

RESEARCH STUDY

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The Impact of Vitamin C Intake and Water Consumption on Perceived Fatigue among Female Tile Workers

Pengaruh Konsumsi Vitamin C dan Konsumsi Air terhadap Kelelahan Subjektif pada Pekerja Perempuan Pembuatan Genteng

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ABSTRACT

Background: The tile industry is known for its demanding nature, primarily due to the high energy requirements involved. The manual production methods necessitate significant physical exertion, including the lifting and transportation of heavy, large tiles. This can lead to fatigue as a result of lactic acid buildup in the muscles. Research indicates that burnout rates among workers in the tile industry can reach as high as 82%. **Objectives:** To analyze the effect of vitamin C consumption and drinking water consumption on perceived fatigue levels among female workers in the tile manufacturing sector.

Methods: This research employed a quasi-experimental design, involving a sample of 52 female workers engaged in tile production for each group. Each group participated in an experimental procedure lasting 6 days, after which they were assessed for levels of fatigue. The independent variables examined were the intake of Vitamin C and water, while the dependent variable was the participants' subjective experience of fatigue. Subjective fatigue was quantified using the Work Fatigue Feelings Measurement Questionnaire (KAUPK2). The statistical methods applied included the Wilcoxon Test and the Kruskal-Wallis test.

Results: The findings indicated that both Vitamin C intake and water consumption significantly influenced subjective fatigue levels before and after the intervention (p-value<0.001). Based on the results of the analysis before being given vitamin C, the subjective fatigue score was 51 after being given vitamin C, it dropped to 25. In contrast, before the introduction of drinking water, the subjective fatigue score was 48.23, which subsequently fell to 31.52 after water consumption. The analysis revealed a notable difference in the average subjective work fatigue scores post-intervention.

Conclusions: The intake of Vitamin C and adequate water consumption effectively reduces subjective work fatigue among female tile-making workers. Consequently, it is recommended that industry owners ensure the provision of sufficient drinking water and Vitamin C for their employees.

INTRODUCTION

Indonesia is a nation characterized by a significant presence of informal sector industries. According to the Central Bureau of Statistics in Indonesia, as of August 2022, casual workers constitute 59.31% of the workforce, surpassing the number of formal workers¹. A notable informal industry that has seen recent growth is the roof tile manufacturing sector in Grobogan². However, it is important to note that the production of roof tiles within this informal sector remains predominantly manual, which poses a risk of worker fatigue³.

Fatigue is primarily caused by the accumulation of lactic acid in muscle tissues. When workers engage in strenuous activities over extended periods, the oxygen supply becomes inadequate, leading to anaerobic

metabolism for energy production. This anaerobic process relies on the breakdown of glycogen stored in muscles, resulting in energy generation alongside the byproduct of lactic acid. As work continues, energy output diminishes while lactic acid accumulates, ultimately leading to fatigue^{4,5}. Numerous workers participate in the roof tile production process, and research indicates that women experience higher levels of fatigue compared to men⁶. Worker Woman more prone to experience fatigue^{6,7}. This matters Because there are different hormones between women (hormones estrogen and progesterone) and men (testosterone hormone) cause of size women's physique, muscle mass, bone mass composition, and bone size are smaller than men⁸. After physical activity, increased metabolites such as lactic acid can decrease muscle cell

vitality, affect glycolysis enzyme activity, and reduce energy production, resulting in fatigue^{9,10}.

Female workers also experience a biological cycle every month in their body mechanisms (menstruation), which will affect their physical condition¹¹. Likewise, fatigue that occurs in female workers can affect reproductive health, for example the menstrual cycle^{12,13}. Apart from that, working women have a double burden because apart from working they are also housewives who are burdened with household tasks. This is the difference between fatigue between female and male workers¹⁴. Another study reported that age at menopause and the severity of menopausal symptoms were influenced by high job strain¹⁵. These incidents can only happen to women.

Previous studies conducted in making roof tiles industry showed burnout as high as 82%¹⁶. Research conducted on workers on the Makassar Nipah building construction project found that 79.7% of workers experienced fatigue¹⁷. Work fatigue in the production area at the rubber factory is 26.32% light level, 72.63% moderate level, and 1.05% severe level¹⁸. Besides That, on the industry rock brick report, the worker's feet Once hit rock brick (100%) and fell (47.70%) because of tension physique and fatigue¹⁹. Another study on worker-made rock bricks in India mentions that 23.8% experienced heavy fatigue while 76.2% experienced light fatigue²⁰. Several studies state that among the causes of work accidents include fatigue in both the formal and informal sectors^{21–23}.

Based on the previous study, vitamin C consumption is related to level fatigue^{24,25}. Vitamin C plays a role in the body's energy metabolism process. Sufficient consumption can help increase production energy and repair level fatigue²⁵. In other studies it was also proven that vitamin C supplementation can reduce oxidative stress after maximum physical activity²⁶. Besides, studies have previously proven that drinking water can lower the average yield test reaction timer from 380.4 to 327.1. That matter signifies that consuming drinking water can reduce fatigue²⁷.

During this time, the informal sector needs to get attention from the government and owner industries like industry precarious. Previous research conducted research on workers in general, both men and women. The study aimed to determine the effect of vitamin C

consumption and water consumption on subjective fatigue in female workers in the roof tile industry.

METHODS

Research Design

This research employed a quasi-experimental design featuring both pre-test and post-test assessments alongside a control group. Ethical approval was granted under number 208/KE/09/2023 by the Health Research Ethics Commission at the Faculty of Health Sciences and Nursing, Muhammadiyah University of Semarang on September 15, 2023. The research was conducted in Karangasem Village, Grobogan, Central Java, during the months of September and October 2023.

Population and Sample

The sampling method utilized was simple random sampling, ensuring that each worker had an equal chance of being selected as a respondent. Sample size calculations were performed using the Lemeshow formula to assess the hypothesis concerning mean differences between two independent groups, in alignment with prior research²⁸. The sample comprised 52 individuals from a total population of 490 female workers engaged in tile production in Karangasem Village, Grobogan, Central Java. Inclusion criteria stipulated that participants must be female and refrain from consuming any medications, traditional herbal remedies, or energy drinks during the study and for one month prior to the survey. Exclusion criteria included unwillingness to participate, withdrawal during the research process, and cessation of employment in the roof tile manufacturing sector. Given the extensive area of the tile manufacturing industry, subjects were selected from various locations to prevent information exchange regarding the interventions. The first group, serving as the control, continued their regular work routine and would receive the intervention post-study. The second group was administered between 2.8 to 3 liters of drinking water, adjusted according to body weight. The third group received 1000 mg vitamin C tablets. Each group participated in the study for a duration of six days, after which evaluations for fatigue were conducted. Refer to figure 1 for further details.

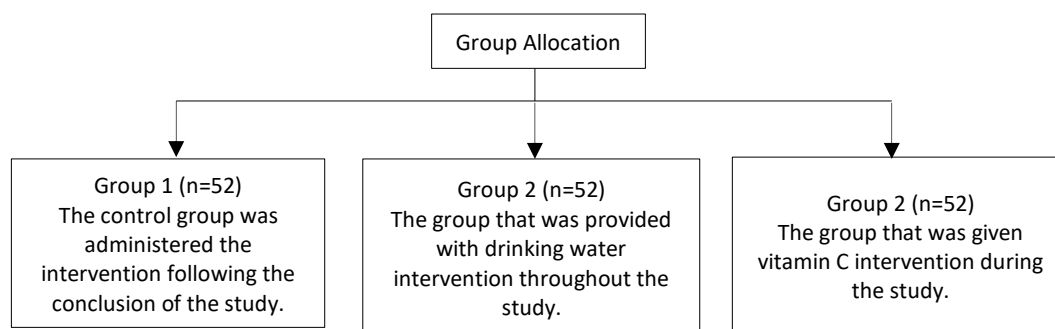


Figure 1. Group allocation

Data collection

The researchers conducted direct data collection, which included participants' age, Body Mass Index (BMI), and subjective work fatigue levels before and after the intervention. Age information was gathered by inquiring about the respondents' dates of birth. BMI was determined by measuring body weight with scales and height using a stature meter. BMI is categorized into Mild degree of Underweight (17-18.4), Normal (25), Mild degree of Overweight (25.1-27)²⁹. Subjective work fatigue data is taken by interview using Job Fatigue Feeling Measurement Questionnaire (KAUPK2)³⁰. KAUPK2 is a questionnaire containing questions specifically designed to measure feelings of work fatigue from each research subject's response. KUPK2 was obtained from a book by Lientje Setyawati K Maurits which has been standardized for workers.

Processing and analysis of data

The collected data underwent a thorough review for completeness to minimize errors. Once verified, the data was organized into tables according to variables and subsequently entered into a computer program for analysis. The statistical analysis employed to evaluate the impact of the intervention on subjective fatigue utilized the Wilcoxon test. Differences between intervention groups were assessed using the Kruskal-Wallis test.

RESULTS AND DISCUSSIONS

The study engaged workers to gather insights regarding their age and BMI. Data collection was facilitated through questionnaires. The subsequent table illustrates the distribution of age and BMI among the respondents, which is anticipated to provide a comprehensive overview of the study's findings

Table 1. Characteristics of respondents

Characteristics	Control		Drinking water		Vitamin C	
	n (%)	Mean±SD	n (%)	Mean±SD	n (%)	Mean±SD
Age (Years)						
Early adulthood (26-35)	4 (7.7)		1 (1.9)		4 (7.7)	
Late adulthood (36-45)	22 (42.3)	46.73±8.139	32 (61.5)	44.71±6.751	33 (63.5)	43.63±7.639
Early elderly (46-55)	15 (28.8)		14 (9.6)		10 (19.2)	
Late elderly (56-65)	11 (21.2)		5 (9.6)		5 (9.6)	
BMI						
Mild degree of Underweight	-		-		6 (11.5)	
Normal	52 (100)	22.835±1.7478	50 (96.2)	22.100±1.5524	42 (80.8)	21.7556±2.2075
Mild degree of Overweight	-		2 (3.8)		4 (7.7)	

BMI: Body Mass Index, n: frequency, %: Percentage, SD: Standard Deviation

The average age in the control group was 46 to 47 years, 44 to 45 years in the drinking water intervention group, and 43 to 44 years in the vitamin C intervention group. The average nutritional status in the control,

drinking water, and vitamin C intervention groups were all normal. Respondents were dominated by late adulthood and normal nutritional status.

Table 2. Effect of drinking water and vitamin c on subjective work fatigue levels

Variable	Subjective Work Fatigue		p-value
	Pre Mean±SD; Median (Min-Max)	Post Mean±SD; Median (Min-Max)	
Control	48.37±5.96 50(33-57)	49.35±6.40 51.50(34-61)	0.224 ^{a**}
Drinking water	48.23±5.28 49(32-57)	31.52±5.38 31.50(20-40)	<0.001 ^{a*}
Vitamin C	50.48±4.95 51(37-59)	24.88±5.30 25(17-36)	<0.001 ^{a*}

a: Wilcoxon Test, *p-value<0.005: There is a difference, **p-value>0.05: No difference

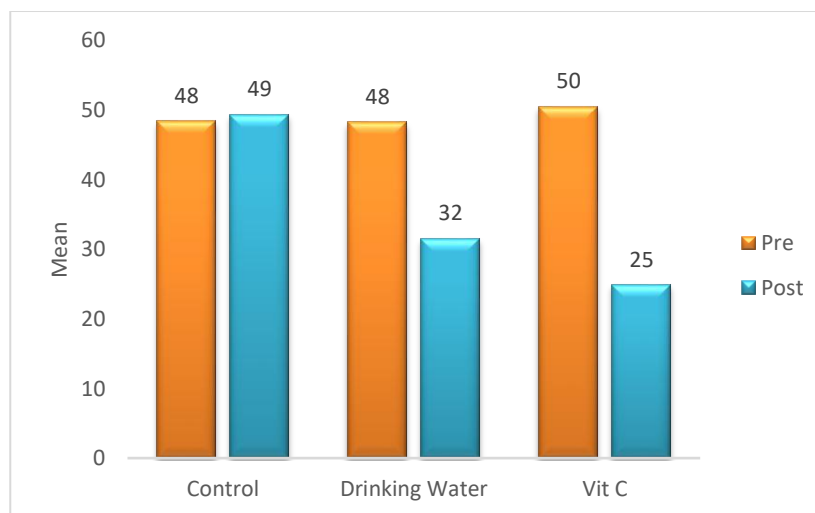


Figure 2. Decreased subjective work fatigue in the intervention group

Table 3. Results of analysis of difference tests between groups on subjective work fatigue

Parameter	p-value
Subjective Work Fatigue	
Pre	0.058 ^{b**}
Post	<0.001 ^{b*}

b: Kruskal Wallis Test; *p-value<0.005: There is a difference; **p-value>0.05: No difference.

Table 4. Results of difference test analysis of changes in subjective work fatigue between groups

Parameter	Average Delta $\pm$ SD			p-value
	Control	Drinking water	Vitamin C	
Subjective Work Fatigue	0.9 $\pm$ 7.8	-16.7 $\pm$ 4.5	-25.6 $\pm$ 3.9	<0.001 ^{b*}

b: Kruskal Wallis Test; *p-value<0.005: There is a difference.

The Wilcoxon analysis results showed no difference in the average subjective work fatigue in the control group, with p-value=0.224. The moderate emotional work fatigue in the group given drinking water and vitamin C decreased after being given the intervention. The Wilcoxon analysis results showed a difference in the average subjective work fatigue before and after the intervention, with p-value<0.001 in the group given Drinking Water and Vitamin C. The Kruskal Wallis test analysis results showed no difference in subjective work fatigue pre-test (p-value=0.058) in all three groups. The results of the Kruskal-Wallis test showed a difference in post-test emotional work fatigue (p-value<0.001) between the three groups. Likewise with Average Delta which shows differences between treatment groups (p-value<0.001).

The results of the study indicate that the average subjective work fatigue before being given vitamin C own score of 51, after drinking vitamin c the score being down to 25. There is a difference in fatigue Work emotional significance between before and after being given vitamin C (p-value<0.001). Studies previously show that supplemented food extract fruit pomegranate, which has a combination of character chemicals vitamin B and vitamin C, is added to the intake of healthy consumers for

two months, reducing prolonged fatigue³¹. Vitamin C is a remover radical powerful free in connection with stress oxidative consequence exists activity excessive.

Other research shows that Vitamin C supplementation is beneficial in arranging balanced redox And reducing the production of oxidative stress biomarkers during excessive³². Soluble vitamin supplementation in water, like vitamin C, can reduce fatigue. Its role in various track metabolism supports elemental system production energy, oxygen transportation, and oxidative stress protection. Besides that, vitamin C plays a role in the maintenance of the brain's structure, allows connection between cells, And leads neurotransmitter synthesis on the enhancement of cognitive And psychological³³.

Stress oxidative is considered to be underlying fatigue, with Serum markers of oxidative stress linked with symptom fatigue. Vitamin C is a famous antioxidant; vitamin C treatment for symptom fatigue has been proven in obese adults undergoing a reduction program in heavy body with sport. Consuming oral vitamin C 500mg/ day over four Sundays was reported to be better than placebo in reducing perceived activity And lower score fatigue³⁴. Vitamin C is helpful as an antioxidant in the body and can help reduce the risk of damage

oxidation during activity And prevent damage to cell consequence activity molecule radical free³⁵. Vitamin C has antioxidant properties because it can easily lose electrons to neutralize and inhibit free radicals from being oxidized to prevent cell damage. It is also commonly used as a food additive that acts as an antioxidant³⁶. Vitamin C is the primary water-soluble antioxidant present in cells and extracellular fluids. This vitamin is able to provide protection against oxidants originating from phagocytes by reducing phagocyte adhesion to the endothelium, attenuating the respiratory burst, and preventing subsequent lipid peroxidation³⁷.

This study indicates that the average subjective work fatigue before being given drinking water own score of 48,23. After being given drinking water, the score went down to 31,52. There is a difference in fatigue Work significant subjective difference between before and after being given drinking water (p -value<0.000). Studies have shown that water supplementation can relieve anger, exhaustion, and total mood disorders²⁶. Providing drinking water by need can lower fatigue work²⁷. Besides that, another study of 12 adults disclosed that water supplementation of 1500 mL reduces dehydration, including vigor, fatigue, and total mood disturbance²⁷.

Studies have shown that providing drinking water can positively contribute work fatigue to overcome problem fatigue due to working in hot temperatures⁴⁰. Activity dan high physical environment temperature causes water-electrolyte disorders and disturbance balance. They improve internal homeostasis and physiological-biochemical⁴¹. Enhancement of temperature during activity in conditions of dehydration can increase the rate of lactate in blood and can also cause disturbance in profile morphology and decline in aerobic capacity³⁰. Results of the study show that drinking water before, when, and after sports effectively lowers heart rate⁴³. Water is an element-based body, about 60%–70% by weight. It is essential for every system and activity metabolism in the body^{44,45}. Working workers in an environment work hot for consume drinking water every 20 – 30 minutes, fine when thirsty or not. If workers consume drinking water at the moment, they feel thirsty. This can cause no balance of fluid inside the body. Liquid coming out through sweat will more lots than incoming fluid into the body⁴⁶.

The strength of this study is that it focuses on female workers in the tile-making industry, who are a group at high risk of experiencing fatigue due to heavy work. This study provides simple, accessible, evidence-based recommendations that are easy for workers to implement, such as optimal vitamin C consumption and hydration patterns, to reduce subjective fatigue and improve the health and productivity of female workers. But there are shortcomings in this study, the level of work fatigue is assessed using a questionnaire so that the results depend on the feelings of each subject, for further research, research on the level of work fatigue can be developed using the Reaction Timer tool. This study also has no control over food consumption, sleep quality and work stress during the study.

CONCLUSIONS

The consumption of Vitamin C and drinking water significantly affects subjective fatigue levels among female workers in the roof tile manufacturing sector. This is evidenced by the variations in subjective fatigue reported among groups that consumed Vitamin C, those with adequate water intake, and the control group following the intervention. It is recommended that industrial employers ensure an adequate supply of drinking water and provide Vitamin C to their employees to enhance stamina and reduce fatigue, thereby improving overall work productivity. While the use of questionnaires to assess perceived fatigue may not be as effective as laboratory measurements involving blood samples, studies of this nature offer valuable insights into the subjective experiences of fatigue reported by individuals, which can inform future considerations regarding fatigue assessment. Future research should consider incorporating additional fatigue markers, such as lactic acid and Malondialdehyde levels, which can be evaluated in laboratory settings.

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CONFLICT OF INTEREST AND FUNDING DISCLOSURE

The authors declare that there are no conflicts of interest associated with this article. This research was conducted independently by the authors without any external funding.

AUTHOR CONTRIBUTIONS

ES: conceptualization, investigation, methodology, supervision, data analysis, writing—original draft, writing—review and editing; HMD: methodology, writing—original draft; S: methodology; formal analysis, writing—original draft; YS: formal analysis, resources; DL: writing—original draft, writing—review and editing.

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