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Ergonomic approach decrease musculoskeletal complaints and increases productivity of *pindang* producers in Kusamba, Bali

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Abstract. Kusamba is a village known to be the largest central *Pemindangan* in Bali, housing 70 blocks of *Pemindangan* slot and can produce approximately 20 ton of *pindang* per day. Group of *pindang* producers consists mostly of women, and perform activities consisting of cleaning fish, salting, until boiling fish. They do all the activities in squatting position, sometimes sitting on a log. After they finish working, they always feel waist pain, stiffness in their whole body, especially back and leg. This study aims to determine the benefits of improved work attitude with an ergonomic approach to musculoskeletal complaints and work productivity of *pindang* producers group in Kusamba Village, Bali. This research design was experimental with treatment by subject. The subjects were 10 female workers who were choose by simple random sampling, and then they were intervened by ergonomic approach working condition. Musculoskeletal complaints were assessed using Nordic Body Map and productivity was measured by counting the number of *pindang* produced in 3 hours. The change of musculoskeletal complaints and productivity were compared before and after intervention using statistical analysis. Our result showed significant decrease of musculoskeletal complaints and increase of *pindang* productivity ($p<0.05$). So we concluded that ergonomic approach helps improve the working attitude of *pindang* workers in Bali.

1. Introduction

Kusamba is a local village which is considered the central of "*Pemindangan*" in Bali [1]. In accordance with the assessment conducted by the Ministry of Maritime and Fisheries Affairs Number: Kep.01/MEN/2007, Kusamba was appointed as a location for central development of fishery management in 2007. As the central location for the process of "*Pemindangan*", Kusamba village can produce 20 tons of "*Pindang*" per day [1]. "*Pindang*" is one of processed fish-themed foods consumed by a wide variety of people, requiring mackerel tunas which fall under the biological *family scromboidae* as one of the main ingredients [2]. Pemindangan is a process to make pindang. "*Pemindangan*" process involves several practical procedures, in which the first step is to clean the selected mackerel tunas. Having been cleaned, the fish are placed in a certain container or bamboo basket which holds 8-10 mackerel tunas, and then followed by putting them in boiling water having been added with some salt at 100^0C for 30 minutes [3].

"*Pemindangan*" slot in Kusamba open from 11 am until 5 pm depending on the number of fish production and availability at the cold storage. The mackerel tunas required for the "*Pindang*" are

harvested by utilizing *purse seine* and trolling line. The process of "*Pemindangan*" is practically conducted by using homey tools. It is performed through several utilizations of bamboo basket on which some salt is sprinkled prior to being used to hold the fish, which is followed by putting the bamboo basket containing the fish into stainless steel containers containing boiling water and adding some ballasts to keep the fist underwater. The process is concluded to be finished as the fish eyes implode [3].

Food-processing workers may fatigue and discomfort when performing highly repetitive tasks, and awkward postures. Working under these conditions may result in chronic injuries to muscles, tendons, ligaments, and nerves. Injuries of this type are known as work-related musculoskeletal disorders. Fish processing workers may face a lot of work related health hazards due to various reasons, which the majorities were females [4]. Based on preliminary study, most of the *pindang* producers in Kusamba were female. They have to do all the *pemindangan* process in squatting position, sometimes in standing position from 11am until 5 pm. This condition made the *pindang* producers work overtime to meet the target of productivity. They always feel fatigue and have musculoskeletal complaints, especially on the back, hip, knee, and leg [3].

Continuous overtime work load could increase stress followed by various impacts that may decrease productivity. Total ergonomic approach pointed out the application of systemic, holistic, interdisciplinary, and participatory approach to analyze working condition. A comprehensive ergonomic intervention design should be taken into consideration to get the best improvement with minimum impact [5]. Studies on the ergonomic improvements have been done by many researchers in many sectors. Meanwhile a study on ergonomic improvement in pindang production has never been done yet. This research is aimed to find out the effect of ergonomic approach to musculoskeletal complaints and productivity of *pindang* producers in Kusamba, Bali.

2. Methods

This research was conducted in one of *pindang* producer group which is located in Kusamba, Bali for 2 months. The research design was experimental research with treatment by subject. The population included female workers of *pindang* producers, with inclusion criteria such as: female, age 30-50 years old, have minimum 3 years working experience as *pindang* producers, healthy, and want to follow this research with informed consent. Subject who have sick during research and leave the research without permission will be excluded. There are 26 female workers in Kusamba and only 10 workers were chosen by simple random sampling.

The subjects were intervened by ergonomic approach working condition. Work station improvement included: 1. arranging the table for washing and salting the fish, 2. raising the stove position. Musculoskeletal complaints were assessed using Nordic Body Map and productivity was calculated by counting number of fish production. The change of musculoskeletal complaints and productivity were compared before and after intervention using statistics. P value below 0.05 means statistically significant.

3. Result and Discussion

Our subjects were 10 female workers and all of the subjects completed this research without drop out. The subjects were 10 female workers. We selected female workers because work in this field (seafood-processing) is mostly done by female. Female make up around half the labor force in seafood plants internationally in comparison to male [4] [6]. Other than that, musculoskeletal complaints after moderate or heavy work are experienced more by female workers [7].

Table 1. Physical Examination result for the subject of research

Description	N	Mean ± Standard Deviation
Age	10	37.0 ± 6.01
Blood Pressure	10	117.0 ± 9.48
Pulse	10	76.0 ± 4.42
Body Mass Index	10	23.05 ± 1.17

Before we started our research, we did some interview and physical examinations to make sure all of the subjects were healthy to join this research. Age of subject varied from 30 to 50 years old as productive age with a stable basal metabolism rate, this condition caused no metabolic difference between younger and older age [8]. Our subjects have normal blood pressure, pulse, and body mass index, and we stated that all of the subjects have good health status for joining this research, as in table 1.

Cleaning and salting fish in Kusamba were usually done in squatting position, see **figure 1**. Squatting is a posture in which the worker supports the body with the feet and the upper and lower legs form an angle of less than 90^{o} relative to each other. Workers who spent more than 15 minutes per working day performing work in a squatting position did show a statistically significant increase in the risk (OR = 1.8; 95% CI 1.1-3.1) of low back pain [9]. Previous studies found that workers who work in a squatting position for more than one hour per working day were about twice as likely to have knee osteoarthritis as workers who hardly ever work in a squatting position [10][11]. Previous research found that workers who spent more than 5 minutes per hour (so more than 40 minutes per day) working in a squatting position had a statistically significant elevated risk (HR = 1.6; 95% CI 1.1-2.3) of lower limb pain (hips, knees, feet) compared with workers who spent less time working in this posture [12].

Beside of squatting while cleaning and salting fish, the workers also bend and twist their trunk when boiling fish, see **figure 1**. Bending is defined as flexion of the trunk, usually in the forward or lateral direction. Twisting refers to trunk rotation or torsion. Awkward postures include non-neutral trunk postures (related to bending and twisting) in extreme positions or at extreme angles. Awkward postures increase total exertion required to complete a job. The body must apply force to the body must apply force to joints and muscles to deviate body parts from the neutral position. Further the deviation, the more force that is applied. The further the deviation, the less force will able to apply tool. Working in awkward postures will cause fatigue, leading to injuries [13]. Many studies have shown that work-related musculoskeletal disorders develop when a major part of a worker's job involves reaching, bending over, lifting heavy objects, using continuous force, working with vibrating equipment, and doing repetitive motions. These injuries affect muscles, nerves, tendons, ligaments, joints, or spinal discs. Bending, twisting, kneeling, reaching, and stretching in particular are stressors on the low back and influence how the workers feel after finishing task [14]. Our research improves the working station by arranging the height of table and stove in order to decrease the awkward posture when producing *pindang*.

Musculoskeletal complaints after intervention decrease in quantity and quality. Working condition improvement decreased the musculoskeletal complaints significantly from 33.03±2.73 to 31.30±3.49 ($p<0.05$). This intervention could decrease the musculoskeletal complaints 5.53%. Musculoskeletal complaints were in back 80%, hip 70%, and leg 60%. Back was the most common musculoskeletal complaints because of static work posture, repetitive, and monotonous work without any rest time for relaxation. Previous research done in a seafood processing, Ghana, the most common musculoskeletal symptoms are the low back, knees, and ankles due to prolonged standing with little no rest and repetitive flexion of the back. Prolonged standing either restricts blood flow in the lower limbs or results in spinal loading of the low back [15].

Figure 1. Awkward postures in producing pindang: squatting when cleaning and salting fish (a), bending and twisting trunk when boiling (b)

The final outcome of working station improvement is increasing productivity. Our research measure the productivity by numbering *pindang* produced in 3 hours working. Our research found that the number of productivity was increased from 150 kilograms into 178 kilograms. The production was increased 18.67%. The increase is possible because the application of this ergonomic approach allow the workers to be more relaxed and more comfortable. Such awkward postures were successfully avoided so some musculoskeletal complaints and fatigue could be inhibited.

Despite of less of subjects, this study has some limitation. In this study, the ergonomic approach is only limited to improving the workplace. Some matters such as arranging work cycles, providing drinks and meals while working, use of masks and gloves at work can be discussed and arranged in subsequent research. It would be better if the future is able to assess the effect of the ergonomic approach to the income of *pindang* workers as the final outcome. Increased productivity without increased income can decrease worker's motivation, but such motivation that drives the employee to work for much income without any attention to their health and safety should be avoided.

4. Conclusion

Based on the result and discussion it could be concluded that the improvement of working condition based on total ergonomic approach decreased musculoskeletal complaints and increased productivity of *pindang* workers in Kusamba.

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