https://doi.org/10.20473/mgi.v20i1.27–37

CORRELATION BETWEEN DIET QUALITY AND BODY COMPOSITION WITH WORK FATIGUE IN FEMALE WORKERS

Dominikus Raditya Atmaka[1,2*], Shintia Yunita Arini[2,3], Mawadatul Khoiroh[1]
[1] Department of Nutrition, Faculty of Public Health, Universitas Airlangga, Surabaya, Indonesia
[2] Center for Health and Nutrition Education, Counseling, and Empowerment (CHENECE), Surabaya, Indonesia
[3] Department of Occupational Health and Safety, Faculty of Public Health, Universitas Airlangga, Surabaya, Indonesia
Correspondence address: Dominikus Raditya Atmaka
Email: dominikus.raditya@fkm.unair.ac.id

ABSTRACT

Introduction : *In 2020, labor force participation rate for women in East Java province was 70,0%, and in Lumajang district reached 66,19%. Women usually have a higher fat mass compared to men. Body composition dominated by fat mass can reduce oxygen distribution process, can cause anaerobic energy metabolism which produce lactic acid as final product and causes fatigue. Low diet quality is related with high energy and fat intake which will result in body fat mass elevation and work fatigue. This study aimed to determine the correlation between diet quality and body composition with work fatigue.* **Method:** *This study used cross sectional design with total respondents of 120 female workers in production division of wood factory. Collected data were means of anthropometric measurements (weight, height, upper arm circumference, and abdominal circumference), Semi Quantitative Food Frequency Questionnaire, and Subjective Self Rating Test. Correlation test used were Chi square test continued with Pearson correlation test.* **Result:** *Result showed a significant correlation between work fatigue and total sodium intake per day (p=0.040), total saturated fat intake (p=0.037), Body Mass Index (p<0.001), abdominal circumference (p<0.001), and upper arm circumference (p=0.002).* **Conclusion:** *Improving diet quality and decreasing body fat mass can reduce work fatigue.*

Keywords: *work fatigue, diet quality, body composition, female worker, occupational health*

INTRODUCTION

In 2021 the Labor Force Participation Rate for women in in East Java province was 70,0%, and in Lumajang district reached 66,19% (the Central Bureau of Statistics of Indonesia, 2020; the Central Bureau of Statistics of East Java, 2022). This high number often did not matched by the implementation of Health and Safety at Work and improvement of work environment. This condition causes worker to experience fatigue easily, and women tend to experience fatigue than men easily (Tseng et al., 2014; Arini, Martiana and Ardyanto, 2019). In general, women usually have higher fat mass than men (Lemieux et al., 1993; Srikanthan et al., 2021).

High body fat can cause a decrease in muscle contraction which then cause fatigue (Segura-Jiménez et al., 2016; de Lima et al., 2019). Fatigue is a feeling of tiredness felt by a person due to accumulation of various causative factors (Aaronson et al., 1999; Zwarts, Bleijenberg and van Engelen, 2008; Marino, 2019). In general, symptoms of fatigue include feeling of pain in the organs, feeling tired, dizziness, nausea, chaotic thought, and others (Zwarts, Bleijenberg and van Engelen, 2008; Klimas, Broderick and Fletcher, 2012; Wright and O’Connor, 2014; Borges et al., 2018).

Fatigue can be divided into two type, namely physical work fatigue and general work fatigue (Tarwaka, 2014). Physical work fatigue is related to muscle fatigue caused by muscle contractions that occur excessively and last a long time (Tarwaka, 2014). General work fatigue is related to psychological factors. Psychological factors perceived by workers can affect the activity of the inhibitory and mobilizing systems in the cerebral cortex reactions correlated with feelings onset of fatigue (Aaronson et al., 1999; Tarwaka, 2014; Lee and Giuliani, 2019).

Fatigue can be caused by various factors, both internal and external (Wright and O’Connor, 2014; Lestari, 2016). Internal factors are related to factors

 Received 20-11-2024, Accepted 17-12-2024, Published online 30-01-2025.

that come from within the individual, for example health status, nutritional status, age, workload, work stress, and sleep duration. External factors are related to factors that come from outside the individual, for example the work climate, work environment (Wright and O'Connor, 2014; Lestari, 2016).

Female workers at wood factory in Indonesia is not common. Usually wood factory workers is men, because this kind of work needs higher power and strength. Since working in wood factory require physical ability, it also create higher fatigue and physical stress. Several ways can be done to decrease the fatigue and physical stress in female workers, one of which is by increasing their diet quality and maintaining body composition to their ideal body mass index. By these background, we aim to determine the relationship of diet quality and body composition with the level of fatigue in female workers.

METHODS

Study Population

This study was a cross sectional study design. Data was collected by interviewing respondents and observing the environment around respondents. Questionnaires that were used include SQFFQ (Semi Quantitative Food Frequency Questionnaire), and SRRT (Subjective Self Rating Test) issued by Industrial Fatigue Research Committee (IFRC). Primary data collected during May-June 2021. The study was conducted at "X" wood factory located in Pasirian District, Lumajang Regency-East Java.

Total samples was calculated using Lemeshow formula with two-proportion population hypothesis test in Putra (2018) and minimum sample required is 100 person. The selection of study respondents were following the inclusion criteria included female workers aged 15 to 64 years, working in production division, has been working for at least 3 months, has fixed salary each month, has no other job besides in the company, had no history of liver disease, and willing to follow the study by signed the informed consent. Respondents excluded if decided not to continue the study, pregnant or breastfed. This research has passed an ethical clearance by the Health Research Ethics Committee, Faculty of Public Health Airlangga University number 56/EA/KEPK/2022.

Dietary Assessment

The nutritional factors observed were food quality and body composition, especially body fat percentage. Diet quality was assessed using the Healthy Eating Index (HEI) method, which this method assess diet quality based on two criteria, adequacy and moderation (Krebs-Smith et al., 2018; Reedy et al., 2018). Body composition is a description or size of compartments in the body, which consists of two main compartments, namely fat mass and non-fat mass (Saltzman and Mogensen, 2013; Wang and Torriani, 2020). Fat mass is the weight of all fat in the body, while non-fat mass is the weight of bone, body fluids, and muscle. A simple body composition measurement done by measuring mid upper arm circumference (MUAC), abdominal circumference, waist circumference, and BMI (Santos et al., 2014; Reedy et al., 2018). Diet quality assessment aims to identify the quality of individual food intake and determine the balance of nutrient intake. A high value of diet quality indicates an individual's intake of adequate macronutrient needs, while a low diet quality indicates that an individual intake dominated by foods that high energy and fat, and low fiber and micronutrients (Cole and Fox, 2008; Krebs-Smith et al., 2018; Reedy et al., 2018).

Diet quality assessment was carried out by identifying eating habits of female workers through SQFFQ (Semi Quantitative Food Frequency Questionnaire) questionnaire from the last 6 months eating habits. SQFFQ contains all types of food ingredients which are grouped according to 7 food groups (including carbohydrate sources, animal proteins, plant proteins, vegetables, fruits, milk and beverages, snacks and packaged foods) consisted of 81 food items. The food ingredients in SQFFQ are foodstuffs that are commonly consumed and can be found by female workers in the study area (nearby or maximum in 1 km radius from the house and the workplace). The results of the SQFFQ were then used to analyze the quality of female workers diet using the HEI method.

HEI measurement using the guidelines of HEI-2015 where the scoring based on 13 components which divided into adequacy components (total fruits, whole fruits, total vegetables, greens and beans, whole grains, dairy, total protein foods, seafoods and plant proteins, fatty acids) and moderation components (refined grains, sodium, added sugars, saturated fats). The overall total score for HEI is 100. The higher the score, the better the diet quality. Based on the scoring, it can be divided into 3 groups, good diet if HEI score more than 80, needs improvement group if HEI score between 51-80, and poor diet if HEI score less than 51.

Anthropometric Measurement

Anthropometric measurements included measurements of weight, height, MUAC and abdominal circumference of the respondent. The measurement of weight uses Omron digital weight scale with level of accuracy of 0.1 kg, while the measurement of height using microtoise with the level of accuracy of 0.1 cm. Measurement of waist circumference and MUAC using a measurement tape with the smallest scale of 0 cm with the level of accuracy of 0.1 cm measured at the midline of the humerus bone measured from the acromion to olecranon of inactive hand based on anatomical position. The measurement repeated 3 times and 2 measurement with the closest value were taken as the result of measurement. Body mass index calculated by dividing body weight in kilogram with body height square in centimeter. Body mass index then classified into 4 categories based on WHO for Asia Pacific population, namely underweight (BMI ≤ 18.5), normal (BMI 18.5 – 23.0), overweight (BMI 23.0-25.0), and obese (BMI > 25.0).

Work Fatigue, Work Stress, and Workload Measurement

Work fatigue commonly defined as fatigue feeling felt by workers during working time. Measurement of work fatigue in this study using Subjective Self Rating Test (SRRT) questionnaire. This questionnaire contains three indicators for assessing work fatigue, namely indicators of weakening activities, weakening motivation, and weakening physical. Each indicator will contain ten questions related to worker conditions with four answer options. The answer choices given have different score values where the answer choices are very often worth 4, often worth 3, rarely worth 2, and never worth 1. Overall score then classified based on the level of fatigue. The level of work fatigue is mild if the total score is 30-52, moderate 53-75, high 76-98, and very high 99-120.

Statistical Analysis

Analysis of the correlation between dependent and independent variables using IBM SPSS 21 application. Normality test using Kolmogorov-Smirnov test. Because all data well normally distributed based on Kolmogorov-Smirnov test, then the test continued with normal inferential test.

Correlation test used Chi square test continued with Pearson correlation test for the respondent's characteristics which include age, workload, work stress, work fatigue, abdominal circumference, MUAC, BMI, total diet quality, components of diet quality and total intake of each nutrient in one day.

In this study, data analysis were using IBM SPSS version 21. Descriptive analysis perform to several types of data to see the distribution of the data. Assumption test including normality test, multicollinearity, and heteroscedasticity data performed as the requirement for multiple linear regression test. Multiple linear regression test used to see the relationship of independent variable on dependent variable. Multiple linear regression test is performed twice because there were intervening variable existed that needs further analysis. The results of the two regression tests are then compared to obtain a conclusion if there is an influence of the independent variable on the dependent variable through the intervening variable.

Work stress measured using HSE indicator tools 2003 with scoring divided into 4 group namely low stress (100-125), moderate stress (75-99), high stress (50-74), and very high stress (25-49). Workload in this study is focused to the mental workload, measured using NASA-TLX, classified into low (<50), moderate (50-80), and high (>80).

https://doi.org/10.20473/mgi.v20i1.27–37

RESULT

Respondents Characteristics

"X" wood factory is one of the biggest factories in Lumajang, East Java which produce FJLB (Finger Joint Laminating Board), plywood, and bare code. Female worker in production division working in assembly and finishing part. Table 1 showed that most of the respondents belong to the early adult age group with percentage of 40% and the average value of mean age ± SD is 36.62 ± 9.22 years.

Based on anthropometric measurements, it was found that 61.67% of respondents had central obesity based on abdominal circumference measurements with an average abdominal circumference of 84.54 cm, based on measurements of MUAC 98.33% of respondents included in the normal category or not in chronic energy deficiency condition. with an average MUAC of 29.58 cm, 53% of respondents had Body Mass Index (BMI) in the normal category (mean BMI 24.79 kg/m2), and 65% of respondents diet quality categorized in the Needs Improvement category with average value 72.87. The average value ± SD respectively for workload and work stress is 73.48 ± 13.78 and 74.96 ± 72.43.

Nutrient Intake

Table 2 shows that from all analysis of the correlation related to total intake of energy, protein, fat, carbohydrates, iron, and calcium, as well as the ratio between these nutrients and work fatigue, there are no significant relationship or significance value > 0.05. The average intake of energy (1708.66 kcal) and carbohydrates (307.22 g) was greater in the moderate work fatigue group.

Table 1. Characteristics of Age, Weight, Height, Abdominal Circumference, Upper Arm Circumference, BMI, Diet Quality of Respondents

Characteristics	n	%	Mean ± SD
Age			
Late adolescent (17-25 y.o.)	18	15.0	
Early adult (26-35 y.o,)	32	26.7	36.62 ± 9.22
Late adult (36-55 y.o.)	48	40.0	
Early elderly (56-65 y.o.)	22	18.3	
Work load	-	-	73.48 ± 13.78
Work stress	-	-	74.96 ± 72.43
Work fatigue	-	-	
Low (30-52)	72	60.0	50.23 ± 10.19
Moderate (53-75)	48	40.0	
Mid upper arm circumference			
Normal (>23.5 cm)	2	2.0	29.58± 3.53
Chronic energy deficiency (<23.5 cm)	118	98.0	
Abdominal circumference			
Central obesity (>= 0.8 m)	74	61.7	84.54 ± 10.54
Normal (< 0.8 m)	46	38.3	
BMI (Kg/m²)			
Underweight (<18.5)	8	7.0	
Normal (18.5-23)	64	53.0	24.79 ± 4.87
Overweight/obesity (>23)	48	40.0	
Diet quality			
Poor Diet (< 51)	8	7.0	
Needs Improvement (51-80)	78	65.0	72.87 ± 18.05
Good Diet (> 80)	32	28.0	

https://doi.org/10.20473/mgi.v20i1.27–37

Table 2. Correlation of Energy, Protein, Fat, Carbohydrate, Iron, and Calcium Intake with Work Fatigue

Nutrient Intake	Work Fatigue				p-value
	Low		Moderate		
	Mean	SD	Mean	SD	
Energy Intake (kcal)	1703.94	297.70	1708.66	312.47	0.20
Protein intake/day (g)	41.07	14.23	36.43	9.89	0.34
Fat intake/day (g)	31.55	17.66	27.81	6.37	0.28
Carbohydrate intake/day (g)	305.02	47.26	307.22	57.35	0.14
Iron intake/day (mg)	13.45	11.38	10.20	7.92	0.15
Calcium intake/day (mg)	338.65	267.47	272.35	167.64	0.89
Protein : energy ratio	0.10	0.03	0.09	0.02	0.10
Fat : energy ratio	0.17	0.08	0.15	0.02	0.17
Carbohydrate : energy ratio	0.72	0.08	0.72	0.06	0.72
Protein : carbohydrate ratio	0.14	0.05	0.12	0.03	0.14
Fat : carbohydrate ratio	0.11	0.06	0.09	0.02	0.11
Fat : protein ratio	0.76	0.28	0.79	0.18	0.76
Iron : protein ratio	0.32	0.26	0.28	0.17	0.32
Iron : energy ratio	0.01	0.01	0.01	0.00	0.10
Calcium : protein ratio	7.90	4.80	7.33	3.43	0.90
Calcium : energy ratio	0.19	0.12	0.16	0.10	0.19

The average intake of protein (41.07 g), fat (31.55 g), iron (13.5 mg), and calcium (338.65 mg) was greater in the low fatigue group. The comparison between intake of protein : energy ratio (0.10), fat : energy ratio (0.17), protein : carbohydrates ratio (0.14), fat : carbohydrates ratio (0.11), iron : protein ratio (0.32), calcium : protein ratio (7.90), calcium : energy ratio (0.19) was greater in the low fatigue group. Meanwhile, fat : protein ratio intake (0.79) was greater in the moderate work fatigue group, and the intake of carbohydrates : energy (0.72) and iron : energy (0.10) had the same value between the low work fatigue group and moderate.

Healthy Eating Index (HEI) Component

In Figure 1 it can be seen that 47% respondents consumed fruit in one day more than 0.8 cup equivalence per 1000 kcal, and 57% respondents consumed whole fruit in one day more than 0.4 cup equivalence per 1000 kcal. Respondents who consume vegetables in one day more than 1.1 cup equivalence per 1000 kcal is 68%. All respondents had consumption levels of green vegetables and nuts in one day more than 0.2 cup equivalence per 1000 kcal, seafood and vegetable protein in one day more than 0.8 oz. equivalence per 1000 kcal, ratio of fat consumption (PUFAs+MUFAs)/SFAs in one day more than 2.5, and total consumption of saturated fat more than 8% of energy. Thirty three percent of respondents consumed whole grains in one day more than 1.5 oz. equivalent per 1000 kcal. Eight percent of respondents consume dairy products in one day more than 1.3 cup equivalence per 1000 kcal. Five percent respondents has a total consumption of protein in one day more than 2.5 oz. equivalence per 1000 kcal. Respondents with a total consumption of refined grains in one day more than 1.8 oz. equivalence per 1000 kcal is 15%. Respondents with a total consumption of sodium in one day less than 1.1 gram equivalent per 1000 kcal were 62%, and no respondents who consumed added sugar less than 6.5% of the total energy.

In Table 3, from overall components of diet quality assessment according to the HEI, only total intake of sodium and saturated fat in one day has significant correlation with level of work fatigue with p-values of 0.040 and 0.37, respectively, and with Correlation Coefficient values are -0.261 and -0.269, respectively. The Correlation Coefficient number is negative which indicates that the relationship between total sodium intake and work fatigue and total saturated fat intake with work

https://doi.org/10.20473/mgi.v20i1.27–37

fatigue is opposite, which means that the lower the total sodium intake and saturated fat intake, the higher the level of perceived work fatigue.

Body Composition

In Table 4 it can be seen that the assessment of body composition which includes measurements of Body Mass Index (BMI), abdominal circumference, and MUAC has a significant correlation with work fatigue (p-value<0.05). Meanwhile p-values respectively for Body Mass Index (BMI), abdominal circumference, and MUAC are <0.001; <0.001; and 0.002, and the Correlation Coefficient value are 0.458; 0.507, and 0.398. The Correlation Coefficient number is positive which means the higher the BMI, abdominal circumference, and MUAC, the higher level of perceived work fatigue.

Table 3. Correlation of Diet Quality Components based on Work Fatigue Score

HEI Component	Work Fatigue				p-value	Correlation Coefficient
	Low		Moderate			
	Mean	SD	Mean	SD		
Adequacy						
Total fruits	93.61	158.24	60.76	77.36	0.272	-0.144
Whole fruits	45.97	53.43	29.23	46.37	0.258	-0.148
Total vegetables	112.69	61.23	108.60	32.77	0.993	0.001
Greens and beans	85.70	47.58	88.17	31.80	0.722	0.047
Whole grains	12.77	25.93	26.14	37.77	0.637	-0.062
Dairy	11.21	44.09	0.81	3.29	0.632	-0.063
Total protein foods	41.07	14.23	36.43	9.89	0.143	-0.192
Seafood and plant proteins	85.35	44.71	85.45	37.86	0.669	-0.056
Fatty acids (PUFAs+MUFAs)/SFAs	0.76	0.25	0.76	0.17	0.617	0.066
Moderation						
Refined grains	6.94	12.10	7.63	12.91	0.909	0.015
Sodium	268.97	299.87	179.48	184.36	0.044*	-0.261
Added sugar	20.79	8.07	19.33	7.78	0.425	-0.105
Saturated fat	12.34	2.46	11.56	1.97	0.037*	-0.269

Note: *) Values were significantly different from low and moderate work fatigue (p<0.05). P was obtained with X^2 test.

Table 4. Body Composition of Respondents based on Respondents Work Fatigue Score

Body Composition	Work Fatigue				p-value	Correlation Coefficient
	Low		Moderate			
	Mean	SD	Mean	SD		
Body Mass Index (kg/cm2)	22.28	3.25	27.30	4.96	<0.001**	0.458
Abdominal circumference (cm)	79.10	6.36	90.03	11.05	<0.001**	0.507
Mid upper arm circumference (cm)	28.13	2.47	31.03	3.85	0.002**	0.398

Note: **) Values were significantly different from low and moderate work fatigue (p<0.01). P was obtained with X^2 test.

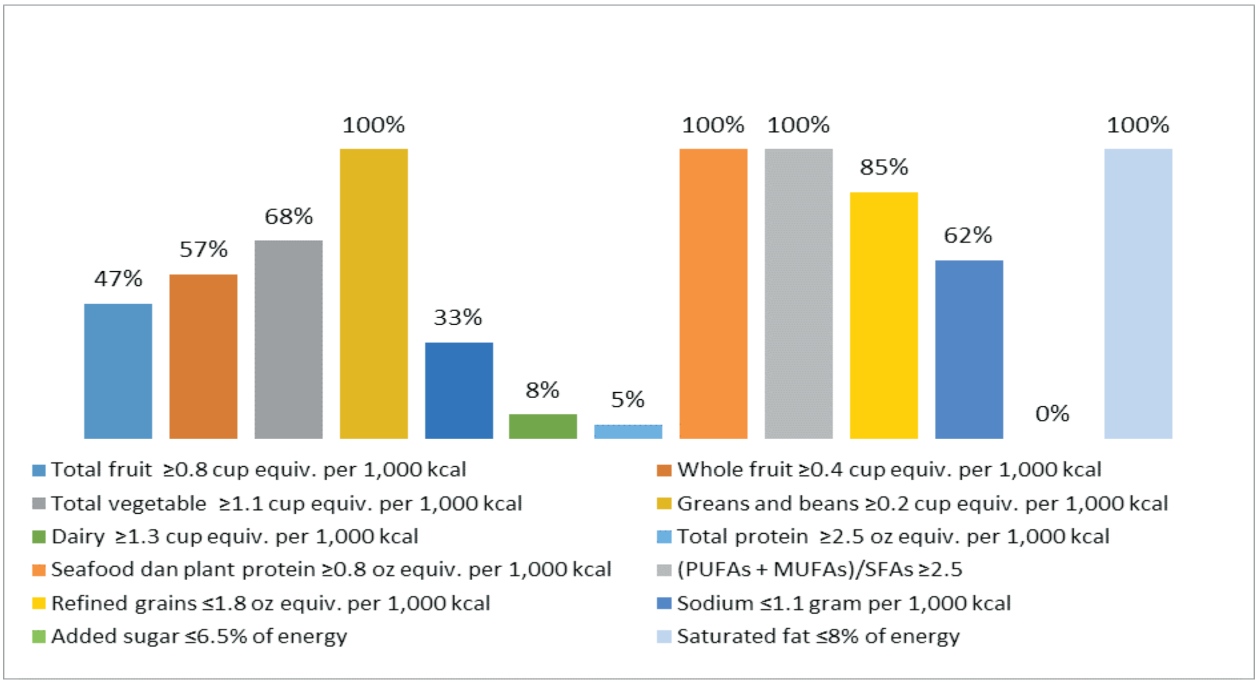

Figure 1. Distribution diagram of respondents consuming the component of diet quality based on the standards of HEI assessment.

DISCUSSION

The study result showed that the criteria for adequacy of each component of diet quality do not have significant relationship with the level of work fatigue, while on the moderating criteria there are two components of diet quality that have a significant correlation to work fatigue, namely total sodium intake and total saturated fat intake.

The correlation coefficient of the correlation between sodium intake and work fatigue is negative, which indicate the lower the respondent's sodium intake, the higher the perceived work fatigue. The average sodium intake of respondents is 0.22 grams with a lower limit of 0.014 grams and an upper limit of 1.3 grams. Most (62%) respondents had a total sodium intake of 1.1 grams in one day. The recommended daily limit for sodium intake is 1.1 grams-2 grams (Bellows and Moore, 2013; US. Food & Drug Administration, 2021).

Sodium is a micronutrient that functions to regulate fluid balance in the body (Hartanto, 2007; Bellows and Moore, 2013). If sodium and water intake is low while sodium expenditure (through sweat and urine) is high, it can cause dehydration with sodium deficiency (Hartanto, 2007; Santikatmaka, 2013). Lack of water and sodium in the blood plasma will be replaced by water and sodium from the interstitial fluid (the fluid that lies between cells). If the loss of water and sodium continues to occur, then water and sodium from the cells will continue to be removed, and if the volume of blood plasma cannot be maintained, circulation failure will occur (Hartanto, 2007; Hood and Scott, 2012; American Society of Health-System Pharmacists, 2020). This condition also causes a person to easily experience fatigue. Meanwhile, when sodium consumption is too high, the brain will stimulate the adrenal glands to secrete Endogenous Digital Like Factors (EDLF) (Blaustein et al., 2006). EDLF triggers sodium retention by increasing the expression of the sodium pump in the kidney. Retention of the sodium pump will inhibit the regulation of Na+/K+-ATPase in arteriolar and arteriolar blood vessel muscle cells, this causes the sodium concentration to increase while the potassium concentration decreases (Blaustein et al., 2006; Mckenna et al., 2006).

A decrement of potassium concentration causes a decrease in muscle function, so that the muscles will be more easily fatigue (Sjøgaard, 1996; Lindinger and Cairns, 2021). Fat is a macronutrient that plays a role in fulfilling body's energy. Fat in food is divided into several types including unsaturated fat and saturated fat. The differences between unsaturated and saturated fats located in the double bonds in carbon chain which only happened in the saturated fats. This difference in double bonds causes differences in physical and chemical properties (Sartika, 2008). Unsaturated fat itself is often correlated with the increased of HDL (High Density Lipoprotein) level (Gardner and Kraemer, 1995; Morton et al., 2019), while saturated fat is often correlated with the increment of LDL (Low Density Lipoprotein) level (Krebs-Smith et al., 2018; Tahuk, P.K., Dethan, A.A., Sio, 2018; Astrup et al., 2020).

Although saturated fat is often correlated with the risk of degenerative diseases, a few types of saturated fat are believed to lower blood cholesterol levels. Medium-chain saturated fats have the effect of lowering blood cholesterol levels, while long-chain saturated fats cause an increase in blood cholesterol levels (Bhavsar and St-Onge, 2016). The production of cholesterol in the blood vessels in the muscles can interfere with the process of muscle contraction, this causes people with higher cholesterol levels to experience fatigue more easily.

In this study, there is a significant correlation between saturated fat intake and the level of work fatigue with a negative correlation coefficient. The negative correlation coefficient means the higher the intake of saturated fat, the lower the work fatigue level. Respondent's saturated fat intake as a whole is below 8% of the total energy intake in one day, in addition, when compared to unsaturated fat intake, saturated fat consumption is much lower (Figure 1 all respondents have a comparison of unsaturated fat and saturated fat intake). The results of the comparison of unsaturated fat intake with saturated fat, which means that saturated fat intake 10% of total energy can reduce cholesterol buildup in blood vessels (Harland, 2012; Brouwer, 2020). Decreased cholesterol buildup in blood vessels can facilitate blood flow to circulate oxygen throughout the body. Fulfillment of sufficient oxygen consumption in the muscles can reduce the buildup of lactic acid, so that muscle contraction can occur optimally and work fatigue can be reduced. But consumption of saturated fat reflected the amount of whole consumption of fat which is acted as energy sources. The lesser fat intake in human, may reflected the low energy consumption in total, which may resulted in work fatigue.

This study found significant correlation between the assessment of body composition and work fatigue. Assessment of body composition in this study was carried out by measuring body fat percentage by measuring BMI, abdominal circumference, and MUAC. Body Mass Index (BMI) is a scale that reflect the percentage of body fat based on body dimension (Nuttal, 2017). MUAC measures the thickness of subcutaneous fat and muscle tissue, while abdominal circumference measurements are used to identify central obesity to describe the condition of excess fat in the abdomen. Body fat percentage is related to VO2 max (Katch, McArdle and Katch, 2013; Mondal and Mishra, 2017; Vargas et al., 2018). VO2 max is the total oxygen used by the body for energy metabolism in muscles (Katch, McArdle and Katch, 2013; Mondal and Mishra, 2017). The high composition of fat in the body can reduce blood flow that carries oxygen to be circulated throughout the body, including muscles (Mondal and Mishra, 2017). The low level of oxygen in the muscles causes energy metabolism to occur anaerobically with a small amount of energy produced and lactic acid as the end product of the metabolic process. Lactic acid that accumulates in the muscles will reduce the power of muscle contraction which then causes fatigue (Proia et al., 2016; Fiorenza et al., 2019).

CONCLUSIONS

There are significant correlations between work fatigue and total sodium intake per day, total saturated fat intake, BMI, abdominal circumference, and MUAC. In assessing the quality of diet, the components of total sodium intake and total saturated fat intake have a significant correlationship with work fatigue. One of the efforts to reduce the level of work fatigue can be done by getting used to a healthy lifestyle, especially by improving diet quality both quantitatively and qualitatively.

ACKNOWLEDGEMENTS

The authors thank you to the Faculty of Public Health Universitas Airlangga for the support of funding on this study through Penelitian Dosen Pemula Funding Scheme.

REFERENCES

Aaronson, L.S., Teel, C.S., Cassmeyer, V., Neuberger, G.B., Pallikkathayil, L., Pierce, J., Press, A.N., Williams, P.D. and Wingate, A., 1999. Defining and measuring fatigue. *Journal of Nursing Scholarship*, 31(1). https://doi.org/10.1111/j.1547-5069.1999.tb00420.x.

American Society of Health-System Pharmacists, 2020. Chapter 12 Electrolytes, Other Minerals, and Trace Elements. In: *Basic Skills in Interpreting Laboratory Data*. American Society of Health-System Pharmacists. pp.261–302. https://doi.org/10.37573/9781585285495.012.

Arini, S.Y., Martiana, T. and Ardyanto, D., 2019. The difference of work fatigue on operator based on shift pattern in Pt. X. *Malaysian Journal of Medicine and Health Sciences*, 15(3), pp.34–37.

Astrup, A., Magkos, F., Bier, D.M., Brenna, J.T., de Oliveira Otto, M.C., Hill, J.O., King, J.C., Mente, A., Ordovas, J.M., Volek, J.S., Yusuf, S. and Krauss, R.M., 2020. *Saturated Fats and Health: A Reassessment and Proposal for Food-Based Recommendations: JACC State-of-the-Art Review*. *Journal of the American College of Cardiology*, https://doi.org/10.1016/j.jacc.2020.05.077.

Bellows, L. and Moore, R., 2013. Sodium and the Diet. *Food and Nutrition Series|Health*, 9(9).

Bhavsar, N. and St-Onge, M.P., 2016. *The diverse nature of saturated fats and the case of medium-chain triglycerides: How one recommendation may not fit all*. *Current Opinion in Clinical Nutrition and Metabolic Care*, https://doi.org/10.1097/MCO.0000000000000249.

Blaustein, M.P., Zhang, J., Chen, L. and Hamilton, B.P., 2006. *How does salt retention raise blood pressure? American Journal of Physiology - Regulatory Integrative and Comparative Physiology*, https://doi.org/10.1152/ajpregu.00819.2005.

Borges, J.A., Quintão, M.M.P., Chermont, S.S.M.C., Mendonça Filho, H.T.F. de and Mesquita, E.T., 2018. Fatigue: A Complex Symptom and its Impact on Cancer and Heart Failure. *International Journal of Cardiovascular Sciences*. https://doi.org/10.5935/2359-4802.20180027.

Brouwer, I.A., 2020. *The public health rationale for reducing saturated fat intakes: Is a maximum of 10% energy intake a good recommendation? Nutrition Bulletin*, https://doi.org/10.1111/nbu.12449.

Cole, N. and Fox, M.K., 2008. Diet Quality of American Young Children by WIC Participation Status: Data from the National Health and Nutrition Examination Survey, 1999-2004. *Mathematica Policy Research Reports*, (July), pp.1999–2004.

Fiorenza, M., Hostrup, M., Gunnarsson, T.P., Shirai, Y., Schena, F., Iaia, F.M. and Bangsbo, J., 2019. Neuromuscular Fatigue and Metabolism during High-Intensity Intermittent Exercise. *Medicine and Science in Sports and Exercise*, 51(8). https://doi.org/10.1249/MSS.0000000000001959.

Gardner, C.D. and Kraemer, H.C., 1995. Monounsaturated versus polyunsaturated dietary fat and serum lipids: A meta-analysis. *Arteriosclerosis, Thrombosis, and Vascular Biology*, 15(11), pp.1917–1927. https://doi.org/10.1161/01.ATV.15.11.1917.

Harland, J.I., 2012. *Food combinations for cholesterol lowering*. *Nutrition Research Reviews*, https://doi.org/10.1017/S0954422412000170.

Hartanto, W.W., 2007. Terapi cairan dan elektrolit perioperatif. *JURNAL FARMASI SAINS DAN KOMUNITAS*, 15(4).

Hood, J.L. and Scott, M.G., 2012. Physiology and Disorders of Water, Electrolyte, and Acid-Base Metabolism. In: *Tietz Textbook of Clinical Chemistry and Molecular Diagnostics*. Elsevier. pp.1609–1635. https://doi.org/10.1016/b978-1-4160-6164-9.00049-4.

Katch, V.L., McArdle, W.D. and Katch, F.I., 2013. *Essentials of exercise physiology: Fourth edition*. *Essentials of Exercise Physiology: Fourth Edition*.

Klimas, N.G., Broderick, G. and Fletcher, M.A., 2012. *Biomarkers for chronic fatigue*. *Brain, Behavior, and Immunity*, https://doi.org/10.1016/j.bbi.2012.06.006.

Krebs-Smith, S.M., Pannucci, T.R.E., Subar, A.F., Kirkpatrick, S.I., Lerman, J.L., Tooze, J.A., Wilson, M.M. and Reedy, J., 2018. Update of the Healthy Eating Index: HEI-2015. *Journal of the Academy of Nutrition and Dietetics*, 118(9). https://doi.org/10.1016/j.jand.2018.05.021.

Lee, C.H. and Giuliani, F., 2019. *The Role of Inflammation in Depression and Fatigue*. *Frontiers in immunology*, https://doi.org/10.3389/fimmu.2019.01696.

Lemieux, S., Prud'homme, D., Bouchard, C., Tremblay, A. and Despres, J.P., 1993. Sex differences in the relation of visceral adipose tissue accumulation to total body fatness. *American Journal of Clinical Nutrition*, 58(4). https://doi.org/10.1093/ajcn/58.4.463.

Lestari, W.S., 2016. *Faktor-faktor yang Berhubungan dengan Kelelahan pada Pekerja Pembuat Tahu di Pabrik Tahu Kelurahan Sumurrejo Kecamatan Gunungpati Semarang*. *Skripsi Kesehatan Masyarakat*.

de Lima, F.D., Neri, S.G.R., Lima, R.M., Valeriano, R. de O., Correia, A.L.M. and Bottaro, M., 2019. Body fat, but not muscle quality, is related to perceived fatigue in young-adult active and inactive women. *Revista Brasileira de Cineantropometria e Desempenho Humano*, 21. https://doi.org/10.5007/1980-0037.2019v21e56093.

Lindinger, M.I. and Cairns, S.P., 2021. *Regulation of muscle potassium: exercise performance, fatigue and health implications*. *European Journal of Applied Physiology*, https://doi.org/10.1007/s00421-020-04546-8.

Marino, F.E., 2019. Defining and measuring fatigue. In: *Human Fatigue*. https://doi.org/10.4324/9781315674759-4.

Mckenna, M.J., Medved, I., Goodman, C.A., Brown, M.J., Bjorksten, A.R., Murphy, K.T., Petersen, A.C., Sostaric, S. and Gong, X., 2006. N-acetylcysteine attenuates the decline in muscle Na + ,K +-pump activity and delays fatigue during prolonged exercise in humans. *J Physiol*, 576(1), pp.279–288. https://doi.org/10.1113/jphysiol.2006.115352.

Mondal, H. and Mishra, S.P., 2017. Effect of BMI, body fat percentage and fat free mass on maximal oxygen consumption in healthy young adults. *Journal of Clinical and Diagnostic Research*, 11(6). https://doi.org/10.7860/JCDR/2017/25465.10039.

Morton, A.M., Furtado, J.D., Mendivil, C.O. and Sacks, F.M., 2019. Dietary unsaturated fat increases HDL metabolic pathways involving apoE favorable to reverse cholesterol transport. *JCI Insight*, 4(7). https://doi.org/10.1172/jci.insight.124620.

Nuttal, F., 2017. Body mass index: Obesity, BMI, and health. *Nutrition Research*, 50(3).

Proia, P., di Liegro, C.M., Schiera, G., Fricano, A. and Di Liegro, I., 2016. *Lactate as a metabolite and a regulator in the central nervous system*. *International Journal of Molecular Sciences*, https://doi.org/10.3390/ijms17091450.

Putra, A.E., 2018. Pemilihan Rumus dan Perhitungan Besar Sampel. *Statistik dan Informatika*.

Reedy, J., Lerman, J.L., Krebs-Smith, S.M., Kirkpatrick, S.I., Pannucci, T.R.E., Wilson, M.M., Subar, A.F., Kahle, L.L. and Tooze, J.A., 2018. Evaluation of the Healthy Eating Index-2015. *Journal of the Academy of Nutrition and Dietetics*, 118(9). https://doi.org/10.1016/j.jand.2018.05.019.

Saltzman, E. and Mogensen, K.M., 2013. Physical and clinical assessment of nutrition status. In: *Nutrition in the Prevention and Treatment of Disease*. https://doi.org/10.1016/B978-0-12-391884-0.00003-2.

Santikatmaka, A., 2013. Cairan dan Elektrolit. *Journal of Chemical Information and Modeling*, 53(9), pp.1689–1699.

Santos, D.A., Dawson, J.A., Matias, C.N., Rocha, P.M., Minderico, C.S., Allison, D.B., Sardinha, L.B. and Silva, A.M., 2014. Reference values for body composition and anthropometric measurements in athletes. *PLoS ONE*, 9(5). https://doi.org/10.1371/journal.pone.0097846.

Sartika, R.A.D., 2008. Pengaruh Asam Lemak Jenuh, Tidak Jenuh dan Asam Lemak Trans terhadap Kesehatan. *Kesmas: National Public Health Journal*, 2(4). https://doi.org/10.21109/kesmas.v2i4.258.

Segura-Jiménez, V., Castro-Piñero, J., Soriano-Maldonado, A., Álvarez-Gallardo, I.C., Estévez-López, F., Delgado-Fernández, M. and Carbonell-Baeza, A., 2016. The association of total and central body fat with pain, fatigue and the impact of fibromyalgia in women; Role of physical fitness. *European Journal of Pain (United Kingdom)*, 20(5), pp.811–821. https://doi.org/10.1002/ejp.807.

Sjøgaard, G., 1996. Potassium and fatigue: The pros and cons. In: *Acta Physiologica Scandinavica*. https://doi.org/10.1046/j.1365-201X.1996.207000.x.

Srikanthan, P., Horwich, T.B., Press, M.C., Gornbein, J. and Watson, K.E., 2021. Sex differences in the association of body composition and cardiovascular mortality. *Journal of the American Heart Association*, 10(5). https://doi.org/10.1161/JAHA.120.017511.

Tahuk, P.K., Dethan, A.A., Sio, S., 2018. THE COMPOSITION OF SATURATED AND UNSATURATED FATTY ACIDS AND CHOLESTEROL IN MEAT OF BALI BULL FATTENED USING GREENLOT SYSTEM IN SMALL HOLDER FARMING. *Jurnal Kedokteran Hewan*, 12(3), pp.66–70. https://doi.org/10.21157/j.ked.hewan.v12i3.10068.

Tarwaka, 2014. *Ergonomi Indutri: Dasar-Dasar Ergonomi dan Implementasi di Tempat Kerja*. *Harapan Press*.

the Central Bureau of Statistics of East Java, 2022. *Provinsi Jawa Timur Dalam Angka 2022*. [online] Badan Pusat Statistik Provinsi Jawa Timur. Available at: <https://www.ptonline.com/articles/how-to-get-better-mfi-results>.

the Central Bureau of Statistics of Indonesia, 2020. *Keadaan Ketenagakerjaan Indonesia Februari 2020*. *Berita Resmi Statistik*, Jakarta Indonesia: Badan Pusat Statistik.

Tseng, L.A., Delmonico, M.J., Visser, M., Boudreau, R.M., Goodpaster, B.H., Schwartz, A. V., Simonsick, E.M., Satterfield, S., Harris, T. and Newman, A.B., 2014. Body composition explains sex differential in physical performance among older adults. *Journals of Gerontology - Series A Biological Sciences and Medical Sciences*, 69(1), pp.93–100. https://doi.org/10.1093/gerona/glt027.

US. Food & Drug Administration, 2021. *Sodium in Your Diet*.

Vargas, V.Z., De Lira, C.A.B., Vancini, R.L., Rayes, A.B.R. and Andrade, M.S., 2018. Fat mass is negatively associated with the physiological ability of tissue to consume oxygen. *Motriz. Revista de Educacao Fisica*, 24(4). https://doi.org/10.1590/S1980-6574201800040010.

Wang, B. and Torriani, M., 2020. Artificial Intelligence in the Evaluation of Body Composition. *Seminars in Musculoskeletal Radiology*, 24(1), pp.30–37. https://doi.org/10.1055/s-0039-3400267.

Wright, J. and O'Connor, K.M., 2014. Fatigue. *Medical Clinics of North America*, 98(3), pp.597–608. https://doi.org/10.1016/j.mcna.2014.01.010.

Zwarts, M.J., Bleijenberg, G. and van Engelen, B.G.M., 2008. *Clinical neurophysiology of fatigue*. *Clinical Neurophysiology*, https://doi.org/10.1016/j.clinph.2007.09.126.