DEVOTION
Journal of Research and Community Service

Volume 3, Number 11, September 2022
e-ISSN: 2797-6068 and p-ISSN: 2777-0915

ERGONOMIC APPLICATIONS REDUCE FATIGUE, MUSCULOSKELETAL COMPLAINTS, HEAT RADIATION, AND INCREASE PRODUCTIVITY OF PIG ROLLERS

Ni Putu Ardiyanti[1], Susy Purnawati[2], Nyoman Adiputra[3], I Made Krisna Dinata[4], I Gusti Ngurah Priambadi[5]

[1,2,4)] Ergonomics Physiology of Postgraduate Work at Udayana University, Denpasar, Indonesia
[3)] Department of Physiology, Faculty of Medicine, Udayana University, Denpasar, Indonesia
[5)] Industrial Engineering Study Program, Faculty of Engineering, Udayana University, Denpasar, Indonesia
ardiyantiputu98@gmail.com[1], susy_purnawati@unud.ac.id[2], nadip2003@yahoo.com[3], krisnadinata@unud.ac.id[4], priambadi.ngurah@unud.ac.id[5]

KEYWORDS
Ergonomics, Pig Rolling Workers, Fatigue, Musculoskeletal Complaints, Productivity

ABSTRACT

One of the typical Balinese culinary tours is Pig Rollers. The process of making pig guling still on human power in the rolling process by doing a continuous circular motion. This study aims to determine the decrease in fatigue, musculoskeletal complaints, heat radiation, and increase in productivity before and after treatment of pig roller workers due to the application of ergonomics applications in the form of repairing work stations. The method used in this study is an experimental (true experimental) with the same subject design (treatment by subject design) and a randomized pre and post-test group design pattern of variables in the form of worker fatigue which is recorded with a 30 Items of Rating Scale of General Fatigue questionnaire; musculoskeletal complaints of workers who were recorded with the Nordic Body Map questionnaire; heat radiation measured with 4ch K Thermometer SD Logger; and the productivity of pig rolling workers is assessed based on the output (weight of the product produced) divided by the input (work pulse) multiplied by time (time). Measurements were carried out before and after working in Period I and Period II on 12 samples for 1 month. The data obtained will be analyzed by paired t-tests at a significance level of 5%. The results showed that there were significant differences ($p<0.05$) in workload, fatigue, musculoskeletal complaints, heat radiation, and work productivity in Period I and Period II. Ergonomics application in the form of work station improvement reduces workload by 10.22%, fatigue by 13.46%, musculoskeletal complaints by 33.61%, heat radiation by 11.81%, and increases productivity by 78.50%. It can be concluded that the application of ergonomics in the form of repairing work stations can reduce workload, fatigue, musculoskeletal complaints, and radiation, and increase the productivity of pig rolling workers in Peliatan Village, Ubud, Gianyar, Bali.

INTRODUCTION

Balinese culinary tourism is currently still growing rapidly. Culinary tourism is also a source of creative economy that not only creates jobs but can reflect the culture of a region. One of the typical Balinese foods that attract tourists is Pig Rollers (Marwanto & Marfianti, 2011) . In addition, Pig Rollers is also used as an offering in religious ceremonies in Bali. This food is often used as a special menu by restaurants or restaurants. Pig guling business at the household level is increasingly prevalent in Bali (Lestari, Rahardjo, & Dewanti, 2018) .

The process of making Pig Rollers at the household business level is still many who have not used machines in the manufacturing process (Mindhayani & Purnomo, 2016) . The pig rolling worker does his job by being quite near the heating fire. The fuel used is firewood and coconut fiber. The rolling handle used to turn the pig is made of iron. The process of making Pig Rollers takes between 2 to 3 hours so workers must remain in a sitting position while

rolling the pig. The rolling process is carried out by rotating the rolling handle continuously until the pork changes color to brownish red, looks crispy and tender which indicates that the pork is cooked. (Armijal & Firdaus, 2021). This condition causes workers to be in a static sitting position for a relatively long time with a bent work attitude because there is no anthropometric seat available (Suarjana, Adiatmika, & Adnyana, 2018).

The wooden planks used by workers as a barrier to heat radiation have not been able to fully cover the workers' bodies. The wooden plank is only placed on one side of the worker and the height is only limited to the worker's chest. Heat radiation originating from the furnace will contribute to the emergence of fatigue (Nariani, 2019). Excessive heat radiation will cause the body to respond by doing vasodilation or widening of the skin blood vessels which aims to drain more blood to the skin to remove heat from the inside out of the body (Fuadah, Ekawati, & Wahyuni, 2022) . This causes the heart to pump blood faster which can be seen from an increase in the work pulse rate so that the body experiences fatigue more quickly. The emergence of fatigue can cause workers to make mistakes at work, thereby increasing the risk of musculoskeletal complaints. The decline in work quality will go hand in hand with a decrease in work productivity (Nariani, 2019).

Pig rolling workers generally work in groups and have not applied ergonomic principles in designing the workplace, especially the place used to roll pigs (Fajrianti, Shaluhiyah, & Lestantyo, 2017). Based on the preliminary study identified problems, namely (1) work stations that are not in accordance with the anthropometry of workers; (2) excessive use of muscle power due to unnatural work positions and attitudes and relatively high exposure to furnace heat; (3) the work process is dominated by static muscle contractions accompanied by repetitive movements performed by workers in a relatively long time; and (4) the microclimate around the workplace is not comfortable, because the environmental temperature is relatively high accompanied by exposure to heat from the fireplace and the air circulation is also not good because the area where the work place is very closed (Eka & DN, 2019).

These conditions result in (1) not being comfortable doing work; (2) fatigue appears more quickly; (3) the appearance of complaints in the skeletal muscles; (4) increased workload; (5) the energy required is higher when doing the same work effort; (6) severe dehydration; (7) the risk of work errors; and (8) decreased productivity (Sutajaya, Risttiati, & Undikksha, 2014).

The results of a preliminary study of 10 pig rolling workers there was an increase in fatigue of 54.32%, an increase in musculoskeletal complaints by 53% with an assessment of work posture using the RULA method at action level 7 which means immediate improvement is needed, musculoskeletal complaints in the category of pain are most felt in the shoulders and thighs, while musculoskeletal complaints in the stiff category are mostly felt in the back, the average heat radiation at work is 35.51□C, and the pulse rate increases by 9.86%. Work organization, work instruments, worker characteristics, and environmental factors also affect the quality of health and work productivity of pig rolling workers (Asriyani & Karimuna, 2017) .

Repairs to the work station carried out in this study were (1) improvement of the rolling handle with a steering wheel shape; (2) the provision of seats in accordance with the anthropometry of workers; and (3) the installation of an ergonomic radiation barrier board, namely the use of a wooden plank with a transverse position added with acrylic glass in the middle so that workers can still see the condition of the pig when rolling.

The problem formulations that can be made based on the background are: (a) does the application of ergonomics in the form of repairing work stations reduce the fatigue of pig rolling workers in Peliatan Village?; (b) does the application of ergonomics in the form of repairing work stations reduce musculoskeletal complaints of pig rolling workers in Peliatan Village?; (c) does the application of ergonomics in the form of repairing work stations reduce the heat radiation of pig rolling workers in Peliatan Village?; (d) does the application of ergonomics in the form of repairing work stations increase the productivity of pig rolling workers in Peliatan Village?

METHOD RESEARCH

The method used in this study is the type of research carried out is experimental (true experimental) with the same subject design (treatment by subject design) with a randomized pre and posttest group design pattern. The research subjects were pig grinders in Peliatan Village, Gianyar District, Gianyar Regency, Bali Province. The target population in this study were all the rolling pig workers in Peliatan Village. The affordable population were all workers who rolled Pig Rollers spread over 10 banjars who met the inclusion criteria, totaling 12 workers. The data obtained in this study were analyzed by: (a) the data on the characteristics of the subject and environmental conditions were analyzed descriptively by looking for the mean and standard deviation or standard deviation; (b) normality test data for fatigue, musculoskeletal complaints, heat radiation, and productivity were analyzed by the Shapiro-Wilk test; and (c) data on fatigue, musculoskeletal complaints, heat radiation, and productivity were analyzed by paired t-test at a significance level of 5%.

RESULTS AND DISCUSSION

Based on the results of data collection, the average age of the subject is 45.75 years with a standard deviation of 7.237 years, which means that they are still in the productive category as workers. The average BMI of workers is 24.18 kg/m2 with a standard deviation of 1.603 kg/m2, which means it is in the normal category according to the Ministry of Health of the Republic of Indonesia.

The results of the data analysis of the working environment conditions can be seen in Table 1.

Table 1
Hypothesis Test Results on Musculoskeletal Complaints

Variable	Period I		Period II		t value	p value
	Average	SB	Average	SB		
Temperature (°C)	28,20	0.752	28.18	0.045	0.564	0.612
Relative Humidity (%)	78.11	0.982	78.03	0.349	0.153	0.888
Light Intensity (lux)	188,22	20.777	197.53	5,806	0.826	0.469
Wind Speed (m/s)	0.27	0.170	0.25	0.129	0.177	0.638
Noise dB(A)	52.65	1,646	52.92	0.412	0.327	0.765

Judging from the results of data analysis in Table 1, it can be explained that the work environment, namely temperature, relative humidity, light intensity, wind speed, and noise between Period I and Period II is comparable or gives the same effect on changes in the dependent variable (p > 0, 05).

The results of hypothesis testing on workload, fatigue, musculoskeletal complaints, heat radiation, and data productivity can be seen in Table 2.

Table 2
Hypothesis Test Results on Fatigue

Variable	Period I		Period II		t value	p value
	Average	SB	Average	SB		
Fatigue (Before Work)	62.67	1,825	64.16	2,691	27,118	0.175
Fatigue (After Work)	94.08	3,423	81.41	2,466	10,325	0.0001

In this study, it was found that the fatigue of pig rolling workers decreased between Period I and Period II by 13.46%. This shows that the application of ergonomics in the form of repairing work stations can improve the quality of workers' health as seen from the decrease in fatigue after work. Work stations and an adequate environment can increase worker comfort so that workers do not easily feel tired after doing their work.

The process of rolling pigs requires a lot of energy because workers have to constantly rotate the roll in a monotonous sitting position. In addition, the exposure to heat received by workers is also quite high because the insulation between workers and the firebox is only a wooden plank placed on the right side of the worker. Exposure to such heat can cause additional burden and discomfort to workers. This non-ergonomic work station can cause fatigue to appear more quickly.

(Hidayat, 2017) states that exposure to excessive heat will cause the heart to work more to transfer heat to the skin surface to keep the thermal body temperature in an optimal state. (Arini & Dwiyanti, 2015) reported that there was a relationship between work fatigue and monotonous sitting. (Asriyani & Karimuna, 2017) states that the heavier the work, the more oxygen is needed by the body. Likewise, blood flow will increase along with a faster heart pump so that it can interfere with the process of transporting oxygen to the muscles. This will cause workers to experience fatigue more quickly at work (Prasojo, Sulistyo, & Listyanto, 2012).

Figure 1. The Rolling Process After Repair With the Installation of Cross-Wood Boards

Source: Personal Documentation, 2022

The use of a wooden plank with a transverse position coupled with acrylic glass in the middle can reduce the exposure to heat radiation received by workers when rolling pigs. The addition of acrylic glass is used so that workers can still see the condition of the Pig Rollers and the size of the burning fire (Arini & Dwiyanti, 2015). Pig rolling workers are exposed to heat radiation for 1 hour and must constantly rotate the roll. With the wooden planks as an insulator, the heat radiation received by workers can go down so that workers feel more comfortable in doing their jobs. The rolling handle with a steering wheel shape also makes it

easier for workers to roll pigs and the seat cushions used also increase the comfort of workers who have to stay in a monotonous sitting position when rolling pigs. Increasing the comfort of the work station can reduce the risk of fatigue in workers. In addition, the decrease in workload also causes a decrease in the fatigue of pig rolling workers (Agustinawati, Dinata, & Primayanti, 2019).

These findings synergize with research: (a) (Putriyani & Sri Darnoto, 2016) reported that there were differences in work fatigue in the work environment; (b) (Eka & DN, 2019) reported that there was an effect of hot temperatures on worker fatigue in construction workshops. The hot temperature received by workers can reduce motor activity so that workers can slow down working time. Repair of work stations in the form of decreasing heat temperatures will reduce the feeling of hotness in workers; (c) (Agustinawati et al., 2019) reported that there was a relationship between workload and fatigue felt by bokor craftsmen.

The results of hypothesis testing on workload, fatigue, musculoskeletal complaints, heat radiation, and data productivity can be seen in Table 3.

Table 3
Hypothesis Test Results on Musculoskeletal Complaints

Variable	Period I		Period II		t value	p value
	Average	SB	Average	SB		
Musculoskeletal complaints (Before Work)	32.83	2,124	31.91	2.065	1,287	0.224
Musculoskeletal complaints (After Work)	68.16	2,724	45.25	2,416	23,557	0.0001

In this study, it was found that the musculoskeletal complaints of pig rolling workers decreased between Period I and Period II by 33.61%. This shows that the application of ergonomics in the form of repairing work stations can improve the health of workers as seen from the decrease in musculoskeletal complaints of pig rolling workers. In Period I, many workers experienced musculoskeletal complaints in the right wrist, as many as 5 people (41.67%), right forearm and waist as many as 4 people (33.33%). In Period II musculoskeletal complaints in the right wrist and waist were only felt by 2 people (16.67%), and in the right forearm only 1 person (8.33%). These findings can be used as a reference to state that work stations that are not yet ergonomic need to be repaired as soon as possible so that workers avoid musculoskeletal complaints.

Pig rolling work stations are still done manually by involving human power. Pig rolling workers will sit for an hour rotating the roll continuously (Suarjana et al., 2018). This is done so that the whole pork guling process is evenly distributed. The roll used has only one handle so that only one hand can hold the roll freely. The rolling motion is carried out with one hand only. This causes the worker's position and working attitude to bend when turning the roll, especially when the turning handle is at the bottom. Workers are also more likely to use their right hand in rolling and only occasionally replace it with their left hand (Sarman & Anshar, 2018). The seat used is higher than the worker's popliteal height. This also causes unnatural work positions and attitudes in workers. Work stations that do not refer to ergonomic principles will cause an increase in musculoskeletal complaints in workers.

(Sunaryo & Rhomadhoni, 2020) reported that static work attitudes in the lower body and repetitive work attitudes in the upper body, especially in the hands, had a correlation with musculoskeletal complaints. Work attitude is influenced by unfavorable work station conditions so an improvement is needed. (Jalajuwita & Paskarini, 2015) stated that non-

ergonomic posture is one of the causes of musculoskeletal complaints. (Asad, Achiraeniwati, Rejeki, & Pradana, 2018) stated that bad work postures that are carried out for a long duration and repeatedly cause workers to feel musculoskeletal complaints. Faudah, et al (2022) reported that there was a relationship between work posture and the emergence of musculoskeletal complaints due to non-ergonomic work stations.

Figure 2. Rolling Process Before and After Repair
Source: Personal Documentation, 2022

Related to these findings, improvements were made to the work station in the form of (a) repairing the roll handle in the form of a steering wheel covered with synthetic leather and referring to anthropometric data on the grip diameter at the 5th percentile (3.4 cm); (b) seat improvement which refers to the anthropometric data of the buttock-popliteal distance with the 50th percentile (45 cm) to design the seat length, the popliteal height data with the 5th percentile (43.10 cm) to design the seat height, and the addition of seat cushions. sit. The improvement of the work station can reduce workers' musculoskeletal complaints. Ergonomically oriented work stations can produce effective, comfortable, safe, healthy, and efficient working conditions so as to achieve the highest productivity.

The findings in this study synergize with other researchers, namely: (a) (Susana, Alit, & Aryadi, 2022) reported that ergonomic intervention in designing a work tool based on worker anthropometric data was able to reduce musculoskeletal complaints; (b) (Tantony & Sarvia, 2022) states that by redesigning the work station that is used during ergonomic activities, it can reduce the risk of work postures that have the potential to cause musculoskeletal complaints; (c) (Danida, 2019) reports that there is a significant relationship between work posture and musculoskeletal complaints, so it is necessary to adjust work tools with worker anthropometry.

The results of hypothesis testing on workload, fatigue, musculoskeletal complaints, heat radiation, and data productivity can be seen in Table 4.

Table 4
Hypothesis Test Results on Heat Radiation

Variable	Period I		Period II		t value	p value
	Average	SB	Average	SB		
Heat Radiation (°C)	31.65	0.465	27.91	0.156	30,174	0.0001

In this study, improvements were made to ergonomics-oriented work stations, namely the provision of insulation in the form of wooden boards between workers and the fire stove.

These improvements were able to reduce the heat radiation that exposed workers by 11.81% between Period I and Period II. This shows that the provision of wooden boards as a protection for workers from exposure to heat radiation from the fire stove can improve the quality of workers' health as seen from the decrease in workload, fatigue and musculoskeletal complaints of workers. The use of wooden planks does not cover the view of the workers because in the middle of the wood, acrylic glass has been installed so that workers can freely see the Pig Rollers.

The heat radiation received by workers in Period I was 31.65□C. According to Permenkes No. 70 of 2016 the temperature exceeds the temperature threshold value with a moderate workload within one hour. The heat radiation comes from the pig rolling furnace which can cause high heat stress. Heat stress will be an additional workload that can increase the risk of occupational diseases. (Marwanto & Marfianti, 2011) stated that heat stress affects the cardiovascular system, namely an increase in heart performance. This is indicated by an increase in pulse rate. (Lestari et al., 2018) stated that an increase in blood pressure occurs as the temperature of the work environment increases. It is characterized by an increase in heart rate to meet the need for oxygen to the working muscles.

The use of wood material as an insulator between workers and the fire stove to reduce heat radiation is due to the fact that wood has a low thermal conductivity value or can be said to have poor heat conductivity. Wood can be used as a heat insulator raw material.

The findings on this synergize with other researchers, namely: (a) (Prasojo et al., 2012) stated that wood has good insulating properties against heat; (b) (Setyaningsih, 2018) states that the heat temperature can be controlled technically, such as insulation of heat sources; (c) (Sunaryo & Rhomadhoni, 2020) states that controlling heat in the workplace can be done by limiting workers to exposure to heat; (d) (Fajrianti et al., 2017) states that it is important to control heat exposure in workers so that workers feel safe and healthy in doing their jobs; (e) (Maftuh, Haryanti, & Johar, 2021) reported that there is an influence between the work climate on the level of work fatigue; (f) (Wangi, 2020) reports that the work environment affects employee performance.

The results of hypothesis testing on workload, fatigue, musculoskeletal complaints, heat radiation, and data productivity can be seen in Table 5.

Table 5
Hypothesis Test Results on Productivity

Variable	Period I		Period II		t value	p value
	Average	SB	Average	SB		
Productivity	2.00	0.111	3.57	0.377	14,588	0.0001

In this study it was found that productivity increased by 78.50% between Period I and Period II. This shows that the improvement of ergonomics-oriented work stations can improve the quality of health and comfort of workers so as to increase productivity. It is stated so because through the improvement of ergonomics-oriented work stations it can reduce workload by 10.22%, reduce fatigue by 13.46%, and reduce musculoskeletal complaints by 33.61% so that there is an increase in productivity of 78.50%.

The measurement of productivity in this study is composed of several components, namely input (work pulse), output (weight of pig rolls produced in one day), and time (working time). Increased productivity is marked by a decrease in the workload on workers because the smaller the workload, the productivity will increase. The decrease in workload is caused by a decrease in the heat radiation received by workers. The decreased workload will

also have an impact on the quality of health as seen from the decrease in fatigue due to work stations and an environment that is comfortable or not too hot. Fatigue is a feeling that arises as a result of bodily discomfort to a working condition. This decrease in fatigue can also have an impact on reducing musculoskeletal complaints in workers (Susana et al., 2022). The decrease in workload, fatigue, musculoskeletal complaints can contribute to each other to increase the productivity of pig rolling workers. This causes workers to always feel safe, comfortable, and healthy to do their jobs so that there is an increase in work productivity.

This finding is in synergy with other researchers, namely (a) (Wangi, 2020)reporting that work safety seen from the work environment and work methods has a contribution to work productivity; (b) (Tantony & Sarvia, 2022) reported that an increase in productivity was due to improvements in ergonomics-oriented work mechanisms. This results in workers becoming more fit, healthy, and comfortable so that productivity increases; (c) (Mindhayani & Purnomo, 2016) reported that improving work systems with ergonomic interventions can reduce fatigue and musculoskeletal complaints and can increase productivity; (d) (Armijal & Firdaus, 2021) reported that repair of work tools contributed to increased productivity; (e) (Suarjana et al., 2018) reported that the redesign of work tools in accordance with anthropometry causes workers to use work tools in a comfortable and safe condition so as to increase work productivity; (f) (Sutajaya et al., 2014) reported that increased productivity was due to an increase in the quality of workers' health after being given improved working conditions based on local wisdom relevant to the ergonomics concept.

CONCLUSION

Based on the results of research and discussions that have been reviewed based on relevant research, it can be concluded: (a) ergonomic application reduces the fatigue of pig rolling workers by 13.46%; (b) application of ergonomics reduces musculoskeletal complaints of pig rolling workers by 33.61%; (c) application of ergonomics reduces heat radiation of pig rolling workers by 11.81%; and (d) application of ergonomics increases the productivity of pig rolling workers by 78.50%. Suggestions that can be conveyed in this study: (a) pig rolling workers are advised to use tools and work stations that are in accordance with anthropometry or body size so that they are comfortable at work; (b) it is recommended that the manager of the Pig Rollers household business pay attention to the condition of the work station and the work tools used to comply with ergonomics rules; (c) local village officials should facilitate efforts to improve ergonomics-oriented work stations in home industries, especially pig rolling workers; (d) further researchers are expected to be able to measure ECPT (extra calorie due to peripheral temperature) and ECPM (extra calorie due to peripheral metabolism), and be able to analyze the pollutants produced by the fuel used on workers' respiratory systems.

REFERENCES

Agustinawati, Kadek Rina, Dinata, I. Made Krisna, & Primayanti, Idaid. (2019). Hubungan Antara Beban Kerja Dengan Kelelahan Kerja Pada Pengerajin Industri Bokor Di Desa Menyali. *Jurnal Medika Udayana*, *9*(9), 1–7.

Arini, Shintia Yunita, & Dwiyanti, Endang. (2015). Analisis Faktor Yang Berhubungan Dengan Terjadinya Kelelahan Kerja Pada Pengumpul Tol Di Perusahaan Pengembang Jalan Tol Surabaya. *The Indonesian Journal Of Occupational Safety And Health*, *4*(2), 113–122.

Armijal, Armijal, & Firdaus, Muhammad. (2021). Usulan Perancangan Perbaikan Stasiun

Kerja Dengan Analisis Peta Kerja Dan Kebutuhan Ruang Untuk Peningkatan Produktivitas. *Jurnal Sains Dan Teknologi: Jurnal Keilmuan Dan Aplikasi Teknologi Industri*, *21*(2), 292–301.

Asad, Nur Rahman, Achiraeniwati, Eri, Rejeki, Yanti Sri, & Pradana, Andri. (2018). *Identifikasi Keluhan Pekerja Dan Pengukuran Tingkat Risiko Kerja Dengan Pendekatan Ergonomi Untuk Mencegah Musculoskeletal Disorders (Msds)(Studi Kasus: Perusahaan Minuman Pt. X)*.

Asriyani, Nyky, & Karimuna, Siti Rabbani. (2017). *Faktor Yang Berhubungan Dengan Terjadinya Kelelahan Kerja Pada Pekerja Pt. Kalla Kakao Industri Tahun 2017*. Haluoleo University.

Danida, Dwi Indica. (2019). *Hubungan Postur Kerja Dengan Keluhan Muskuloskeletal Pada Pekerja Room Attendant Dan Public Area Attendant Di Hotel Kartika Chandra Tahun 2019*. Universitas Pembangunan Nasional Veteran Jakarta.

Eka, Lintang, & Dn, Agnes Theresia. (2019). Pengaruh Iklim Kerja Terhadap Kelelahan Tenaga Kerja. *Gema Lingkungan Kesehatan*, *17*(2).

Fajrianti, Gita, Shaluhiyah, Zahroh, & Lestantyo, Daru. (2017). Pengendalian Heat Stress Pada Tenaga Kerja Di Bagian Furnace Pt. X Pangkalpinang Bangka Belitung. *Jurnal Promosi Kesehatan Indonesia*, *12*(2), 150–162.

Fuadah, Irvina Wahyu, Ekawati, Ekawati, & Wahyuni, Ida. (2022). Hubungan Postur Kerja Dan Desain Stasiun Kerja Pada Aktivitas Penjemuran Dengan Keluhan Musculoskeletal Disorders Pada Pekerja Laundry Di Kelurahan Tembalang. *Kesmas Indonesia*, *14*(1), 59–74.

Hidayat, Raga Aditya. (2017). Hubungan Konsumsi Air Minum Dengan Keluhan Subjektif Akibat Tekanan Panas Pada Pekerja Pandai Besi Di Desa Bantaran Probolinggo. *Jurnal Keperawatan Muhammadiyah*, *1*(2).

Jalajuwita, Rovanaya Nurhayuning, & Paskarini, Indriati. (2015). Hubungan Posisi Kerja Dengan Keluhan Muskuloskeletal Pada Unit Pengelasan Pt. X Bekasi. *The Indonesian Journal Of Occupational Safety And Health*, *4*(1), 33–42.

Lestari, Dinda Tri, Rahardjo, Mursid, & Dewanti, Nikie Astorina Yunita. (2018). Hubungan Paparan Panas Dengan Tekanan Darah Pada Pekerja Pabrik Baja Lembaran Panas. *Jurnal Kesehatan Masyarakat (Undip)*, *6*(6), 79–86.

Maftuh, Muhammad, Haryanti, Titik, & Johar, Syefira Ayudia. (2021). Pengaruh Iklim Kerja Panas Terhadap Kelelahan Kerja Pada Operator Steam Di Pt. Xyz Boyolali. *Jurnal Penelitian Dan Pengembangan Kesehatan Masyarakat Indonesia*, *2*(2), 141–147.

Marwanto, Zuhdan, & Marfianti, Erlina. (2011). Perbedaan Tekanan Darah Sebelum Dan Sesudah Paparan Heat Stress Pada Pekerja Perusahaan Industri Alumunium Yogyakarta. *Jkki: Jurnal Kedokteran Dan Kesehatan Indonesia*, 31–37.

Mindhayani, Iva, & Purnomo, Hari. (2016). Perbaikan Sistem Kerja Untuk Meningkatkan Produktivitas Karyawan. *Penelitian Dan Aplikasi Sistem Dan Teknik Industri*, *10*(1), 182841.

Nariani, Ni Komang. (2019). Pengembangan Kuliner Lokal Berdasarkan Persepsi Wisatawan Di Ubud, Bali. *Journey: Journal Of Tourismpreneurship, Culinary, Hospitality, Convention And Event Management*, *1*(2), 85–98.

Prasojo, Anton, Sulistyo, Joko, & Listyanto, Tomy. (2012). Konduktivitas Panas Empat Jenis Kayu Dalam Kondisi Kadar Air Yang Berbeda. *Prosiding Seminar Nasional Mapeki*, *14*, 97–101.

Putriyani, Andhita Juli, & Sri Darnoto, S. K. M. (2016). *Perbedaan Kelelahan Kerja Yang*

Terpapar Iklim Kerja Panas Pada Pekerja Bagian Pengecekan Dan Perbaikan Di Pt. Kereta Api Daerah Operasi Vi Yogyakarta Dipo Kereta Api Solo Balapan. Universitas Muhammadiyah Surakarta.

Sarman, Anwar, & Anshar, Anshar. (2018). Hubungan Antara Tekanan Panas Dengan Ketahanan Kerja Karyawan Pada Bagian Peleburan Di Pt. Aneka Tambang Tbk. Ubpn Pomalaa 2013. *Media Fisioterapi Politeknik Kesehatan Makassar*, *10*(2), 1–9.

Setyaningsih, Yuliani. (2018). *Buku Ajar Higiene Lingkungan Industri.*

Suarjana, I. Waya Gede, Adiatmika, I. Putu Gede, & Adnyana, I. Wayan Bandem. (2018). Redesain Alat Pemarut Kelapa Mengurangi Beban Fisiologis Dan Meningkatkan Produktivitas Kerja Pada Pekerja Industri Adonan (Luluh) Sate Di Desa Kaba-Kaba Kediri Tabanan. *Jurnal Ergonomi Indonesia (The Indonesian Journal Of Ergonomic)*, *4*(2), 39–52.

Sunaryo, Merry, & Rhomadhoni, Muslikha Nourma. (2020). Gambaran Dan Pengendalian Iklim Kerja Dengan Keluhan Kesehatan Pada Pekerja. *Medical Technology And Public Health Journal*, *4*(2), 171–180.

Susana, I. Gede Bawa, Alit, Ida Bagus, & Aryadi, I. G. A. K. Chatur Adhi Wirya. (2022). Aplikasi Ergonomi Berdasarkan Data Antropometri Pekerja Pada Desain Alat Kerja. *Energy, Materials And Product Design*, *1*(1), 28–34.

Sutajaya, I. Made, Risttiati, Ni Putu, & Undikksha, Jurusan Pedidikan Biologi Fmipa. (2014). Pemberdayaan Masyarakat Melalui Pelatihan Dan Implementasi Ergonomi Untuk Meningkatkan Kualitas Kesehatan Pematung Di Desa Peliatan Ubud Gianyar Bali. *Proceeding Senari*, *2*.

Tantony, Vincent, & Sarvia, Elty. (2022). Redesain Fasilitas Dan Perbaikan Postur Kerja Pada Stasiun Penggulungan Dan Pengukusan Adonan Pembuatan Krupuk Dengan Metode Rapid Entire Body Assessment. *Journal Industrial Servicess*, *7*(2), 234–242.

Wangi, Vani Kenanga Nan. (2020). Dampak Kesehatan Dan Keselamatan Kerja, Beban Kerja, Dan Lingkungan Kerja Fisik Terhadap Kinerja. *Jurnal Manajemen Bisnis*, *7*(1), 40–50.