

Ergonomic Work Facilities Design to Reduce Musculoskeletal Disorders Among Chips Workers

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ABSTRACT *Work facilities used by chips workers affect work postures and risk level faced, ranging from negligible complaints until undue complaints, are known as musculoskeletal disorders (MSDs). Work facilities which are appropriate for workers anthropometry may reduce muscular fatigue felt while working. Chips frying process conducted by female workers includes activities of taking raw chips from buckets placed on the floor with stand up and bend work posture repeatedly, frying chips and moving half-cooked chips to the next pan. These activities are done for six to seven hours per day repetitively. Assessment using Standard Nordic Questionnaire (SNQ) reveals that female workers in frying stations are dominant in painful and very painful category. Workers with score 9 which fall under very painful category feel undue pain in right hand, as they only use right hand to fry and move the oil. Undue pain also felt in both left and right knee, calves, wrist, and feet caused by standing work posture while working for as long as 5-6 hours daily for 6 days per week. Painful category is found in waist, left thigh and right thigh due to work posture of 20⁰-60⁰ arched back and non-ergonomic facilities. Assessment of action level of working postures using Rapid Entire Body Assessment (REBA) shows high risk level as big as 8 to 10, which means the facilities need improvement immediately. Ergonomic work facilities design application including three-leg chair and wheeled chips container will reduce MSDs problem. Workers will do frying chips process with work posture of sitting in which their hand reach raw chips inside wheeled chips container. The research used treated group with ergonomic work facilities and control group with existing facilities. Pre-test and post-test like work postures assessment using REBA method followed the treatment. The acceptance of ergonomic work facilities design is indicated by workers' increasing productivity such as the product quality and product quantity at the chips frying station.*

Keywords : *Ergonomic work facilities, Complaints, Work postures, MSDs, REBA*

1. INTRODUCTION

The chips frying activities are carried out by female and male workers. Especially the first stage of frying chips are performed by women workers with 1 minute cycle time for the extraction of raw chips from a bucket that lies on the floor with standing work and bowed posture repeatedly, frying chips and moving half fried chips to the second pan. The activities carried out by the standing and bent posture alternately for 7 hours each day in 6 days a week. Bending activities conducted as many as 60 times in an hour to insert raw chips into the frying pan. This condition is performed repeatedly (repetitive) every day with uncomfortable facility and unfit to the workers body's anthropometry.

Research conducted by Stephani Sirait (2010) found that there's relationship between operators' unnatural prolonged and repeatedly work posture with complaints of pain experienced at spinning coir work. Holding spun coir with standing work posture during working hours, the operators complained pain on the left and right forearm, left and right thigh, left and right leg.

In Ernitua's study (2014) of the chips' fryer using *Nordic Standard Questionnaire* (SNQ) indicated that the percentage of highest very sick sense category experienced by women workers is equal to 47.4% while male workers only 28.2%. Energy consumption by the working pulse is 120 bpm at 350.8975 kcal /hour so it is a heavy workload. Measurements performed on women workers showed that 80% of energy consumption are in the weight category 351-379 kcal /hour while 20% on male workers. Based on CVL% known

that female workers are in the category of necessary repair while only 60% of male workers who were in the category of needed extend repair, are in the category of fatigue does not occur. Therefore, the study was only focused on women workers. Based on the actual condition of the work done to improve the design of the facility in accordance with the worker anthropometry.

Figure 1 showed a woman worker who was frying chips with a simple working facilities and standing work posture.



Figure 1 Chips Frying Activity

Elements of frying activity is take raw chips, bring raw chips, insert raw chips into the frying pan, fry chips, take the filter, and move chips to the second frying pan.

Workers complained pain and have a value of 9 to the category of very sick on the right hand and right shoulder at just use the right hand to fry and move the oil. Statically standing continuously for 7 hours each day resulted in contraction of the leg muscles, giving rise to MSDs complaints. Vey sick complaint was on the left knee, right knee, left calf, right calf, left ankle, right ankle, left foot and right foot due to standing work posture. Sick complain was on in the waist, left thigh and right thigh due to workers' posture that must bent 200-600 as much as 60 times in 1 hour to take raw chips from a bucket placed on the floor.

Standing work posture continuously for 7 hours interspersed by bent activity to retrieve raw chips from the container located on the floor can be improved by administering 3-foot saddle seat and raising raw chips' containers. The 3-foot saddle seat can be used when workers began to feel pain in both legs and workers can still perform activities of frying chips.

In this paper, described in depth discussion about the design of 3-foot saddle seat that can reduce MSDs complaints of frying chips' workers.

2. RESEARCH METHODOLOGY

2.1. Subject of Research

The study was conducted in a small business that produce chips from tapioca in Tuntungan district of Medan, North Sumatra. Subjects in this study were female workers who fry chips with standing working posture and very simple work facilities. Observation conducted to female worker at the frying station. Additional data of anthropometric measurements were taken from ergonomics laboratory, Department of Industrial Engineering Faculty of Engineering, University of North Sumatra.

2.2. Method and Research Instrument

The method used in this study were field observations and interviews using a questionnaire. Field observations involves identifying and measuring the dimensions of the work facilities and worker's body.

The instrument used in this study is the Standard Nordic Questionnaire (SNQ) to identify MSDs complaints of workers, Heart Rate to determine the workload of women workers in the frying station with labours pulse counting, Human Body Measuring Instrument Model YM-1 to measure the body dimension data of workers, goniometer to measure the angle of the workers posture.

3. RESULT AND DISCUSSION

3.1. Processing Time Calculation

Chips frying process conducted by workers during the five-day work can be seen in Table 1.

Table 1. Chips Frying Time

Work Day	Process Time (minute)
1	1.7
2	1.5
3	1.6
4	1.5
5	1.6
Sum	7,9
Average	1,6

Researchers used a confidence level of 95% and 5% level of accuracy and obtained an average value of \bar{x} as 1.6 minutes with $\sigma = 0,1$; UCL = 1,8 minutes; LCL = 1,4 minutes.

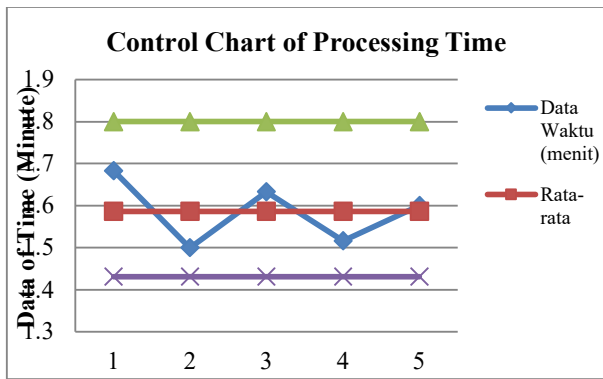


Figure 2. Control Chart of Frying Process Time

3.2. Work Posture Assessment with REBA

Work posture assessment with REBA method performed on the right and left body parts using sheet Rapid Entire Body Assessment (REBA) Worksheet. The assessment is done by giving a score in the box provided. Parts of the body which first assessed are the neck, legs, and body. Scores of the three sections are then inserted into table A to obtain value from table A. The value of Table A added by workload value will result in a score value of A. The next assessed body part are the wrist, forearm and upper arm. Scores of the three sections are then inserted into table B to obtain the value of table B. Value of table B then summed with the value of grip that will result in a score of B. Scores value of A and B are then put into table C to produce C table value. Obtained data seen that almost all elements of the activities are in the high risk level with category of necessary corrective action as soon as possible.

3.3. Measurements of Workers' Body Dimension

Measured body dimensions of frying chips workers to get a 3-foot saddle seat design is foot standing elbow height (TSB) to determine height of saddle chair legs; seated hip width (LPD) to determine the width of the saddle seat pads; buttock popliteal (PP) to determine the length of the saddle seat cushion (Table 2).

Table 2 Calculation of Percentile of Body Workers Dimensions

N	Dimension	\bar{X} (cm)	σ (cm)	X_{min} (cm)	X_{max} (cm)
1	TSB	103,24	12,39	87,7	136
2	LPD	32,94	4,58	25	45
3	PP	45,04	3,61	36	54
4	LT	9,19	0,87	7,6	12
5	PT	17,53	1,25	15	20

Uniformity data test is used to control the process of the rejected or not uniform data because of its unfulfillment to the existing criteria. Uniformity data with map control $UCL = \bar{X} + k \sigma$; $LCL = \bar{X} - k \sigma$. The adequacy data test used to analyze the representation of the number of measurement samples. Normality data test were calculated using SPSS 17 software-The adequate dimensional data are then processed to test the normality of the data

Table 3. Data Adequacy Test Results

N	Dimension	N	N	Descrip-
1	TSB	3	4	Ade-
2	LPD	4	2	Ade-
3	PP	4	6	Ade-
4	LT	4	7	Ade-
5	PT	4	8	Ade-

3.4. Results of Application Design

Analysis of actual work posture on chips frying stated that ergonomic facility that can change a working system is needed so workers can stand up and sit alternately in order to dynamic muscle work. Therefore, the researchers designed a saddle seat so that workers can change the sit-stand alternately work systems.

After the application of work facility design on chips frying process then the obtained value of the Nordic Standard Questionnaire (SNQ) showed that female workers in frying station are dominant with no pain category. Not sick category is at the upper neck, lower neck, back, waist, buttocks, buttocks, left elbow, right elbow, left forearm, right forearm, left wrist, right wrist, left hand, left thigh, thigh right, left ankle, right ankle, left leg, and right leg. A bit sick category is on the left shoulder, right shoulder, left upper arm, right upper arm, right hand, left knee, right knee, left calf and right calf. A bit sick category is on the right hand because workers only use the right hand to fry and move the oil. A bit sick category is also presented in the left knee, right knee, left calf, right calf, due to the standing work posture. This condition has been reduced from the very sick became a bit sick as it has done 3-foot saddle seat design in the frying station, so the workers can sit for a while in the process of frying so that the perceived grievances of workers is reduced.

Assessment carried out on the right and left body parts using sheet Rapid Entire Body Assessment (REBA) Worksheet. Parts of the body are first assessed are the neck, legs, and body. The next parts of the body assessed are wrist, forearm and upper arm.

Based on REBA assessment done to the right and left body, the REBA score was 4 and 4 Recommendations for improvement from posture assessment is that the taking raw chips activity is in the risk level of necessary corrective action later.



Figure 2. Frying Raw Chips

The provision of ergonomic work facilities such as 3-foot saddle chairs can reduce the number of risk levels of body posture for the elements of taking raw chips activities from 10 and 9 to 4 and 4 Elements of frying raw chips activities from scores of 8 and 8 to 2 and 4.

4. CONCLUSIONS

1. Activities ranging from take raw chips to move half-baked chips to the next pans which done with standing work posture cause pain complaints (MSDs) on several limbs of women workers.
2. Work posture assessment by REBA method known that the risk level of body posture for elements of taking raw chips activity scores 10 and 9, while the elements of fry chips activity are 8 and 8 These results require corrective action as soon as possible.
3. Application of the design in the form of 3-foot saddle seat corresponding to workers' body dimensions (anthropometry) reduces the risk level of body posture for the elements of taking raw chips activity into 4 and 4, while for elements of frying chips activity into 2 and 4.

5. ACKNOWLEDGEMENTS

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