

Natural posture while working reduces the risk of deteriorating concentration and quality of health

I K Widana¹, N W Sumetri², I K Sutapa¹

¹ Department of Mechanical Engineering, Politeknik Negeri Bali, Kampus Bukit Jimbaran, Bali, Indonesia

² Department of Business Administration, Politeknik Negeri Bali, Kampus Bukit Jimbaran, Bali, Indonesia

Email: ketutwidana@pnb.ac.id

Abstract. Occupational health is a very important aspect in determining the life expectancy. The high life expectancy is correlated with the quality of occupational health of workers and will have an important meaning if in carrying out activities the workers have good concentration and health. The purpose of this study is to look at the relationship of posture when working with occupational health and concentration. Improved posture by improving the workstation so that the body is always in a natural attitude. The research method is an experimental study using the treatment by subjects who worked before and after intervention. Ten carving artists participated as research subjects. Data were tested by two pair sample t-test and Wilcoxon signed rank test. The results show that utilizing natural posture can improve health quality and concentration. Indicators of occupational health such as workload decreased by 18.67 percent, namely 132.56 bpm in period I to 107.81 bpm in period II. Musculoskeletal disorders decreased by 14.27 percent, from a score of 55.63 in the first period to 47.69, as well as concentration indicators, such as speed, accuracy and constant all showing better signs after treatment, so it can be concluded that the improvement workers' body posture.

1. Introduction

Many carving artists can tell that after getting older, art activities can not be done anymore. The ability to sit for long on the floor is no longer sufficient. A less natural carving position, namely bending with legs folded is felt to be very tormenting and leaves pain and fatigue after completing several stages of activity. Indeed, pain and fatigue and increased heart rate when working have scientific logic that can be explained scientifically and its intensity can be reduced and even eliminated by correcting the trigger factors [1]. Reference [2] provide an explanation that supports the above statement, that fatigue, pain and even an increase in heart rate have a strong correlation with the work environment. A hot work environment can cause heat stress which stimulates the heart rate. In normal conditions our heart will beat 60 times per minute, but if the range is up to 125 - 150 beats/minute (bpm), which includes heavy classifications, it can cause various health effects [3, 4]. Feeling tired is also not good if left to last for a long time. Fatigue is the same as sirens or warning lights that indicate something is wrong with our body. Fatigue is actually the same as a baby who is crying, even though it is unpredictable, but at least we can guess there is something that needs to be handled, for example his diaper is wet, hungry, thirsty or just wants attention. From the aspect of production, the feeling of fatigue that we feel will cause the



Content from this work may be used under the terms of the [Creative Commons Attribution 3.0 licence](https://creativecommons.org/licenses/by/3.0/). Any further distribution of this work must maintain attribution to the author(s) and the title of the work, journal citation and DOI.

growth of work productivity. Reference [5], gives a reasonable argument, that if the producer gives little attention to the aspects of the human who runs the engine, then productivity will certainly increase. There are psychological aspects that can explain the logic, that when tired all desires to achieve will decrease.

In line with [2], [5] and [6] also prove in their analysis that humans can be very productive if they are always in a fit state. Fitter conditions are characterized by low levels of musculoskeletal complaints or musculoskeletal disorders (MSd) when on the move. Musculoskeletal disorders can be reduced and even eliminated if humans in their activities can still be in a natural position [7]. Reference [8], found an effective way to reduce pain in skeletal muscles at work, that the size of the human body using a tool is used to design the size of work tables and chairs, so that the body position of the worker while on the move remains natural or natural. The results of this study are in line with the results of the analysis of [9] who conducted a survey of industrial workers in North India, which concluded that the anthropometric workpiece position could eliminate work-related pain.

From the various problems above, in the realm of carving also experienced the same thing. There is a general phenomenon that can be witnessed in the community that when carving carved artists will experience various occupational health problems. There has been no serious effort from the health community to provide socialization and a way out of the problems. Academics need a helping hand to research, is it possible for carving artists to be able to move comfortably without complaints of skeletal muscles, cardiovascular load that is not too high and workload under heavy workload, so that work productivity can increase [10]. This study tries to reduce pain, fatigue and excessive workload by making the bodies of the artists remain in their natural attitudes and supported by comfortable environmental conditions, namely arranging chairs and work tables according to the size of the anthropometry of art workers and adjusting the intensity of lighting, wind speed, noise, temperature and relative humidity of the room [11, 12]. Based on preliminary study data, it was found that the shape and size closest to the anthropometric size for carving art workers.

The problems raised in this study are how ergonomic work stations can reduce workload, reduce musculoskeletal disorders and reduce cardiovascular load of carving craftsmen and how the relationship between workload variables, musculoskeletal disorders and cardiovascular load with work productivity of artisans, while the purpose of research is to change the paradigm the old, rigid and dogmatic, namely "the work of the sculptor sitting on the floor with his back bent" becomes a dynamic new paradigm, namely "the work of the sculptor is fun because he can choose a comfortable position and working attitude in a place that is in line with the worker anthropometry [13]. In the long term, this study has the aim that all carvers work by sitting in special chairs with workpieces on the table in front of them. The art of carving or carving is an ornamental image with concave parts and convex parts that make up a beautiful picture This understanding develops until it is known as carving art which is the art of forming images on wood, stone, or other materials. Carving craft products range in variety from souvenir to carving for Balinese buildings. Some problems related to occupational health are workload, skeletal muscle complaints and cardiovascular load. The method used to determine the amount of workload, one of which is by calculating the work pulse with the 10 pulse method, while the measurement of resting pulse is used 15 seconds method [14].

Reference [10] and [15] gave an explanation, that working anywhere is inseparable from workload, because in the process of work activities muscle and mental work is needed which is simultaneously shown through fatigue which is marked by a change in the pulse frequency. The pulse per minute describes the work of the heart in pumping blood out of the heart's inner organs. The greater the heart rate per minute means the higher the body's activity that causes an increase in body metabolism [16]. Reference [17] and [18] further said that according to ergonomic rules, every burden received by the body must be balanced with physical and cognitive abilities and limitations of the body that receives the burden. The ability of the human body to accept the load varies greatly, depending on the level of skill, fitness, nutritional intake, gender, age and body anthropometry. The light weight of an activity can be seen from oxygen demand, lung ventilation capacity, changes in body core temperature, energy requirements and sweat production or changes in body weight. Heart rate is a tool for estimating a good

metabolic rate, except in emotional states and vasodilation (dilation of blood vessels) [19]. The category of light weight workload is based on metabolism, breathing, body temperature and heart rate. The second problem related to occupational health is musculoskeletal disorders. Art workers in activities will experience physiological changes as a result of the accumulation of external and internal loads. Internal burdens such as weight, mind burden and health problems also coincide with workers, all of which can cause stress [20]. Stress received by the body is actively anticipated in the form of work system efficiency and passivity in the form of physiological reactions known as adaptive responses. According to [21] and [2] in his research conclusions, physiological changes aim to maintain cell metabolism in optimal conditions. To achieve this, continuous intake of oxygen and nutrients is needed. In addition, muscle contraction and relaxation must be regular. When the energy supply is limited and the flow of oxygen and food substances is disrupted, the cell metabolism will be disrupted, thereby accelerating the emergence of musculoskeletal disorders. Workers who use work stations and work equipment that have dimensions that are not in accordance with worker anthropometry will cause less natural movements and work attitudes, so that musculoskeletal disorders will occur earlier and more severely. The musculoskeletal system is a muscular system that is attached to the bone consisting of latitude fibers which are voluntary [10].

One obvious effect of musculoskeletal disorders is reduced alertness [22]. A person will not be able to concentrate continuously for mental activities. After experiencing tension during a certain period, there will be a disturbance in perception, and the reaction speed becomes slow. To overcome this disturbance, refreshment needs to be done outside the pressure. Refresher occurs especially during nighttime sleep or rest periods and during work breaks.

2. Methodology

To find out the impact of treatment/intervention on the condition of the subject, experimental research will be conducted with the design of the same subject (treatment by subjects design). Based on the design, measurements were made twice namely before and after the implementation of workstations and ergonomic environments. Data was collected from samples at the station's carving industry center in Tangeb Village and Kapal Village, namely UD. P. Jatayu, UD. Rinna Dewata Sari, UD. Agus. Selected samples were collected at UD. Agus for treatment. The object of research is the workstation and work environment of Balinese carving craftsmen. Occupational health and productivity data were taken using a stopwatch and questionnaire. The officers involved in conducting observations were ergonomics (master or doctor of ergonomics) and doctors who mastered the palpation technique (holding and calculating the pulse on the wrist), while the questionnaire used was Nordic body map. Environmental conditions will be observed with sound level meters (to measure noise levels), lux meters (to measure light intensity), sling thermometers (measuring wet and dry temperatures), black globe thermometers (measuring radians) and anemometers (to measure wind speed).

3. Results and discussion

3.1. Characteristics of subjects

Characteristics of subjects including age, weight, height and body mass index (BMI) are presented in Table 1. Most of the research subjects were of high school level (50%), while those with elementary and tertiary education were 30% and 20% respectively. Subjects numbered 10 people all male sex and employees of UD. Jatayu, UD. Rinna and UD. Agus. The age range of the subject is 25 dd. 46 years, average 35.71 ± 4.42 . Subject weight ranged from 47 to 74 kg with an average of 59.55 ± 6.02 kg. The subject's height is in the range of 155 to 168 cm with an average of 168.71 ± 4.22 cm. The work experience of the subject as a farmer ranges from 8 to 20 years with an average of 10.33 ± 3.84 years. Work experience is related to adaptability and the level of physical fitness of the craftsmen [23, 24].

Table 1. Characteristics of subjects.

No.	Description	Average	Standard of Deviation	Range
1	Age (years)	35.71	4.42	25 – 46
2	Body Weight (kg)	59.55	6.02	47 – 74
3	Height (cm)	168.71	4.22	155 – 168
4	Body mass index (kg/m ²)	21.67	3.37	18.34 – 24.89

3.2. Environment conditions

Environmental conditions consisting of dry temperature, wet temperature, relative humidity, wind speed, light intensity, ball temperature and noise also greatly affect the subject's condition. Data on light intensity, wind speed and noise are the results of measurements at five points and at different times. The results of data analysis showed that environmental conditions were seen from dry temperature, wet temperature, ball temperature, relative humidity, wind speed, light intensity and noise period I and in period II there were no differences. It is said that because all values are $p > 0.05$ or it can be said that: (a) the average dry temperature in the period I study is not significantly different from the mean dry temperature at the time of observation period II; (b) the mean wet temperature in period I observations did not differ significantly from the average period II wet temperature; (c) the average ball temperature in period I observations was not significantly different from the period II ball temperature average; (d) the mean relative humidity in period I observations was not significantly different from the average relative humidity during period II observations; (e) the average wind speed in period I observations was not significantly different from the period II wind speed average, and (f) the average noise, WBGT and light intensity in period I observations did not differ significantly from the mean noise, WBGT and light intensity in period II.

3.3. Occupational health

There are two health parameters that are used as a benchmark, namely workload and musculoskeletal disorders. Working pulse in first period was 132.56 ± 2.80 pulse per minute and working pulse in the second period was 107.81 ± 5.92 pulse per minute or decrease of 18.67%. Working pulse in the first period was still in heavy workloads category, mean while in the second period was in mild workloads [3]. Decrease of workload was as a result of ergonomic implementation with SHIP and TTG approach applied in the second period. Work pulse (the different of work pulse and rest pulse) in the first period was 50.27 pulse per minutes, on the other hand, for the second period was 30.56 pulse per minutes.

An average of musculoskeletal disorders before activity in the first period and the second period were 32.56 ± 0.96 and 32.00 ± 0.97 , respectively. Musculoskeletal decrease in the second period after activity was 14.27%. Musculoskeletal disorder in the first period was due to muscle load, especially the wrist as a result of high and wide. During work, there were no rest and drink, all of these were also leads to addition of long muscle load and induce muscle fatigue. Therefore, there will be a cheating rest to reduce this fatigue. According to [25] and [26], static load and force working time induce blood flow, therefore, not enough oxygen supplied to the muscle. This condition, leads to lactate acid and body heat accumulation and finally results in musculoskeletal disorder. Besides that, static muscle load due to force condition was also as a cause of accumulation of blood vein, accumulation of fluid, and varices vein, especially on feet and frequently feel as a form of muscle fatigue. On the other hand, improvement of carving work condition with ergonomic tools, reduce average muscle fatigue to 14.27%.

This was due to subject work position during work is more ergonomic with hand position was natural without static and force skeletal muscle load, especially in wrist, loin, and wise. The present of working organization with resting every $\frac{1}{2}$ hour for 5 minutes and have tea protect initial muscle fatigue, preparing body to relax and freshness. All improvement effort in either tools and organization with SHIP and TTG approach. Reference [27] and [28] was also stated that working with frequent short resting

time 2-3 minutes increase production and satisfaction and decrease fatigue compare to one and long resting time.

3.4. Concentration

The results of normality test data for speed, accuracy and constant can be seen in Table 2.

Table 2. Speed, accuracy and constant data normality test results.

No.	Description	Value Z	Df	Value p
1	Speed in period I	0.823	10	0.065
2	Speed in period II	0.871	10	0.103
3	Accuracy in period I	0.367	10	0.689
4	Accuracy in period II	0.257	10	0.537
5	Constant in period I	0.443	10	0.563
6	Constant in period II	0.489	10	0.501

It can be seen that the velocity Z value in period I was 0.823 with a value of $p = 0.065$, likewise in period II it was 0.871 with a value of $p = 0.103$. It turns out that the p value > 0.05 , so it can be concluded that the two data are normally distributed. Z values for accuracy, both in period 1 and period 2 are also normally distributed, as well as constant data. Since the data is normally distributed, the mean difference testing uses t-paired. Based on the calculation of the Bourdon Wiersma test using quantitative interpretation calculations the results of calculations of speed, accuracy and constant are obtained. The results of testing the mean difference using t-paired can be seen in Table 3.

Table 3. Analysis of difference test results for concentration indicator data.

No.	Variable	Period I		Period II		Value	Value
		Average	SD	Average	SD	t	p
1	Speed (minutes)	10.81	0.54	09.39	1.29	-03.182	0.0001
2	Accuracy (times)	05.08	0.23	02.71	0.21	-04.145	0.0001
3	Constant (minutes)	02.99	0.11	02.24	0.35	-03.221	0.0001

Subjects observed for concentration in the first period, where subjects were not yet given treatment showed a speed of completing the task was 10.81 minutes and experienced improvement in period II to 09.39 minutes or an increase of 13.14 percent. In period II subjects were given treatment in the form of the use of an ergonomic anthropometric desk [4]. Accuracy in period I is calculated based on the number of item errors made by the subject while working on the Bourdon Wiersma test. The more mistakes the subject can say the less thorough. In period I, the subjects made an average of 5.08 times. After being treated in period II, the subject experienced an increase in performance of 46.65 percent with a number of errors of 2.71 times. The number of errors, in addition to being caused by the level of fitness of the worker's body is also caused by the compatibility between the worker and the machine or work tool [7]. Another concentration indicator, namely constant also improved by 25.08 percent in period II, namely the average of 02.99 minutes in period I to 02.24 minutes in period II. Constancy or constant is the ability of workers to hold on to certain attitudes in the allotted time [26]. The speed, accuracy and constant have a value of $t = -03.182$, -04.145 and -03.221 and all of them have a value of $p = 0.0001$. Because the value of $p < 0.05$, it can be said that all data in period I is significantly different from data in period II. To get a clearer picture, it is also worth looking at the conversion values from the quantitative interpretation in Table 4.

Table 4. Value conversion in quantitative interpretations.

No.	Variable	Period I		Period II	
		Average	Conversion Value	Average	Conversion Value
1	Speed (minutes)	10.81	08.00	09.39	09.00
2	Accuracy (times)	05.08	07.00	02.71	08.00
3	Constant (minutes)	02.99	08.00	02.24	08.50

From the table of conversion values in the quantitative interpretation, it can be seen that the subject's speed has increased from 8 to 9, so also the accuracy indicator has increased from 7 to 8. Constant has increased from 8 to 8.5. The meaning of the increase in the value of quantitative interpretations of speed, accuracy and constant shows that with good and ergonomic working tools make workers able to maintain work concentration well. The impact is that the precision of work results remains the same or even increased.

Table 5. Conversion of weighted scores (WS) on quantitative interpretation.

No.	Variable	Period I		Period II	
		Average	Weighted Scores 1	Average	Weighted Scores 2
1	Speed (minutes)	10.81	12.00	09.39	14.00
2	Accuracy (times)	05.08	-	02.71	13.00
3	Constant (minutes)	02.99	12.00	02.24	13.00

The conversion table Weighted Score (WS) also shows the same thing. The WS value in period I (WS1) was 12 and rose significantly to 14 in period II (WS2). WS1 value on the accuracy indicator was not detected in period I, whereas in period II, WS2 value was at level 13. The WS value on the constant indicator increased by 7.7 percent from period I (WS1) to period II (WS2), namely from the value of WS 12 becomes WS 13.

Table 6. Group conversion in quantitative interpretations.

No.	Variabel	Period I		Period II	
		Average	Group	Average	Group
1	Speed (minutes)	10.81	Good Enough	09.39	Good
2	Accuracy (times)	05.08	Enough	02.71	Good Enough
3	Constant (minutes)	02.99	Good Enough	02.24	Good Enough

The next data which is also an indicator of concentration is Group. Subjects whose speed was observed in period I showed that the data were in a good enough level and increased significantly to Good in period II. Accuracy data also increased, that is, from enough. to good enough. What is unique is the data constant, where from period I to period II there was no change, it remained in the group quite well.

4. Conclusions

Based on the previous discussion, it can be concluded some research essence to answer the existing problems, as follows. Subjects observed for concentration in the first period, where subjects were not yet given treatment showed a speed of completing the task was 10.81 minutes and experienced improvement in period II to 09.39 minutes or an increase of 13.14 percent. Accuracy in period I is calculated based on the number of item errors made by the subject while working on the Bourdon Wiersma test. The more mistakes the subject can say the less thorough. In period I, the subjects made an average of 5.08 times. After being treated in period II, the subject experienced an increase in performance of 46.65 percent with a number of errors of 2.71 times. Another concentration indicator,

namely constant also improved by 25.08 percent in period II, namely the average of 02.99 minutes in period I to 02.24 minutes in period II.

The amount of workload is dependent on the size of the heart rate in units of beats per minute (bpm). The pulse of work in period I was 132.56 ± 2.80 bpm and the working pulse in period II was 107.81 ± 5.92 bpm, or decreased by 18.67 percent. The pulse in period I was still in the category of heavy workload, while in period II included a moderate workload.

Musculoskeletal disorders are pain that is felt in several parts of the body. The mean musculoskeletal disorders score before activity in period I and period II were 32.56 ± 0.96 and 32.00 ± 0.97 respectively, while the average musculoskeletal disorders after activities in period I and II were 55.63 ± 4.29 and 47.69 ± 3.36 . The magnitude of the decrease in musculoskeletal disorders in period II after activity was 14.27 percent. The amount of musculoskeletal disorders in period I is caused by loading on the muscles, especially on the wrists, waist, back and buttocks because the craftsman must sit bent on the floor, thus affecting the central nervous system and causing muscle fatigue. During work there is no rest and drink, this also increases the muscle burden that is too long which causes muscle fatigue so that stolen breaks often occur to eliminate fatigue.

5. References

- [1] Chaffin D B 1974 *Journal of Occupational Medicine* **9** 248-254
- [2] Epstein Y and Moran D S 2006 *Industrial Health Journal* **44** 388-98
- [3] Christensen E H 1991 *Physiology of Work* in Parmeggiani L *Encyclopedia of Occupational Health and Safety* (Geneva: ILO) pp. 1698-7000
- [6] Erensal Y C and Albayrak E 2007 *Journal of Human Factors and Ergonomics in Manufacturing* **17** 1-19
- [7] Widana I K 2012 *Redesigning Tractors for increased productivity in the Agricultural Sector in Indonesia. Ergonomics In Asia: Development, Opportunities and Challeges* (London : Taylor & Francis).
- [8] Hignett S, Wilson J R and Morris W 2005 *Occupational Medicine Journal* **55** 200-7
- [9] Chandna P, Deswal S, and Chandra A 2010 *International Journal of Industrial and Systems Engineering* **6** 110-28
- [10] Carrivick P J W, Andy H, Lee, Kelvin K W and Yau 2002 *Journal of Occupational Health* **44**
- [11] Habibi E and Soury S 2015 *Journal of Education and Health Promotion* **4**
- [12] Eastman K 1983 *Ergonomics Design for People of Work* (New York : Van Nostrand Renhold) p. 133-137
- [13] Grandjean E 2000 *Fitting the Task To The Man, A Textbook of Occupational of Ergonomics. 4th Edition* (London: Taylor & Francis).
- [14] Dul J and Weerdmeester B 1993 *Ergonomic for Beginners A Quick Reference Guide* (London: Taylor & Francis)
- [15] Pheasant S 1991 *Ergonomics, Work and Health* (London : Macmillan Academic Profesional Ltd)
- [16] Pandit S, Kumar P and Chakrabarti D C 2013 *International of Scientific and Research Publications* **3** 1-7
- [17] Nishanth R, Muthukumar M V and Arivanantham A 2015 *International Journal of Computer Applications* **113**
- [18] Helander G M 1995 *A Guide to the Ergonomics of Manufacturing* (London : Taylor & Francis)
- [19] Gilad I 1998 *Ergonomic Participatory Plan in The Diamond Industry. Global Ergonomic* (Cape Town South Africa: Elsevier)
- [20] Chan A D C and Fishbein J 2009 *The Journal of Policy Engagement* **1** 4-9
- [21] Mitchell K S 2013 *Journal of Facilities Management* **20** 258-276
- [22] Alamgir H, Li O W, Yu S, Gorman E, Fast C and Kidd C 2009 *Journal of Injury* **40** 987 – 992
- [23] Chung M K and Choi K I 1997 *Journal of Computers and Industrial Engineering* **33** 521-524
- [24] McCann M 2010 *American Journal of Industrial Medicine* **30** 125-129

- [25] Borg G 1990 *Journal of Work Environ Health* **16** 55 – 58
- [26] Dutta T, Holliday P J, Gorski S M, Baharvandy M S and Fernie G R 2011 *Journal of Applied Ergonomics* **43** 521 – 531
- [27] Parasuraman A, Zeithaml V A and Berry L L 1988 *Journal of Retailing* **64** 12-40
- [28] Caverley N 2005 *International Journal of Public Sector Management* **18** 401-413

Acknowledgments

The authors would like to thank the Government of the Republic of Indonesia, especially the Bali State Polytechnic who has funded this research. The authors also thank the Head of P3M PNB who has helped facilitate the writing, implementation and reporting of research.