of *gipang* produced by a worker in one day is 644 seeds per person. Putro and Hariyono (2017) state that fatigue is one of the problems that can be found in home industry workers.

The results of a preliminary study of 11 workers found that there were 54.55% of workers whose consumption patterns were inadequate and there was an increase in fatigue by 54.59% and an increase in work pulse by 32.30%. Based on the results of a preliminary study on 11 workers, it is known that the calories consumed by workers is not in accordance with the calories for workers with a rather heavy load with the female gender it is 1,949 kcal. The workers don't get snack or food, so at 15.00 pm the workers experience increased fatigue and decreased work motivation and productivity. The average Body Mass Index (BMI) of workers

is 21.9 kg/m^2 which is still in the normal category. The wage system for workers, namely the daily work mechanism, is given Rp. 60,000. The workers do not get days off. If workers take a day off, the worker will not get paid. Participatory in ergonomics is the involvement of all workers from the beginning to the completion of an activity. Work motivation through providing active rest and snacks is needed in overcoming work fatigue. Provision of active rest, in which workers will carry out activities to take *jaja gipang* wrappers in the space provided and workers take snacks and drinking water available at the workplace. Based on this description, it is necessary to conduct research on how to reduce fatigue and increase work motivation and productivity through providing active rest and snacks.

METHOD

This research is a quasi-experimental study using the same subject design (treatment by subject design) and the pre and post-test group design including Period I (without intervention) and Period II (with intervention) interspersed with a washing out period for a day on Sundays to eliminate the residual effect of Period I. Furthermore, the subject was given the opportunity to adapt for a day by providing active rest and snacks. The new findings in this study are the provision of active rest and snacks. The implications of these findings on the one hand can improve the quality of *jaja gipang* employee health and on the other is increase productivity. The research subject was the *jaja gipang* employee in Sading Village, Mengwi District, Badung Regency. The population in this study were all of the *gipang jaja* employee in the village of Sading totalling 13 people. The samples involved in this study were 13 people with a total sampling method. The data about Fatigue was measured using 30 items of rating scale questionnaire, work motivation was measured using a work motivation questionnaire and productivity was measured using the output (product produced) divided by the input (pulse) multiplied by time. The data obtained will be analyzed, is: (a) data on the characteristics of *gipang jaja* employee and environmental conditions analyzed descriptively for means and standard deviations; and (b) data on fatigue, work motivation and productivity, were analyzed using t-paired test at a significance level of 5%.

RESULTS AND DISCUSSION

The results of hypothesis on fatigue can be seen in Table 1.

Table 1
Hypothesis Test Results on Fatigue in *Jaja gipang* Employee

Variable	Period I		Period II		t value	p value
	Mean	SD	Mean	SD		
Fatigue (Before Work)	30,51	0,400	30,31	0,480	1,689	0,117
Fatigue (After Work)	61,31	1,974	44,59	0,894	27,018	0,0001
Fatigue (deviation)	30,79	2,176	14,28	0,961	28,729	0,0001

The fatigue of the workers who made *jaja gipang* after working decreased by 27.27%. Providing intervention to workers who make *jaja gipang* in the form of rest that is balanced with working time so that their physical capacity is more in line with the demands of the job. The characteristics of the workers who make *jaja gipang* work stand for 4 hours in the

production process and sit for 4 hours in the packaging process. The workers who make *jaja gipang* tend to work with a static work attitude with a bent position when the packaging process is monotonous and repetitive. The application of active rest can reduce the burden due to the sitting position during the packaging process for a period of ±4 hours and also increase the variety of activities. Thus, active rest can increase blood flow which can affect metabolism and increase work endurance so that it can slow down the onset of fatigue. Green (2002) states that even the shortest of active breaks can reduce fatigue levels. In addition, providing snacks between work hours can reduce work boredom and consequently can reduce fatigue. Environmental conditions (temperature, light intensity, humidity, and noise) in periods I and II are comparable or have the same effect on changes in fatigue, work motivation and productivity. Snacks are given at 15.00 WITA in a participatory manner, it is by asking workers about the types of snacks and the dosage is adjusted to the average BMI of the workers. The types of snacks provided are *klepon*. *Klepon* is a snack made from rice flour or sticky rice which contains brown sugar. The nutritional of *klepon* is that 1 *klepon* has 100 kcal consisting of 23% fat, 72% carbohydrates and 5% protein. *Klepon* given was 3 pieces which were in accordance with the average calorie of workers, it is 214.73 kcal. The decrease in the level of fatigue is caused by the regulation of active rest and optimization of rest periods so that the body's endurance is better maintained. The application of active rest periods is by doing walking activities to grab snacks and take plastic and water which can reduce fatigue. The reduction in fatigue is physiologically caused by the oxygen supply obtained after active rest and the nutritional intake obtained by the *gipang* workers.

Regarding these findings, several researchers reported that providing adequate and appropriate active rest can reduce fatigue in workers by 17.78% (Puspadewi, et al., 2018); improving working conditions through a total ergonomic approach, namely regulating work attitudes, providing short breaks, and providing tea can reduce worker fatigue from 37.77% to 35.37% (Adiatmika, 2007); giving bananas, short breaks and stretching can reduce worker fatigue in oil palm harvesters by 23.75% (Damantalm, 2018); giving snacks in the form of sweet tea and applying short breaks to odontectomy practitioners in the Department of Dentistry can reduce fatigue 52.73% to 47.00% (Wiradharma, 2012); and the application of active rest to sculptors associated with the culture that is developing in the local community, namely at Tengai Tepet or 12.00 WITA and Sandikala or 18.30 WITA may not do work and are able to improve blood circulation so that resulting in a decrease in fatigue by 11.27% (Sutajaya & Ristiati, 2014). The results of hypothesis testing on work motivation can be seen in Table 2.

Table 2
Hypothesis Test Results on Motivation of Work in *Jaja gipang* Employee

Variable	Period I		Period II		t value	p value
	Mean	SD	Mean	SD		
Motivation of Work (Before work)	32,36	1,015	42,02	1,554	23,005	0,0001
Motivation of Work (After work)	57,29	2,178	83,97	4,509	18,941	0,0001

The work motivation of *jaja gipang* employee has increased by 46.57%. As for the increase in work motivation is due to the subjective impression because of the various benefits and attention obtained such as providing active rest and providing snacks. The low work

motivation is caused by the provision of a wage (salary) of Rp. 60,000 rupiah for one work. The wage system in this industry uses a daily system. The workers are not given anything during the work process. This can be seen from the results of the questionnaire that the boss pays less attention to workers, such as never being given an award so that work motivation decreases. This results in workers just coming and working without any internal motivation to learn about their abilities. After the intervention was carried out in the form of providing active rest and snacks, the workers experienced an increase in motivation at work which was evident from the enthusiasm of the workers to make a schedule regarding taking drinking water from *Beji* which is located near the production process with a distance of ±700 meters. Initially the workers brought water from the house with a size of only ±240 ml, but after an agreement was made between the researcher and the company owner regarding the importance of providing a water container, it was followed up with the provision of a drinking water container in the workplace.

Arida (2010) reports that work motivation affects worker performance. Workers who have high work motivation will use all their abilities to complete their work. Self-awareness process can be done to motivate someone. Work motivation aims to encourage workers to be able to work optimally and optimally so that it benefits the company. The individual factors that influence a person's motivation are needs, goals, attitudes, and abilities, and factors originating from the organization, namely pay, job security, fellow workers (co-workers), supervision, praise (praise), and work done by him (job itself). Related to this research, several researchers reported: (a) Theodora (2015) reported that providing active rest can increase the work motivation of PT. Sejahtera Motor Gemilang 24.35%; (b) Manurung (2008) states that the company policy at PT. X which is related to providing snacks can increase work motivation at PT. X which includes the wage system, working days, recreation and sports, rewards. A harmonious relationship between workers and company owners so that the job can be done well. (c) Widana (2012) reported that the implementation of ergonomics in the form of active rest application and nutrition in the form of sticky rice cakes and sweet tea can increase work motivation by 12.14% in vegetable farmers in Tabanan Bali; (d) Sutajaya (2006) reports that learning through the SHIP approach can increase motivation by 48.5% of students of the Department of Biology Education, IKIP Singaraja. The results of hypothesis testing on productivity can be seen in Table 3.

Table 3
Hypothesis Test Results on Productivity in *Jaja Gipang* Employee

Variable	Period I		Period II		t value	p value
	Mean	SD	Mean	SD		
Productivity	19,63	0,613	27,65	0,717	33,878	0,0001

Productivity is calculated based on the increase in the number of products produced as output and the pulse as input with in a four-hour working duration. The average productivity of *jaja gipang* employee in period I was 19.63 and in period II was 27.65 or an increase of 40.86%. The increase in productivity by an increase of *jaja gipang* products that can be completed at the same time and through consideration of workloads with pulse indicators which are predominantly influenced by the increase in the results of making and packing snacks. In addition, it was caused by ergonomic interventions in the form of active resting and provision of snacks in period II. A balanced nutritional intake, together with the provision of active rest for 3 minutes, can maintain the optimal physiological condition of the *gipang* maker

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workers so that the body's metabolism remains normal which in turn will be able to increase work productivity.

The presence of rest arrangements seems to take up work time so it is feared that the amount of production will decrease. However, it is proven that by taking optimal rest and active rest for about 3 minutes and giving snacks, the physical and psychological condition of workers can be maintained so that the amount of production will not decrease due to fatigue and work motivation. The average amount of production has increased due to adequate rest so that workers can be better prepared and ultimately more dexterous at work. Ergonomic intervention through the application of active rest and provision of snacks is intended to create conformity between workers and task demands so that workers can create a match between workers and job demands and workers can carry out their duties safely, comfortably and productively (Sutajaya, 2018). In the first period of each worker, the average *gipang* produced per day was 470 *jaja gipang* seeds, while in the second period it increased to 579 seeds per day. In other words, the amount of production for each worker of *jaja gipang* maker has increased by approximately 109 seeds per day with active rest and snacks.

In relation to this research, several researchers reported that: (a) Puspadewi (2018) reported that there was an increase in productivity of 19.05% due to the application of active rest to ceramic forming workers at BTIKK BPPT Bali; (b) Ariati (2013) reports that work productivity can be influenced by various factors that play an important role in work, one of which is work nutrition. The application of ergonomics is carried out through a system, which is studied through interdisciplinary studies, and is holistic or all problems are studied thoroughly and involves participation from all parties involved. The intervention was given in the form of active rest and snacks which were given in a participatory manner and combined with the application of appropriate technology, namely: (a) economically, the cost of buying snacks (*klepon*) was very affordable so as not to cause harm to the company; (b) technically the implementation of active rest can be done or carried out by workers who manufacture *jaja gipang*; (c) in a health condition, a safe, comfortable, healthy, fit, effective and efficient condition can be created after active rest activities are carried out; (d) socially and culturally it can be mutually accepted by workers and entrepreneurs making *jaja gipang*; (e) energy use can be reduced; and (f) will not damage the environment. This shows that industrial owners benefit by increasing the amount of production produced by their workers.

Figure 1. The worker who makes *Jaja Gipang* during the snack packaging process in a sitting position for 4 hours of work

Meanwhile, the expenditure for providing snacks was not too burdensome, as evidenced by the willingness and enthusiasm of the industrial owners and workers to provide snacks and look for drinking water in *Beji* a holy temple near the production site. The increase in profits

during one production after being given intervention in the form of providing active rest and snacks is Rp. 401,200. With the increase in the production process produced by workers, it is hoped that the owner of the company can increase the salaries (wages) of workers so that it is expected that the welfare and work motivation of the workers who make *jaja gipang* workers will increase. The documentation for giving active rest and snacks is as follows at Figure 1 and Figure 2.

Figure 2. Workers who make *Jaja Gipang* take active rest by walking and taking the snacks provided

CONCLUSION

The conclusions of this study are: (a) providing active rest and snacks can reduce fatigue of *jaja gipang* employee by 27.27%; (b) providing active rest and snacks can increase the work motivation of workers who make *jaja gipang* by 46.57%; and (c) providing active rest and snacks can increase the productivity of the *jaja gipang* employee by 40.86%. Suggestions that can be conveyed in this study are: (a) workers who make *jaja gipang* should keep doing active rest activities and pay attention to nutritional intake in the form of snacks in order to reduce fatigue and increase work motivation and productivity; (b) company managers should pay attention to active resting and snacks in order to reduce fatigue and increase motivation and productivity and not cause health problems to workers.

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Analisis Antropometri Mahasiswa Untuk Desain Mebel pada Program Studi Desain Interior Universitas 'X' di Surabaya

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Abstrak

Kegiatan belajar mengajar bagi mahasiswa desain interior Universitas 'X', dari semester awal hingga semester akhir memiliki aktivitas yang cukup berbeda. Kebutuhan mebel pengisi ruang interior pun tentu berbeda, sehingga dibutuhkannya mebel yang dapat sesuai dan nyaman bagi pengguna untuk menunjang aktivitas tersebut. Faktor utama yang dapat mendukung kesesuaian dan kenyamanan aktivitas terhadap mebel yang digunakan adalah pentingnya data ukuran tubuh mahasiswa, agar data tersebut dapat menjadi pedoman perancangan desain. Penelitian ini bertujuan untuk mendapatkan data antropometri mahasiswa program studi desain interior yang lebih akurat dan sesuai, sehingga penelitian dapat menjadi acuan untuk perancangan mebel pendukung aktivitas di kelas kuliah dan studio desain interior. Metode penelitian yang digunakan adalah campuran metode kualitatif (studi lapangan dan observasi) dan kuantitatif (survei dalam bentuk kuisioner) untuk dapat menampilkan fakta data antopometri serta pendapat pengguna terhadap kenyamanan dan kepuasan penggunaan mebel. Hasil dari penelitian ini adalah ukuran antropometri mahasiswa desain interior untuk dapat menjadi acuan perancangan mebel penunjang aktivitas program studi desain interior Universitas 'X' dan data dimensi ukuran mebel yang sesuai dengan data antropometri mahasiswa.

Kata kunci: antropometri, desain interior, mahasiswa

Student Anthropomethry Analysis for Furniture Design in Interior Design Study Program 'X'University in Surabaya

Abstract

Teaching and learning activities for interior design students of 'X' University, from the begining of semester to the end of semesterhave quite different activities. The need for interior space fill furniture is certainly different, so the need for furniture that could be suitable and comfortable for users to support these activities. The main factor that can support the suitability and conveniece of activities for the furniture used is the importance of student body size data, so that the data can be used as design guidelines. This study aims to obtain anthropometric data for interior design students that are more accurate and appropriate, so that research could be a reference for designing furniture supporting activities in lecture classes and interior design studios. The research method used is a mixture of qualitative methods (field studies and observations) and quantitative (surveys in the form of questionnaires) to be able to display the facts of antopometric data and user opinions on the convenience and satisfaction of using furniture. The results of this study are the anthropometry measurements of interior design students to become a reference for the design of furniture supporting the activities of the 'X' University interior design study program and the dimensions of furniture size data in accordance with student anthropometric data.

Keyword: anthropometry, interior design, student

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PENDAHULUAN

Antropometri adalah suatu bidang ilmu yang bertujuan khusus untuk mempelajari ukuran tubuh manusia, ukuran tubuh manusia dapat berbeda-beda disebabkan oleh berbagai faktor. Tujuan dari pengukuran perbedaan tubuh adalah agar dapat mengetahui acuan rata-rata ukuran tubuh, sehingga tidak terlalu menyimpang jauh dari yang sebenarnya dan dapat mengurangi tingkat kecelakaan kerja (Iridiastadi & Yassierli, 2015). Kesesuaian ukuran tubuh dengan ukuran mebel untuk menunjang kegiatan/aktivitas bertujuan agar aktivitas pengguna efektif, efisien, dan juga dapat meningkatkan produktivitas kerja (Iridiastadi & Yassierli, 2015).

Menurut pengamatan lapangan, kuisioner, dan wawancara terhadap mahasiswa Program Studi Desain Interior Universitas X, terbukti bahwa mebel yang digunakan sebagai sarana pembelajaran di Universitas X masih belum sesuai dengan kebutuhan dari pengguna. Hal ini disebabkan karena ukuran mebel yang digunakan masih belum berpedoman pada ukuran tubuh pengguna. Mahasiswa Program Studi Desain Interior Universitas X, memiliki jumlah perempuan (354) lebih banyak dibanding laki-laki (112), dari data Tabel 1 terlihat bahwa ukuran tubuh mahasiswa laki-laki dan perempuan sangat berbeda. Begitu pula dengan penelitian dari Ismaila (2013) terhadap mahasiswa Nigeria dan penelitian dari Octivjani (2011), yang menjelaskan bahwa ukuran tubuh mahasiswa laki-laki lebih besar dari perempuan, dari penelitian tersebut juga didapatkan bahwa ukuran tubuh antara mahasiswa Nigeria dengan mahasiswa Indonesia memiliki ukuran yang berbeda. Perbedaan ukuran tubuh tersebutlah yang dapat mempengaruhi ukuran untuk perancangan mebel agar ukuran mebel dapat disesuaikan dengan kebutuhan dan ukuran tubuh penggunanya.

Perbedaan dari antropometri tersebut merupakan salah satu alasan pentingnya melakukan penelitian ini agar dapat menentukan ukuran mebel yang sesuai dengan pengguna. Penelitian tentang antropometri terhadap mahasiswa Program Studi Desain Interior ini bertujuan untuk menghasilkan antropometri mahasiswa perempuan dan laki-laki di Universitas X. Adapun data antropometri yang didapatkan juga dapat menjadi bahan pertimbangan acuan ukuran mebel penunjang aktivitas di kampus yang sesuai dengan ukuran penggunanya. Sehingga untuk merancang mebel kedepannya dapat disesuaikan dengan ukuran dari data antropometri dipenelitian ini, dan pertimbangan aktivitas pengguna yang berbeda dari penelitian ini.

METODE

Penelitian ini dilakukan dengan pengamatan terhadap pengguna mebel (aktivitas dan tingkah laku), pengukuran antropometri dengan metode statis. Subjek pada penelitian ini adalah mahasiswa Program Studi Desain Interior angkatan 2016-2019, di Universitas ‘X Surabaya. Pengambilan sampel secara acak menggunakan rumus slovin dengan *margin of error* sebesar 5%, total sampel 215 data mahasiswa (70 laki-laki dan 145 perempuan) dari populasi 466 mahasiswa aktif, pengamatan dan pengukuran dilakukan dari bulan Januari hingga Maret 2020. Penelitian ini juga disertai dengan pembagian kuisioner dengan pertanyaan seputar kesesuaian ukuran dan kebutuhan mebel bagi pengguna. Hasil dari penelitian ini adalah ukuran mebel yang sesuai dengan kebutuhan dan ukuran tubuh mahasiswa, dengan pertimbangan dari pengamatan lapangan dan perhitungan berdasarkan sumber literatur. Penelitian ini dilakukan secara terstruktur berdasarkan diagram alur penelitian yang telah dilakukan, seperti pada Gambar 1.

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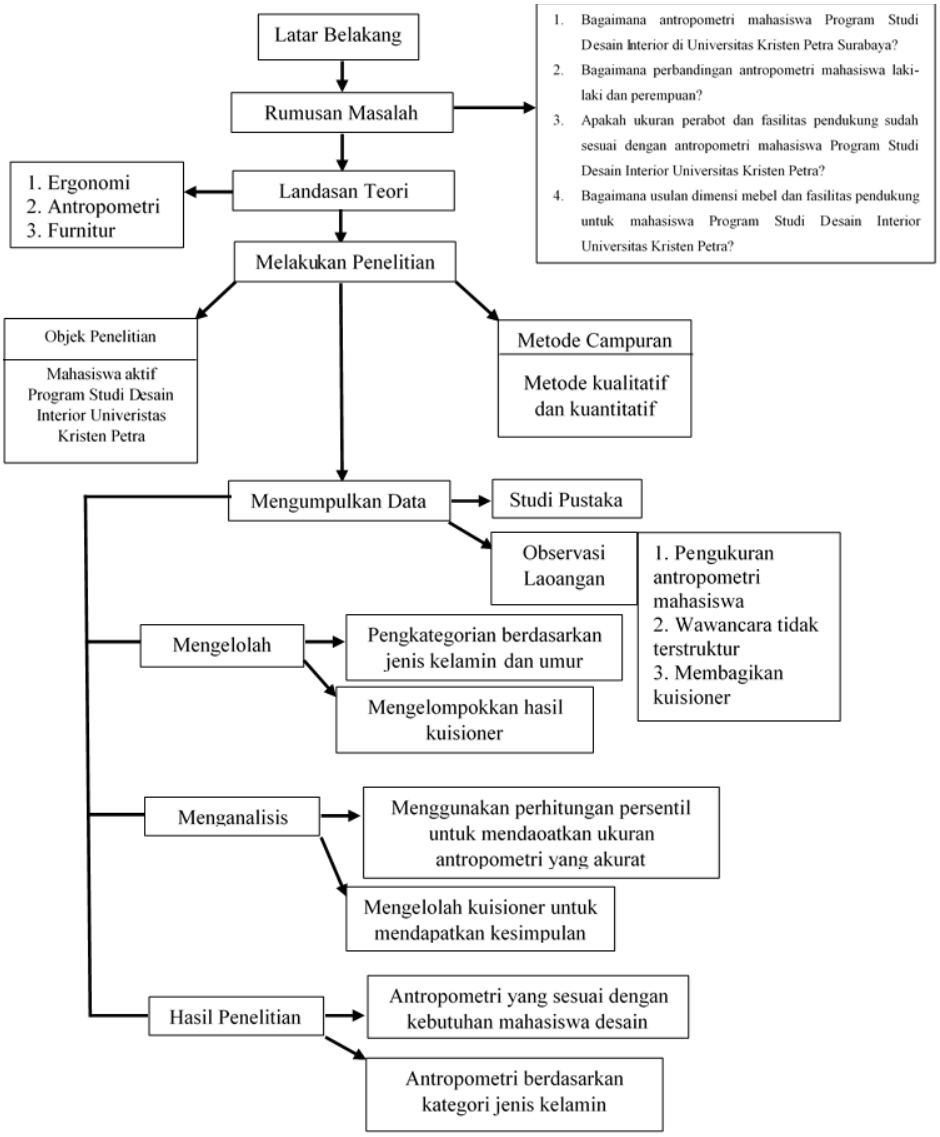

Gambar 1. Diagram Alur Penelitian

HASIL DAN PEMBAHASAN

Penelitian ini dilakukan di Universitas ‘X’ khususnya untuk mebel penunjang aktivitas di ruangan yang digunakan mahasiswa Program Studi Desain Interior, seperti: Material Library, Laboratorium Komputer, Laboratorium Bahan, Laboratorium Kayu, Laboratorium Tekstil, Ruang Kelas, dan Studio Interior. Berikut ini merupakan antropometri mahasiswa yang telah dikelola:

Tabel 1
Antropometri mahasiswa program studi desain interior tahun 2020

No	Dimensi tubuh	Statistik deskriptif (cm)		
		Persentil	Pria	Wanita
1	Tinggi tubuh pada posisi berdiri tegak	Rerata	171	158
		Sd	7	5
		P5	160	150
		P95	182	166

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2	Tinggi mata	Rerata	159	147
		Sd	6	5
		P5	148	139
		P95	169	155
3	Tinggi bahu	Rerata	140	130
		Sd	6	5
		P5	130	121
		P95	150	138
4	Tinggi siku	Rerata	109	99
		Sd	11	6
		P5	90	89
		P95	128	109
5	Cengkraman tangan pada posisi rileks ke bawah	Rerata	74	69
		Sd	4	4
		P5	67	63
		P95	81	75
6	Tinggi badan posisi duduk	Rerata	89	82
		Sd	5	4
		P5	81	76
		P95	97	88
7	Tinggi mata posisi duduk	Rerata	77	71
		Sd	4	4
		P5	70	65
		P95	85	78
8	Tinggi bahu posisi duduk	Rerata	58	57
		Sd	4	48
		P5	51	48
		P95	64	65
9	Tinggi siku posisi duduk	Rerata	23	25
		Sd	4	3
		P5	17	20
		P95	30	30
10	Tebal paha	Rerata	15	11
		Sd	3	2
		P5	10	7
		P95	21	15
11	Jarak dari pantat ke lutut	Rerata	55	53
		Sd	4	4
		P5	47	46
		P95	62	59
12	Jarak dari lipat lutut ke pantat	Rerata	46	47
		Sd	4	3
		P5	40	41
		P95	52	53
13	Tinggi lutut	Rerata	52	49
		Sd	3	3
		P5	47	45
		P95	57	53
14	Tinggi lipat lutut	Rerata	43	41
		Sd	3	2
		P1	36	36
		P5	38	38
		P95	48	43

15	Lebar bahu	Rerata	46	45
		Sd	4	3
		P5	40	39
		P95	53	50
16	Lebar panggul	Rerata	20	23
		Sd	5	6
		P5	12	12
		P95	47	45
17	Tebal dada	Rerata	20	23
		Sd	5	6
		P5	12	12
		P95	28	33
18	Tebal perut	Rerata	20	19
		Sd	6	4
		P5	10	13
		P95	31	25
19	Jarak dari siku ke ujung jari	Rerata	47	44
		Sd	3	2
		P5	41	40
		P95	53	48
20	Lebar kepala	Rerata	18	19
		Sd	2	2
		P5	15	16
		P95	21	22
21	Panjang tangan	Rerata	19	18
		Sd	1	1
		P5	17	16
		P95	20	20
22	Lebar tangan	Rerata	11	11
		Sd	1	1
		P5	9	9
		P95	12	12
23	Jarak bentang dari ujung jari	Rerata	172	163
		Sd	9	7
		P5	158	152
		P95	187	174
24	Tinggi pegangan tangan pada posisi tangan vertikal ke atas dan berdiri tegak	Rerata	207	197
		Sd	14	8
		P5	184	184
		P95	230	210
25	Tinggi pegangan tangan pada posisi tangan vertikal ke atas dan duduk	Rerata	141	123
		Sd	21	20
		P5	106	90
		P95	175	156
26	Jarak genggaman tangan ke punggung pada posisi tangan ke depan (horisontal)	Rerata	72	66
		Sd	6	5
		P5	62	58
		P95	82	74

Mebel penunjang aktivitas untuk mahasiswa Program Studi Desain Interior adalah meja kerja laboratorium, meja komputer, meja studio, meja dan kursi kelas, kursi studio, kursi

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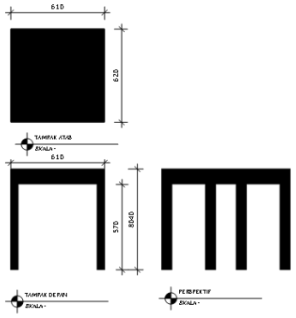
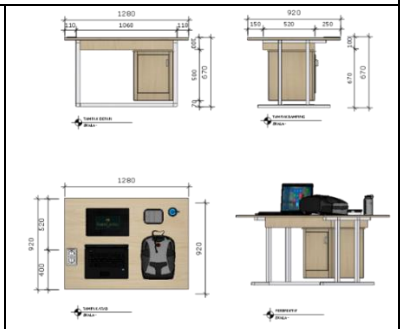
laboratorium, loker, dan *display*. Berikut ini adalah hasil analisis dan usulan ukuran mebel yang disesuaikan dengan antropometri dan kebutuhan mahasiswa. Untuk perhitungan ukuran meja sesuai antropometeri diperoleh hasil seperti Tabel 2.

Tabel 2
Analisis Perhitungan Usulan Ukuran Meja

Usulan Ukuran Meja(Satuan dalam mm)				
				
Meja Laboratorium	Meja Komputer		Meja Studio	
Analisis Perhitungan				
Kategori	Antropometri	Persentil	Literatur (satuan dalam cm)	
Tinggi Permukaan Meja	(9+14)	P5(Wanita)+15% sol sepatu	70-78	Kroemer dan Grandjean 1997,Panero dan Zelnik, 2003, dan Ismaila 2013
Tinggi Keyboard dari Permukaan Meja	(9+14)	P5(Wanita)	10 di bawah meja	Purnomo, 2013 dan Lawson 2013
Ruang Gerak Bawah Meja	13	P95(Pria)	54,7-69,9	Panero dan Zelnik, 2003
Panjang Meja	16	(P95(Pria)+15% pakaian+15% jarak bersih)	101-162	Purnomo, 2013dan Ismaila 2013
Kedalaman Meja	26	P5(Wanita)	60-76	Lawson 2013dan Purnomo, 2013
Jangkauan Stopkontak	19	P5(Wanita)	35,5-67,3	Purnomo, 2013
Tinggi Sandaran Kaki	14	P5-P1(Wanita)	2-23	Purnomo, 2013
Jangkauan Sandaran Kaki	11	P5(Wanita)	42	Purnomo, 2013
Tinggi Loker	Barang bawaan+15% jarak bersih			
Kedalaman Loker			45,7-66	Panero dan Zelnik, 2003
Lebar Loker	15	P5(Wanita)	33	Gani 17

Menurut Kroemer dan Grandjean (1997), ketinggian permukaan meja harus berada di bawah siku (tinggi siku posisi duduk dan tinggi lipat lutut) agar pengguna tidak perlu memaksakan bahunya untuk naik mengimbangi aktivitasnya. Perhitungan menggunakan persentil kecil agar pengguna bertubuh kecil dapat menggunakan dengan nyaman dan tidak memaksakan diri. Menurut Ismaila (2013), perhitungan tinggi permukaan meja harus ditambahkan 15% untuk perkiraan menggunakan sol sepatu.

Menurut Purnomo (2013), perhitungan untuk tinggi peletakkan *keyboard* menggunakan tinggi siku duduk ditambah dengan tinggi lipat lutut oleh persentil kecil. Agar siku pengguna berukuran tubuh lebih kecil sejajar dengan tinggi *keyboard.* Menurut Panero dan Zelnik (2003), untuk menghitung ruang gerak di bawah meja harus menggunakan ukuran tinggi lutut dengan mempertimbangkan persentil besar agar meja tidak terbentur lutut dari pengguna bertubuh besar.

Menurut Ismaila (2013), panjang meja yang dibutuhkan untuk 1 orang menggunakan perhitungan dari lebar panggul persentil 95 ditambahkan 15% untuk pakaian dan 15% untuk jarak bersih. Sedangkan perhitungan untuk lebar meja untuk jarak ideal sebaiknya menggunakan jangkauan tangan horizontal ke depan oleh persentil kecil, agar pengguna

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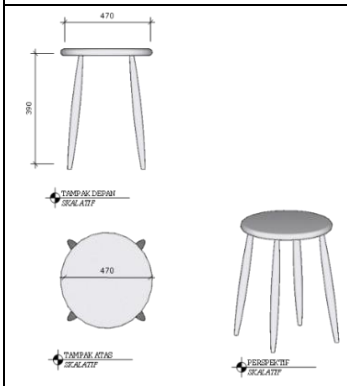
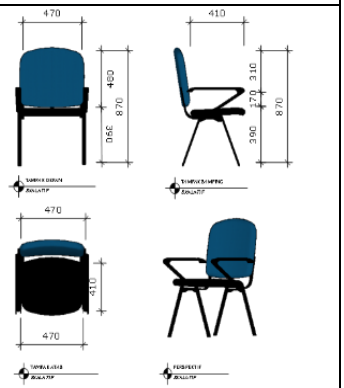
berukuran tubuh kecil tidak memaksa dalam menjangkau area terjauh meja (Purnomo, 2013). Khusus untuk panjang meja komputer di atasdigunakan untuk 2 orang, sehingga panjang meja awal dikali 2 orang (122 cm) dan ditambahkan kebutuhan lain untuk menempatkan CPU dengan ukuran maksimal 20 cm, jadi panjang meja yang dibutuhkan untuk 2 orang adalah 142 cm.Panjang dan lebar untuk meja studio dihitung dengan mempertimbangkan barang yang akan diletakkan oleh mahasiswa menurut kuisioner (Laptop 44x25 cm, sketchbook A3 42x30 cm, dan tas laptop 15 in)

Menurut Purnomo (2013), jangkauan normal di meja kerja saat duduk sebaiknya mempetimbangkan ukuran dari jarak siku ke ujung jari P5, hal ini agar pengguna tidak perlu berdiri atau menggapai terlalu jauh saat menjangkaunya. Perhitungan untuk ketinggian sandaran kaki dapat dihitung dengan mengurangi P5-P1 dari tinggi lipat lutut (Purnomo, 2013). Menghitung jangkauan sandaran kaki dengan memperkirakan letak kaki pengguna saat menggunakan meja, pengguna akan cenderung mendaratkan kaki di area bawah meja saat duduk, sehingga dapat menghitung dengan jarak dari pantat ke lutut P5 agar pengguna berukuran tubuh kecil dapat menjangkau sandaran kaki (Purnomo, 2013).

Selanjutnya untuk analisis perhitungan ukuran kursi sesuai dengan anthropomteri, disajikan seperti pada Tabel 3.

Tabel 3
Analisis Perhitungan Usulan Ukuran Kursi

Usulan Ukuran Kursi(Satuan dalam mm)				
				
Kursi Tanpa Sandaran	Kursi Sandaran Punggung		Kursi Sandaran Tangan	
Kategori	Antropometri	Persentil	Literatur (Satuan dalam cm)	
Tinggi Alas Duduk dari Lantai	14	P5(Wanita)+0,45cm untuk sol sepatu	36,45-38,9	Ismaila, 2013 dan Purnomo, 2013
Tinggi Sandaran Punggung dari Permukaan Tempat Duduk	8	P5(Wanita)	42	Ismaila 2013 dan Panero dan Zelnik 2003
Tinggi Sandaran Tangan	9	P5(Pria)	15,5-23,4	Ismaila, 2013 dan Purnomo, 2013
Diameter Alas Duduk	16	P95(Pria)+15% untuk pakaian	40,2-43,9	Ismaila, 2013 dan Purnomo, 2013
Kedalaman Alas Duduk	12	P5(Wanita)	32,05	Ismaila 2013
Lebar Alas Duduk	16	P95(Pria)+15% untuk pakaian	40,2-43,9	Ismaila, 2013 dan Purnomo, 2013
Lebar Sandaran Punggung	16	P95(Pria)+15% untuk pakaian	41,4	Ismaila 2013
Sudut Sandaran Punggung	90 º		100-110 º	Ismaila, 2013 dan Purnomo, 2013

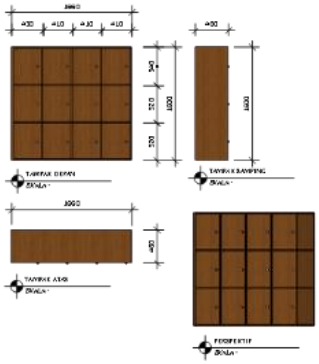
Menurut Purnomo (2013), pengguna (terutama persentil kecil) harus menapakkan kakinya ke lantai saat menggunakan kursi, idealnya ketinggian alas duduk harus sama dengan tinggi lipat lutut agar lutut pengguna dapat membentuk siku 90º. Perhitungan tinggi alas duduk juga perlu ditambahkan 0,45 cm untuk memperhitungkan ketinggian dari sol sepatu pengguna (Ismaila, 2013). Menurut Panero dan Zelnik, standar untuk ketinggian punggung harus dapat mengakomodasi seluruh punggung pengguna, namun dalam penggunaanya pengguna tetap

dapat bebas bergerak. Menurut Ismaila (2013), perhitungan menggunakan tinggi bahu posisi duduk oleh persentil kecil, agar pengguna dapat tetap bebas bergerak. Menurut Purnomo (2013), tinggi sandaran tangan yang harus berada tepat dengan tinggi siku posisi duduk dari pengguna berukuran tubuh kecil, tujuannya agar pengguna dapat mengistirahatkan tangannya dengan mudah.

Menurut Purnomo (2013) perhitungan untuk lebar alas duduk menggunakan persentil 95 dalam perhitungannya agar pengguna bertubuh besar dapat menggunakan kursi tersebut, dan pengguna bertubuh kecil juga tidak terganggu terhadap ukuran tersebut. Menurut Panero dan Zelnik (2003), kedalaman alas duduk yang ideal harus dapat mengakomodasi jarak lipat lutut ke pantat tetapi tetap memperhatikan pengguna berukuran tubuh kecil, agar kaki pengguna tidak menggantung dan menyebabkan peredaran darah tidak lancar. Purnomo (2013) perhitungan untuk lebar alas duduk dan sandaran punggung menggunakan persentil 95 dalam perhitungannya agar pengguna bertubuh besar dapat menggunakan kursi tersebut, dan pengguna bertubuh kecil juga tidak terganggu terhadap ukuran tersebut. Menurut Purnomo (2013), sudut normal untuk sandaran kursi adalah 100-110º, semakin besar sudut sandaran punggung semakin besar beban tulang punggung ditopang oleh sandaran tersebut. Penentuan sudut sandaran kursi perlu disesuaikan dengan kebutuhan, untuk sandaran kursi di atas sebaiknya menjadi 100º agar mahasiswa tetap fokus dan rileks dalam melakukan aktivitasnya.

Sementara itu, dilakukan pula analisis ukuran loker sebagai tempat penyimpanan berbagai perlengkapan. Hasil analisis disajikan seperti Tabel 4.

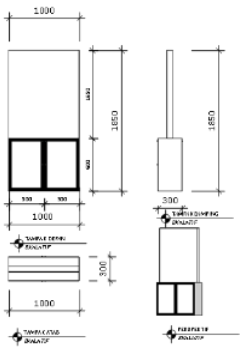
Tabel 4
Analisis Perhitungan Usulan Ukuran Loker

Usulan Ukuran Loker (Satuan dalam mm)				
				
Kategori	Antropometri	Persentil	Literatur (Satuan dalam cm)	
Tinggi Lemari	24	P5(Wanita)	137,2-180	Panero dan Zelnik, 2003 dan Gani, 2017
Tinggi Loker	Barang bawaan+15% jarak bersih			
Kedalaman Loker			45,7-66	Panero dan Zelnik, 2003
Lebar Loker	15	P5(Wanita)	33	Gani 2017

Tinggi Lemari Menurut Gani (2017), jangkauan maksimal untuk mencapai lemari tertinggi menggunakan perhitungan dari tinggi tangan vertikal ke atas posisi berdiri oleh persentil 5, agar seluruh pengguna dapat dengan mudah mencapai tinggi maksimalnya. Menurut kuisioner tanggapan mahasiswa, rata-rata menyatalan barang bawaan adalah A3 tinggi maksimal 43 cm, tas laptop lebar maksimal 39 cm. Sehingga untuk mendapatkan ukuran minimal untuk loker barang bawaan ditambahkan dengan 15% untuk jarak bersih. Menurut Gani (2017), untuk menentukan lebar loker minimal dapat mempertimbangkan ukuran dari lebar bahu persentil 5.

Salah satu hal penting yang perlu diperhitungkan adalah ukuran display yang akan dipasang. Hasilanalisis seperti pada Tabel 5.

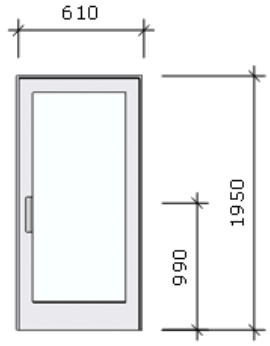
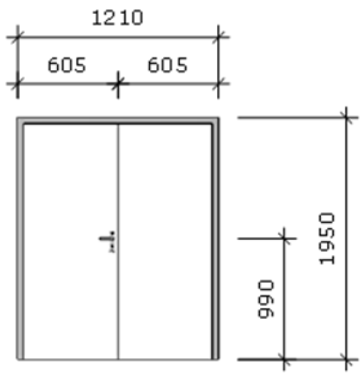
Tabel 5
Analisis Perhitungan Usulan Ukuran Display

Usulan Ukuran Display (Satuan dalam mm)				
				
Kategori	Antropometri	Persentil	Literatur (Satuan dalam cm)	
Tinggi Display Maksimum	2	P5+30º	172,7	Panero dan Zelnik, 2003 dan Purnomo, 2013
Jarak Pandang Mata	80 cm diketahui dari data lapangan		45,7-75	Purnomo, 2013 danPanero dan Zelnik, 2003
Maksimum Rotasi Mata			30º	Tilley, 2002 danPanero dan Zelnik, 2003

Menurut Purnomo (2013), dalam penentuan standar ukuran maksimal pandangan display dapat menggunakan ukutan tinggi mata posisi berdiri oleh persentil kecil agar pengguna bertubuh kecil tetap dapat memandang bagian tertinggi dari display. Menurut Panero dan Julis (2003) sudut maksimal rotasi mata adalah 30º. Sehingga untuk menentukan tinggi makismal display perlu menggunakan rumus trigonometri (sisi, sisi, sudut). Diketahui sudut rotasi mata 30º, jarak maksimum pandangan mata (80 cm), hasilnya (46 cm) akan ditambahkan dengan tinggi mata posisi duduk P5 wanita (139 cm), menjadi 185 cm.

Selanjutnya dilakukan analisis ukuran pintu sebagai jalur lalu lintas keluar masuk. Hasil analisis disajikan seperti pada Tabel 6.

Tabel 6
Analisis Perhitungan Usulan Ukuran Pintu

Usulan Ukuran Pintu (Satuan dalam mm)			
			
Satu Daun Pintu		Dua Daun Pintu	
Kategori	Antropometri	Persentil	Literatur (Satuan dalam cm)

Ketinggian Pintu	1	P95(Pria)+3 cm sepatu+5 cm topi+5 cm bebas	210-240	Akmal, 2020 dan Nurmianto 2004
Lebar Pintu	15	(P95(Pria)+15% jarak bersih)x2 daun pintu	80-90	Akmal, 2020 dan Purnomo, 2013
Ketinggian Handle	4	P50(Wanita)	114,3	Akmal,2020

Dalam menghitung ketinggian pintu perlu memikirkan kemungkinan yang terjadi seperti menambahkan perhitungan ukuran topi dan sepatu (Nurmianto, 2004), sehingga ukuran pintu didapatkan dari tinggi berdiri persentil 95 ditambahkan ukuran topi dan sepatu. Menggunakan persentil 95 agar pintu dapat digunakan oleh semua ukuran pengguna. Pada pintu ini, karena memiliki 2 daun pintu perlu memperhitungkan kemunginan 2 orang yang akan menggunakan pintu tersebut, sehingga perhitungan dari lebar bahu persentil 95 dikali 2 orang dan ditambah jarak bersih 15% untuk kemungkinan seseorang menggunakan tas. Ketinggian *handle* perlu menggunakan perhitungan tinggi siku berdiri, dan agar ukuran dapat universal keseagal ukuran tubuh, maka menggunakan tinggi rata-rata (P50) untuk dapat memperhatikan kesanggupan jangkauan.

SIMPULAN

Hasil analisis menyatakan bahwa perbandingan antropometri mahasiswa Program Studi Desain Interior Universitas ‘X’ berdasarkan jenis kelamin sangat berbeda. Perbedaan ukuran tersebut dapat mempengaruhi perhitungan untuk ukuran mebel agar dapat sesuai dengan ukuran tubuh dari kedua jenis kelamin. Berdasarkan antropometri mahasiswa Universitas ‘X’, ukuran masing-masing mebel yang telah dihitung berdasarkan antropometri pengguna dengan membandingkan data literatur.

Dengan hasil olahan data antropometri mahasiswa tersebut, peneliti menghasilkan ukuran mebel yang telah disesuaikan melalui pengamatan dan perhitungan berdasarkan sumber literatur terhadap ukuran penggunanya.

Peneliti memberikan usulan ukuran mebel baru dengan tujuan dapat sesuai dengan ukuran tubuh dan kebutuhan dari penggunanya. Hasil penelitian ini kiranya dapat membantu pengguna beraktivitas dengan mebel yang sesuai dengan ukuran kebutuhan pengguna sebenarnya, tentunya usulan ukuran ini dapat dipertimbangkan lagi melalui pengamatan aktivitas pengguna yang berbeda.

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Empowerment of *Angkul-Angkul* Culinary Sellers with Ergo-Entrepreneurship Oriented Improving of Entrepreneurship and Concern on Environmental Attitude

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Abstract

The culinary delights that are sold in front of the house entrance gate (*angkul-angkul*) are currently starting to develop rapidly in Peliatan Village, Ubud, Gianyar, Bali. The research objectives are: (1) to prove that empowerment of *angkul-angkul* culinary ergo-entrepreneurship oriented can improve entrepreneurial and environmental care attitudes and (2) to know how to solve ergonomic and entrepreneurial problems faced by culinary sellers. This quasi-experimental research used the same subject design. The subjects were 25 *angkul-angkul* culinary sellers who were randomly selected from 37 available populations. The independent variable in this study is the empowerment of *angkul-angkul* culinary with ergo-entrepreneurship orientation. The dependent variable is an entrepreneurial attitude and an environmental care attitude which is recorded before and after empowerment. The data obtained were analyzed using paired t test at a significance level of 5%, because the data were normally distributed. The results showed that the entrepreneurial attitude of sellers increased by 20.13% and the attitude of caring for the environment increased by 20.01% and the obstacles faced related to the empowerment of sellers were more technical and economic in nature which could be overcome through awareness programs. The conclusion is that the empowerment of *angkul-angkul* culinary with ergo-entrepreneurship orientation can significantly improve entrepreneurial attitudes and environmental care attitudes ($p<0.05$).

Keywords: ergo-entrepreneurship, culinary, environment, empowerment

Pemberdayaan Kuliner Angkul-angkul Berorientasi Ergo-Entrepreneurship Meningkatkan Sikap Kewirausahaan dan Peduli Lingkungan

Abstrak

Kuliner yang dibuka di depan pintu gerbang masuk rumah (angkul-angkul) saat ini mulai berkembang pesat di Desa Peliatan, Ubud, Gianyar, Bali. Tujuan penelitian adalah: (1) membuktikan bahwa pemberdayaan kuliner angkul-angkul berorientasi ergo-entrepreneurship dapat meningkatkan sikap kewirausahaan dan sikap peduli lingkungan dan (2) mengetahui cara mengatasi permasalahan ergonomi dan kewirausahaan yang dihadapi pedagang kuliner. Penelitian eksperimental semu ini menggunakan rancangan sama subjek. Subjeknya pedagang kuliner angkul-angkul sebanyak 25 orang yang dipilih secara acak sederhana dari 37 orang populasi terjangkau. Variabel bebas pada penelitian ini adalah pemberdayaan kuliner angkul-angkul berorientasi ergo-entrepreneurship. Variabel terikat adalah sikap kewirausahaan dan sikap peduli lingkungan yang didata sebelum dan sesudah pemberdayaan. Data yang diperoleh dianalisis dengan uji t paired pada taraf signifikansi 5%, karena datanya berdistribusi normal. Hasil penelitian menunjukkan bahwa sikap kewirausahaan pedagang meningkat 20,13% dan sikap peduli lingkungan meningkat 20,01% serta kendala yang dihadapi terkait

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dengan pemberdayaan pedagang lebih bersifat teknis dan ekonomis yang dapat ditanggulangi melalui program kesadaran. Simpulannya adalah pemberdayaan kuliner angkul-angkul berorientasi ergo-entrepreneurship dapat meningkatkan secara bermakna sikap kewirausahaan dan sikap peduli lingkungan (p<0,05).

Kata kunci: ergo-entrepreneurship, kuliner, lingkungan, pemberdayaan

INTRODUCTION

Currently, the economy of the people in Peliatan Village has been slumping, since Mount Agung erupted, because many foreign tourists have canceled their tourist visits to Bali in general and to Peliatan Village in particular. This village was chosen as the object of research, because it has the privilege of being a village that is highly dependent on cultural tourism. The decline in cultural tourism will certainly result in a decline in the community's economy. The downturn in cultural tourism can be seen from the increasingly quiet performances of regular arts from foreign audiences, which previously could support the economy of people who are active in the tourism sector. Angkul-angkul culinary development is promising in overcoming this economic downturn.

The culinary delights that were opened in front of the house entrance gate (angkul-angkul) are currently starting to develop rapidly in Peliatan Village. The culinary sells a variety of foods, for example: mixed rice, *tipat santok*, topot, Balinese snacks, *jukut mebejek*, *plecing*, grilled chicken, grilled fish, and others. This condition will certainly develop if given a touch of ergonomics, especially in the food preparation, how to serve it, and how to promote it. This culinary development is expected to overcome the economic downturn of the community as a result of the downturn of cultural tourism in the village. Ergo-entrepreneurship-oriented culinary development, which is an implementation of ergonomic principles in an effort to increase entrepreneurship, seems to be used as a way to overcome this economic downturn (Sutajaya, et al., 2014; Sutajaya, 2018). Ergo-entrepreneurship is a community empowerment strategy with a participatory ergonomic approach that has been proven to significantly increase the entrepreneurial attitude of sellers by 9.57% (Sutajaya, et al., 2016; Sutajaya, 2018). Ergo-entrepreneurship has advantages in terms of considering the elements of health, comfort, safety, effectiveness and efficiency in an entrepreneurial activity.

On the other hand, culinary sellers often feel reluctant to sell to a place that is quite far from their house. They prefer to sell in front of *angkul-angkul*. However, nowadays *angkul-angkul* culinary is still relatively quiet, because it only relies on buyers from local residents. In addition, the arrangement of tables, arrangement of merchandise, and the delicacy of food being sold have not become a special concern for sellers. Promotion efforts through social media have also not been carried out. In addition, the courage of local culinary sellers to compete with sellers from outside the village or from outside Bali, seems very worrying. This is evident from the impatience of sellers when there are fewer visitors. Local culinary sellers give up more easily than sellers from outside the village. This shows that their entrepreneurial attitude needs to be further developed so that they are more resilient, persistent, and optimistic in developing their culinary delights. In this case, ergonomic principles which emphasize more on health and managerial elements in activities combined with entrepreneurial concepts really need to be socialized to *angkul-angkul* culinary sellers so that their entrepreneurial attitude can be improved. This is the basic capital to compete in the global era.

Viewed from the ergonomic aspect, it turns out that the sellers have not considered the aspects that must be applied in running a culinary business. For example: (a) when choosing a table and seating the buyer does not consider the comfort of the visitor; (b) when choosing the color of the facilities and infrastructure used do not refer to the ergonomic concept which

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emphasizes that red is very suitable for culinary businesses; (c) when determining the time to sell, it does not take into account the behavior of the local community who likes adventures in the culinary field; and (d) lack of courage to increase sales turnover on certain days or certain events held by the village, which is an opportunity to increase income.

Based on the synthesis of the relevant literature with the research variables used to solve the problems found, it is necessary to conduct research in the form empowerment of angkul-angkul culinary based ergo-entrepreneurship oriented. This statement is strengthened by the results of a preliminary study in the form of problems found, namely: (a) minimal business capital; (b) do not have the courage to borrow capital from a bank; (c) lack of entrepreneurial knowledge; (d) low processing quality; and (e) difficult product marketing. This condition worsens the economy of the community. The application of ergonomics is very necessary to overcome these conditions, because it strives for a person to always be in a healthy, safe and comfortable condition, and free from stress conditions and inadequate environmental conditions for activities, such as noise, pollutants, insufficient light intensity, environmental temperature. that is too hot or cold, and inadequate air circulation, is an urgent matter to be implemented and should be implemented as soon as possible (Manuaba, 2015; Lea, et al., 2017; Thepaksorn, et al., 2017; Ojima, 2017; Choi and Byoung, 2017; Saleh, et al., 2017). Profile factors, physiological, psychological and biomechanical capacities greatly determine human abilities and limitations, while task demands are largely determined by the characteristics of the job, task, organization, and environment in which the work is carried out (Manuaba, 2015; Wei, et al., 2014; Kim, et al., 2015; Fullemann, et al., 2016; Tsuno, et al., 2017, Moeloek, 2016).

Starting from the identification of these problems, problem formulations can be made: (1) can the entrepreneurial attitude of sellers be improved through empowerment of ergonomically oriented *angkul-angkul* culinary based on ergonomics?, (2) can the empowerment of *angkul-angkul* culinary based ergo-entrepreneurship oriented improve people's awareness of environmental conditions?; and (3) how to handle ergonomics and entrepreneurship problems that have been accompanying *angkul-angkul* culinary sellers in Peliatan Village? The research objectives are: (1) proving that the empowerment of ergo-entrepreneurship oriented *angkul-angkul* culinary can improve the entrepreneurial attitude of sellers, (2) prove that empowerment of ergo-entrepreneurship oriented *angkul-angkul* culinary can increase people's awareness of environmental conditions; and (3) knowing how to handle ergonomic and entrepreneurial problems that have been accompanying *angkul-angkul* culinary sellers in Peliatan Village. The benefits of the research are: (1) it can be used by culinary sellers as a reference in developing ergo-entrepreneurship-oriented culinary businesses and (2) it can be implemented by related agencies, especially in improving the working conditions of *angkul-angkul* culinary which is currently being developed by the community.

METHOD

This quasi-experimental study used a randomized posttest only group design (treatment by subject design). The subjects involved in the implementation of this research were 25 angkul-angkul culinary sellers who are scattered in Peliatan Village who are currently experiencing ergonomic and entrepreneurial problems when they want to market their products. Subjects were selected randomly simple (simple random) from an affordable population of 37 sellers with the following inclusion criteria: (a) selling in front of the house, (b) selling Balinese culinary specialties, (c) identifying ergonomic problems, and (d) identifying there are entrepreneurial problems based on the results of preliminary studies.

The independent variable used as a treatment in this study is the empowerment of *angkul-angkul* culinary with ergo-entrepreneurship orientation. The dependent variables recorded

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before and after empowerment are entrepreneurial attitudes and environmental care attitudes. The paired t test at the 5% significance level was used to test the research hypothesis, because the results of the data normality test using the Kolmogorov-Smirnov test showed that the data were normally distributed (p>0.05).

RESULTS AND DISCUSSION

The results of data analysis on the characteristics of *angkul-angkul* culinary in Peliatan Village can be seen in Table 1.

Table 1
Characteristics of *Angkul-angkul* Culinary (n=25)

Characteristics	Number of Sellers	Percentage (%)
1. Peddling traditional preparations	21	84
2. Peddling unique local community preparations	17	68
3. Using raw materials from the local village market	19	76
4. Cook the food sold themselves	25	100
5. Do not use monosodium glutamate for flavoring	18	72
6. Cook directly at the selling place	11	44

The data obtained in Table 1 is based on the results of interviews with 25 sellers and recorded six items of *angkul-angkul* culinary characteristics. Of the 25 sellers, the percentage per item characteristics were analyzed based on the number of sellers who said "yes" to the statement items in the interview guide.

The findings in this study indicated that all sellers cook their own food and only 11 sellers (44%) cook directly at the place of sale. Other characteristics are: (a) some sellers (28%) still use monosodium glutamate for flavoring, (b) selling traditional preparations reaches 84%, (c) only 6 sellers (24%) buy raw materials outside the local village market, and (d) selling unique products from the local community, there are 17 sellers (68%).

Table 2
Results of Hypothesis Testing for Entrepreneurial and Concern on Environmental Attitudes (n=25)

Variable	Before Empowerment		After Empowerment		t	p
	Mean	SD	Mean	SD		
Entrepreneurial Attitude	56.42	1.986	67.78	1.236	27.098	0.0001
Concern on Environmental Attitude	58.43	2.207	70.12	1.902	25.643	0.0001

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Based on the research hypothesis which states that there is an increase in entrepreneurial and concern on environmental attitudes between before and after empowerment, the hypothesis is tested with a paired t test at the 5% significance level. The results of different tests on entrepreneurial and concern on environmental attitudes can be seen in Table 2.

Data on entrepreneurial attitudes and environmental care attitudes were recorded using a Likert scale questionnaire. The data obtained were analyzed descriptively by looking for the mean and standard deviation. Furthermore, the data normality test was carried out with the Kolmogorov-Smirnov test and it turned out that the data were normally distributed. Furthermore, tested by paired t test to compare the mean score of entrepreneurial attitudes and environmental care between before and after empowerment.

Judging from the average entrepreneurial attitude between before and after empowerment shows that there is a significant increase of 20.13% ($p<0.05$) between before and after the socialization of ergo-entrepreneurship oriented *angkul-angkul* culinary empowerment. This happened as a result of the increasing understanding of culinary actors about entrepreneurship, which was supported by a higher self-confidence for entrepreneurship. This condition will certainly have implications for other members of the community who were initially not interested in entrepreneurship in the culinary field and finally dared to try to open up new businesses in that field. In addition, residents who have previously been involved in the culinary field seem to be interested again in developing this business. This can happen because one of the programs implemented in empowering *angkul-angkul* culinary is to generate entrepreneurship in the local community. Through entrepreneurship training in the form of ergo-entrepreneurship, it turns out that it can motivate people to develop local culinary businesses that are quite attractive to consumers (Sutajaya & Warpala, 2017). These findings are in synergy with the statement described in Wikipedia (2012) that the characteristics of an entrepreneur are: (a) having the characteristics of confidence, independence, individuality, optimism; (b) always strives for achievement, is profit-oriented, has perseverance and fortitude, has a strong determination, likes to work hard, is energetic and has initiative; (c) has the ability to take risks and likes challenges; (d) behave as a leader, can get along with other people and like suggestions and constructive criticism; (e) has high innovation and creativity, is flexible, versatile and has a wide business network; (f) have future-oriented perceptions and perspectives; and (g) have the belief that life is the same as hard work which will greatly support the success of an entrepreneur in running and developing his business. In this study, entrepreneurial attitudes are applied in developing culinary businesses which are supported by the existence of infrastructure in an alley (*rurung*) that is strived to be clean and green so that it deserves to be called a clean and green *rurung* tourism area.

Related to these findings, it was also reported that 66.7% of culinary actors tend to increase the number of products produced and 33.3% try to increase the number and quality of their products (Sutajaya & Gunamantha, 2014). Culinary characteristics in Peliatan are: (a) traditional preparations are sold by 73.3% of sellers; (b) unique local community products sold by 40.0% of sellers; and (c) 73.3% preparations cooked by sellers themselves (Sutajaya & Warpala, 2015). This condition will certainly have implications for the sustainability of the culinary business in Peliatan Village, especially if it is supported by an increasingly stable entrepreneurial attitude and an ergonomically oriented culinary business development mechanism known as ergo-entrepreneurship. In this case Manuaba (2015); Gohari, et al. (2013); Lee, et al. (2014); and Yumang, et al. (2014) stated that the use of ergonomic principles in designing a product makes the product more user friendly, satisfying, comfortable, safe, energy efficient, and environmentally friendly.

Discipline is the key to success for an entrepreneur to use as a motto that can motivate culinary sellers in Peliatan Village. When given training, it is always emphasized that in carrying out its activities, an entrepreneur must have high discipline. The meaning of the word

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discipline is the accuracy of an entrepreneur's commitment to his duties and jobs. The accuracy referred to is comprehensive, namely timeliness, quality of work, work system and so on. High commitment in developing a culinary business has implications for the success in developing the business. This commitment is always emphasized in training and is expected to improve one's entrepreneurial attitude. Commitment is an agreement regarding something that is made by a person, both for himself and for others. In carrying out its activities, an entrepreneur must have a clear commitment, directed and progressive (progress-oriented). Commitment to oneself can be made by identifying the ideals, hopes and targets planned in his life. High creativity and innovation as measurable indicators used in assessing entrepreneurial attitudes are quite visible in culinary business development. It is stated so because culinary actors are always creative and innovative in developing their culinary products. This condition is accordance with Sutajaya (2018) which states that to win the competition, an entrepreneur must have high creative power. This creativity power should be based on an advanced way of thinking, full of new ideas that are different from existing products on the market. In general, creative ideas cannot be limited by space, form or time. In fact, often the genius ideas that provide new breakthroughs in the business world are initially based on creative ideas that seem impossible.

The findings in this study indicated that the culinary actors' concern for the environmental conditions around them increased significantly by 20.01% ($p<0.05$) between before and after the socialization of ergo-entrepreneurship oriented *angkul-angkul* culinary empowerment. To create a harmonious environment and environmental factors must be balanced. A person's sensitivity and awareness of the environmental conditions of his settlement will greatly support efforts to save and conserve the environment. In this case Rini, et al. (2017) stated that awareness and sensitivity to the environment makes the environment better and provides a positive atmosphere for humans. Environmental management can be interpreted as a conscious effort to maintain or improve the quality of the environment so that basic needs can be best met. Environmental awareness is awareness to direct people's attitudes and understanding of the importance of a clean, healthy, beautiful and attractive environment. Regarding these findings, Chen (2010) argues that a series of ecological knowledge has implications for environmental care, development, and preservation, (b) Julina (2013) emphasizes that consumer attitudes are influenced by knowledge of the environment, (c) Lee (2011) explains that behavioral commitment indispensable in environmental protection activities, (d) Rini, et al. (2017) reported that environmental knowledge has significant implications and is positively correlated with environmental care attitudes, and (e) Ardianti, et al. (2017) reported that the increase in environmental care behavior and responsibility for environmental conservation was in the high category with an increase of more than 50%. The synergy of this opinion shows that a person's ecological attitude is influenced by the level of knowledge and attention to the environment.

Concern for the residential environment as an implication of the ergo-entrepreneurship training carried out in empowering *angkul-angkul* culinary seems to need to be done early on so that the character of the younger generation will be reflected in their concern for the residential environment. Repetitive behavior will form a strong character. This opinion is reinforced by the findings of Rini, et al. (2017) who reported that children's character development can occur as a result of something that is seen, heard, and done repetitively. Good and strong character in children can be formed through good behavior in their daily life. Purwanti (2017) also reports that developing a person's attitude in improving and managing the environment in a sustainable manner can be done through character education caring for the environment.

The implementation of entrepreneurship based on ergonomics is constrained by: (1) the lack of public knowledge about ergonomic principles that can be implemented in culinary

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development, (2) structuring and procurement of infrastructure in the development of *angkul-angkul* culinary requires relatively high costs, (3) too fanatical about designs that are already exists to force the design to be implemented so that the product will be uncomfortable and unsafe, (4) the infrastructure that supports *angkul-angkul* culinary has not fully referred to the anthropometry and geometry of the local community, (5) further development of *angkul-angkul* culinary seems to be still many have encountered obstacles because the marketing mechanism has not been maximal, and (6) the sustainability of *angkul-angkul* culinary cannot be ascertained considering that buyer visits have not met the target of sellers.

Effective and efficient steps that can be taken to overcome the aforementioned obstacles are: (1) it is necessary to provide an example or pilot project on the ergo-entrepreneurship oriented *angkul-angkul* culinary development strategy and be disseminated through counseling, social media, print media, and electronic media, (2) in every strategic place, information boards are installed about the unique culinary design of *angkul-angkul* with ergo-entrepreneurship orientation with implications for increasing entrepreneurial attitudes and concern for the residential environment, (3) on every supporting infrastructure in the development of *angkul-angkul* culinary comfortable places to enjoy culinary favored by buyers, (4) social media that can be seen by many people seems to be quite effective if it is used for media socialization of *angkul-angkul* culinary with its uniqueness that can create a special attraction for visitors, (5) hen government not starting to pay attention to the conditions of the residential environment, especially alleys or *rurung* which are very potential to be used for roads, because it will have implications for economic activity in the area, given that the more visitors passing through the area the higher their chances of enjoying their culinary delights. and (6) the public should begin to realize how important it is to know and understand the ergo-entrepreneurship-oriented strategy of *angkul-angkul* culinary development, for the sake of the sustainability of the culinary business in the area.

CONCLUSION

The conclusion of this study are: (a) the entrepreneurial attitude of sellers increased significantly by 20.13% after being empowered, (b) the sellers' concern for the environmental conditions of the settlement increased significantly by 20.01% after being empowered, and (c) the obstacles faced related to the culinary empowerment of ergo-entrepreneurship oriented *angkul-angkul* which is more technical and economic in nature which can be overcome through an awareness program. It suggested as follows: (a) culinary sellers should keep trying to use ergo-entrepreneurship references in developing their culinary business, (b) further research is needed to improve working conditions of culinary sellers who are at risk to their health, and (c) related agencies should always facilitate efforts to improve working conditions in small industries, particularly in the development of the *angkul-angkul* culinary business.

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Beban Tas Siswa di Sekolah Dasar Saraswati 5 Denpasar

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Abstrak

Penggunaan tas sekolah dengan desain yang tidak ergonomis, cara menggendong yang tidak ergonomis, beban tas yang berlebihan serta menggendong tas dengan durasi yang lama, berisiko menimbulkan gangguan sistem muskuloskeletal. Penelitian ini bertujuan untuk mengetahui distribusi frekuensi kategori beban tas siswa sekolah dasar di Sekolah Dasar (SD) Saraswati 5 Denpasar menurut kelas, usia, jenis kelamin dan berat badan responden. Penelitian ini menggunakan desain penelitian deskriptif dengan rancangan *cross-sectional* yang dilakukan di SD Saraswati 5 Denpasar. Sampel pada penelitian ini dipilih dengan *systematic random sampling*. Terdapat 86 responden yang lebih banyak membawa beban tas kategori sedang 40 siswa (46,5%), beban tas kategori berat lebih banyak dibawa oleh siswa kelas 3 SD yaitu 12 siswa (54,5%), siswa laki-laki dan perempuan membawa kategori beban tas yang sama yaitu kategori sedang berjumlah 40 (46,5%) dan kelompok dengan berat badan paling ringan di antara kelompok lainnya cenderung membawa beban tas kategori berat berjumlah 16 siswa (55,2%). Dapat disimpulkan bahwa siswa SD Saraswati 5 Denpasar lebih banyak membawa beban tas kategori sedang. Beban tas kategori berat lebih banyak dibawa oleh siswa berusia 7 tahun – 9 tahun. Kelompok siswa dengan berat badan paling ringan cenderung membawa beban tas kategori berat.

Kata kunci: beban tas, ergonomis, siswa sekolah dasar

The Bag Burden in Students of Elementary School Saraswati 5 Denpasar

Abstract

The use of school bags without ergonomics design, miscarriage school bag, excessive bag load and carrying bags with long duration could be risk of disrupting the musculoskeletal system. The aim of this research is to know the frequency of bag load category of elementary students at SD Saraswati 5 Denpasar according to class, age, gender and weight of respondent. This research method was a descriptive cross-sectional study conducted at SD Saraswati 5 Denpasar. The sample in this study was selected by systematic random sampling. There were 86 respondents who carried load of bag of medium category amounted to 40 (46.5%) student, heavy bag category tend to carried by grade 3 student amounted to 12 (54.5%), male and female students carried the same bag load that is the moderate category 40 (46.5%) and the group with the mildest weight among other groups tend to carried heavy bag category amounted to 16 (55.2%). The conclusion is Students of Elementary School Saraswati 5 Denpasar more often carry the bag burden of the medium category. More heavy bag load categories

are carried by students aged 7 years - 9 years. Groups of students with the lightest weight tend to carry heavy bag loads.

Keywords: bag load, ergonomic, elementary school students

PENDAHULUAN

Tas merupakan benda yang hampir setiap hari digendong oleh siswa untuk membawa perlengkapan sekolah (Javadivala dkk., 2012; Mahendrayani dkk., 2014). Penggunaan tas sekolah dengan desain yang tidak ergonomis, cara menggendong yang tidak ergonomis, beban tas yang berlebihan serta menggendong tas dengan durasi yang lama berisiko menimbulkan gangguan sistem muskuloskeletal (Kim dkk., 2015). Pada anak-anak usia 12-14 tahun di Denpasar, sebanyak 38,7% mengeluh nyeri punggung yang dicurigai akibat membawa tas dengan beban yang berat (Mahendrayani dkk., 2014). Membawa tas punggung dengan beban yang berat dicurigai dapat menimbulkan beberapa gangguan muskuloskeletal pada punggung, bahu, tangan dan pergelangan tangan (Dianat dkk., 2011).

Penelitian tahun 2011 menunjukkan siswa sekolah yang membawa tas punggung yang berat 50% berisiko mengalami keluhan nyeri punggung dan 42% berisiko terhadap timbulnya gangguan postur pada punggung walaupun hasil yang ditunjukkan tidak signifikan (Dianat dkk., 2011). Beberapa penelitian juga menyatakan bahwa seseorang dengan riwayat nyeri punggung pada masa pertumbuhannya cenderung akan mengalami nyeri punggung bagian bawah dan skoliosis saat dewasa karena terdapat kebiasaan yang membuat postur tubuh menjadi tidak ergonomis (Paloma dkk., 2012). Penelitian lain menyatakan sebanyak 51,6% orang tua tidak memperhatikan rekomendasi berat tas yang dianjurkan untuk dibawa maupun digendong oleh putra-putri mereka, adapun sebanyak 56,3% orang tua juga tidak memperhatikan ukuran tas yang sesuai untuk putra-putri mereka. Kemudian sebanyak 96% orang tua siswa tidak pernah memeriksa isi maupun bawaan yang ada di dalam tas punggung putra-putri mereka (Javadivala dkk., 2012).

Mengetahui hal tersebut, peneliti tertarik untuk mengetahui distribusi frekuensi kategori beban tas siswa sekolah dasar menurut kelas, usia, jenis kelamin dan berat badan siswa. Siswa sekolah dasar dijadikan subjek dalam penelitian ini karena periode emas pertumbuhan sedang berlangsung, sehingga membutuhkan perhatian serius dan dikhawatirkan dapat menimbulkan gangguan pertumbuhan yang salah satunya akibat timbulnya nyeri punggung. Sekolah Dasar (SD) Saraswati 5 Denpasar dijadikan sebagai tempat penelitian karena pada survei pendahuluan diketahui jadwal akademik dan non akademik di sekolah ini cukup padat, sehingga hal tersebut diperkirakan dapat mempengaruhi beban tas yang dibawa oleh siswa.

METODE

Penelitian ini menggunakan desain penelitian deskriptif dengan rancangan *cross-sectional* yang dilakukan di SD Saraswati 5 Denpasar tahun 2017 dalam kurun waktu 10 minggu. Penelitian ini telah dinyatakan laik etik oleh Komisi Etika Penelitian Fakultas Kedokteran dan Ilmu Kesehatan Universitas Warmadewa. Sampel pada penelitian ini dipilih dengan *systematic random sampling.* Adapun populasi terjangkau adalah seluruh siswa kelas 3, 4, 5 dan 6 di SD Saraswati 5 Denpasar pada tahun 2017. Kriteria inklusi berupa siswa yang bersedia diteliti, membawa tas sekolah jenis ransel, tas selempang atau tas jinjing pada waktu penelitian. Kriteria ekslusi adalah siswa yang membawa tas jenis *trolley bag*.

Pada penelitian ini berat beban tas punggung yang dibawa oleh siswa diukur dengan timbangan. Beban tas punggung di golongkan dalam 3 kategori, ringan apabila berat tas <10% dari berat badan, sedang 10-15% berat badan dan berat apabila berat tas >15% berat badan.

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Variabel lain yang diteliti adalah jenis kelamin, usia dan berat badan siswa. Data disajikan dalam bentuk tabel, analisis yang digunakan adalah analisis univariat untuk mendeskripsikan variabel penelitian yang ingin diketahui.

HASIL DAN PEMBAHASAN

Responden penelitian yang terpilih berjumlah 86 orang dari 361 siswa kelas III, IV, V dan VI. Peneliti tidak memilih siswa kelas I dan II sebagai responden penelitian oleh karena siswa kelas I dan II dianggap belum kooperatif untuk diajukan pertanyaan maupun dilakukan pengukuran serta pihak orang tua masih membantu siswa kelas I dan II untuk membawakan tas mereka. Tidak ada responden yang *drop out*, semua responden bersekolah saat hari pengambilan sampel data penelitian. Karakteristik responden terdiri dari empat poin, yaitu jenis kelamin, usia, kelas dan kategori beban tas (Tabel 1).

Tabel 1
Karakteristik Dasar Responden Penelitian

Karakteristik	Frekuensi	Persentase
Kelas		
III SD	22	25,6%
IV SD	23	26,7%
V SD	25	29,1%
VI SD	16	18,6%
Usia		
7 tahun	1	1,2%
8 tahun	17	19,8%
9 tahun	24	27,9%
10 tahun	24	27,9%
11 tahun	19	22,1%
12 tahun	1	1,2%
Jenis Kelamin		
Laki-laki	39	45,3%
Perempuan	47	54,7%
Berat Badan		
21 kg – 30,5 kg	29	33,7%
30,6 kg – 40,6 kg	30	34,9%
40,7 kg – 50,7 kg	16	18,6%
50,8 kg – 60,8 kg	10	11,6%
60,9 kg - 71 kg	1	1,2%
Jenis Tas		
Tas Ransel	85	98,8%
Tas Selempang	1	1,2%
Tas Jinjing	0	0%

SD : Sekolah Dasar
kg : kilo gram

Selanjutnya beban tas yang dikelompokkan sesuai tingkatan kelas dapat disajikan seperti pada Tabel 2.

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Tabel 2
Kategori Beban Tas Responden Menurut Kelas

Kelas	Kategori Berat Tas		
	Ringan f (%)	Sedang f (%)	Berat f (%)
III	2(9,1)	8(36,4)	12(54,5)
IV	3(13,0)	13(56,5)	7(30,4)
V	11(44,0)	12(48,0)	2(8,0)
VI	8(50,0)	7(43,8)	1(6,3)
Total	24(27,9)	40(46,5)	22(25,6)

Sementara itu bila dikelompokkan beban tas menurut usia subyek, dapat disajikan seperti pada Tabel 3.

Tabel 3
Kategori Beban Tas Responden Menurut Usia

Usia	Kategori Berat Tas		
	Ringan f (%)	Sedang f (%)	Berat f (%)
7	0(0,0)	0(0,0)	1(100,0)
8	0(0,0)	8(47,1)	9(52,9)
9	6(25,0)	9(37,5)	9(37,5)
10	8(33,3)	15(62,5)	1(4,2)
11	9(47,4)	8(42,1)	2(10,5)
12	1(100,0)	0(0,0)	0(0,0)
Total	24(27,9)	40(46,5)	22(25,6)

Sementara itu, untuk kategori berat tas yang dikelompokkan menurut jenis kelamin dan berat badan subyek disajikan seperti pada Tabel 4.

Tabel 4
Kategori Beban Tas Responden Menurut Jenis Kelamin

Jenis Kelamin	Kategori Berat Tas		
	Ringan f (%)	Sedang f (%)	Berat f (%)
Laki-laki	10(25,6)	20(51,3)	9(23,1)
Perempuan	14(29,8)	20(42,6)	13(27,7)
Total	24(27,9)	40(46,5)	22(25,6)

Bila dikelompokkan kategori berat tas berdasarkan berat badan, maka dapat disajikan seperti pada Tabel 5.

Tabel 5
Kategori Beban Tas Responden Menurut Berat Badan Siswa

Berat Badan (kg)	Kategori Berat Tas		
	Ringan f (%)	Sedang f (%)	Berat f (%)
21 kg – 30,5 kg	1(3,4)	12(41,4)	16(55,2)

30,6 kg – 40,6 kg	9(30,0)	15(50,0)	6(20,0)
40,7 kg – 50,7 kg	6(37,5)	10(62,5)	0(0,0)
50,8 kg – 60,8 kg	7(70,0)	3(30,0)	0(0,0)
60,9 kg – 71 kg	1(100,0)	0(0,0)	0(0,0)
Total	24(27,9)	40(46,5)	22(25,6)

kg : kilo gram

PEMBAHASAN

Berdasarkan kategori beban tas menurut kelas menunjukkan siswa kelas III memiliki kecenderungan membawa beban tas kategori berat berjumlah 12 (54,5%) siswa. Sedangkan pada siswa kelas IV, V dan VI menunjukkan kecenderungan membawa beban tas kategori ringan dan sedang. Hasil penelitian ini serupa dengan penelitian yang di Sekolah Dasar Al-Ahsa, Arab Saudi, yang menyatakan bahwa dari 541 siswa kelas III terdapat 400 siswa membawa beban tas kategori berat (>15%) dan sangat berat (>20%), siswa kelas IV dan V cenderung membawa tas kategori sedang namun, siswa kelas VI di Arab Saudi cenderung membawa beban tas kategori sedang hingga sangat berat yaitu sejumlah 452 siswa (Al-Saleem dan Ali, 2016).

Penelitian ini menunjukkan adanya penurunan beban tas yang dibawa oleh siswa pada tingkatan kelas yang lebih tinggi, sedangkan penelitian di Sekolah Dasar di Arab Saudi menggambarkan kecenderungan adanya peningkatan beban tas sesuai dengan tingkatan kelas Sekolah Dasar yang menunjukkan hasil yang bermakna dengan nilai p=0,0001 (Al-Saleem & Ali, 2016). Perbedaan temuan tersebut didasarkan oleh sistem pendidikan yang berbeda antara Arab Saudi dan Indonesia. Sistem pendidikan di Arab Saudi dibagi menjadi 3 bagian utama, yaitu Pendidikan umum untuk laki-laki, Pendidikan umum untuk perempuan dan Pendidikan keagamaan untuk laki-laki. Pendidikan umum baik siswa laki-laki dan perempuan dibagi menjadi 4 bagian, yaitu Pendidikan Dasar (6-12 tahun), Pendidikan Menengah (12-15 tahun), Pendidikan Sekunder (15-18 tahun) dan Pendidikan Tinggi (Universitas atau Akademik). Penambahan mata pelajaran juga diterapkan di luar pendidikan umum tersebut. Siswa perempuan ditambahkan mata pelajaran manajemen rumah tangga sedangkan siswa laki-laki ditambahkan mata pelajaran jasmani (Syah, 2001).

Standar proses pendidikan dasar dan menengah di Indonesia sesuai dengan Peraturan Menteri Pendidikan dan Kebudayaan Republik Indonesia Nomor 22 tahun 2016 yang menyatakan bahwa salah satu prinsip pembelajaran di Indonesia adalah peserta didik yang diberitahu menjadi mencari tahu, sehingga yang berperan adalah keaktifan siswa dalam mencari informasi ilmu pengetahuan. Semakin meningkatnya jenjang kelas, nalar siswa sudah terlatih untuk mencari pengalaman belajar sendiri. Mata pelajaran yang wajib dipelajari, yaitu Agama, Bahasa Indonesia, PPKn, Matematika, Kesenian, Pendidikan Jasmani Olahraga dan Pengetahuan Umum. Mata pelajaran yang termasuk dalam Ujian Nasional adalah tiga mata pelajaran yaitu Bahasa Indonesia, Matematika dan Ilmu Pengetahuan Alam. Hal tersebut memberikan gambaran bahwa pada saat siswa mencapai jenjang kelas 6 SD lebih menitik beratkan persiapan dalam menghadapi tiga mata pelajaran yang diujikan, sehingga berat beban tas yang dibawa semakin ringan (Kemendikbud RI, 2016). Pada ketentuan Kurikulum Tingkat Satuan Pendidikan untuk Sekolah Dasar (KTSP-SD) menyatakan bahwa durasi belajar siswa kelas 1, 2 dan 3 lebih singkat yaitu 26-28 jam per minggu dibandingkan siswa kelas 4, 5 dan 6 yaitu 32 jam per minggu. Pihak sekolah umumnya menambahkan mata pelajaran pengembangan pada siswa kelas 1, 2 dan 3 seperti mata pelajaran bahasa asing selain bahasa Inggris. Hal tersebut dapat mempengaruhi jumlah material bahan belajar yang dibawa oleh siswa kelas 3 (Kemendikbud RI, 2014).

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Penelitian ini memperoleh hasil bahwa usia 7-12 tahun membawa beban tas kategori sedang berjumlah 40(46,5%) siswa. Penelitian di Sekolah Dasar Tehran juga memperoleh hasil yang sama yang menyatakan sebanyak 212 siswa berusia 6-11 tahun membawa beban tas kategori sedang dengan hasil yang bermakna nilai p=0,001 (Mohammadi dkk., 2017).

Apabila diamati dari kelompok responden berusia 7 dan 8 tahun cenderung membawa beban tas kategori berat dibandingkan responden yang berusia 9 sampai 12 tahun yang membawa beban tas kategori ringan sampai sedang. Usia 6 sampai 12 tahun adalah masa usia sekolah disebut juga sebagai masa laten. Hal ini mungkin terkait dengan teori perkembangan kognitif Piaget, usia 6 sampai 12 tahun telah memasuki fase *concrete operational* yaitu suatu fase dimana anak belajar dan mulai mampu mengklasifikasikan benda serta perintah maupun menyelesaikan permasalahan yang sederhana (Soetjiningsih dan Ranuh, 2013). Kebiasaan siswa membawa tas atau peralatan sekolah pada usia ini sesuai dengan teori tersebut, dimana siswa dapat menyesuaikan buku bawaan sesuai dengan jadwal pelajaran sekolah yang sudah ditentukan, namun belum mampu memahami buku pelajaran yang wajib untuk dibawa ke sekolah maupun dapat dipelajari di rumah saja.

Berdasarkan kategori beban tas menurut jenis kelamin, menunjukkan bahwa anak laki-laki dan perempuan membawa berat beban tas yang hampir sama. Penelitian tersebut serupa dengan penelitian yang dilakukan pada 108 siswa sekolah dasar di Polandia yang menunjukkan tidak terdapat perbedaan yang signifikan antara kategori beban tas yang dibawa oleh siswa laki-laki dan siswa perempuan dengan nilai p=0,647 (Lasota, 2014). Anak perempuan selain membawa buku mata pelajaran juga membawa bekal makan siang, botol minum dan buku catatan tambahan. Anak laki-laki membawa peralatan olahraga dan bekal makan siang dalam tasnya (Mahendrayani dkk., 2014).

Berdasarkan kategori beban tas menurut berat badan, siswa dengan berat badan 21 kg – 30,5 kg atau kelompok siswa dengan berat badan terendah sebagian besar membawa beban tas kategori berat 16 siswa (55,2%), sedangkan siswa dengan berat badan 50,8 kg – 60,8 kg atau kelompok berat badan tertinggi sebagian besar membawa beban tas kategori ringan berjumlah 7 siswa (70,0%). Hasil berbeda didapatkan pada penelitian lain yang menunjukkan responden yang berusia 8 tahun sampai 11 tahun dengan berat badan minimal 22,97 kg membawa beban kategori sedang sedangkan responden pada kelompok berat badan maksimal 65,56 kg membawa beban tas kategori berat, penelitian tersebut memperoleh hasil signifikan dengan nilai p=0,0001 (Kistner dkk., 2013).

Berat beban tas yang dibawa maupun digendong idealnya tidak lebih dari 10% berat badan pengguna tas, karena membawa tas dengan berat beban melebih 10% berat badan dapat menimbulkan suatu gangguan seperti keluhan nyeri pada otot, kelelahan pada otot bahkan beberapa penelitian telah menghubungkan berat beban tas terhadap kemampuan ekspansi paru-paru saat bernafas yang diperkirakan apabila membawa beban tas kategori berat dapat menahan atau membatasi gerakan otonomi tubuh seperti bernafas (Abarogu dkk., 2016).

SIMPULAN

Berdasarkan hasil penelitian yang didapat, dapat disimpulkan bahwa siswa SD Saraswati 5 Denpasar lebih banyak membawa beban tas kategori sedang dibandingkan kategori lainnya. Beban tas kategori berat lebih banyak dibawa oleh siswa kelas III SD atau siswa berusia 7 tahun – 9 tahun. Tidak terdapat perbedaan beban tas yang dibawa oleh siswa laki-laki dan perempuan. Siswa dengan berat badan 21 kg – 30,5 kg atau kelompok siswa dengan berat badan paling ringan dibandingkan kelompok siswa dengan berat badan lainnya cenderung membawa beban tas kategori berat. Adapun dari hasil pengukuran dan pembahasan yang diperoleh pada penelitian ini berisiko menimbulkan gangguan sistem muskulosketal.

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Saran yang dapat diambil dari penelitian ini di antaranya bagi SD Saraswati 5 Denpasar, dapat memperhatikan jenis dan jumlah material bahan belajar yang dibawa oleh siswa agar tidak membebani kemampuan tubuhnya serta menyediakan lemari penyimpanan barang bawaan siswa, orang tua siswa agar mengawasi setiap barang bawaan sekolah anak, sehingga berat beban tas yang dibawa oleh siswa tidak berlebih. Perlu dilakukan penelitian lanjutan yang dapat mengetahui hubungan maupun perbandingan masing-masing variabel yang diteliti serta dapat mengetahui dampak menggendong beban tas kategori berat terhadap timbulnya keluhan nyeri maupun keluhan pada sistem muskuloskeletal lainnya.

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