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# Effect of Physical Workload, Nutritional Status with Work Fatigue on Work Productivity at PT. Semen Tonasa Pangkep Regency South Sulawesi

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## ABSTRACT

**Background:** Occupational fatigue is a problem that is often overlooked despite its serious impact on worker safety. It contributes 60% to workplace accidents. Prolonged high rates of fatigue can reduce cognitive function, and factors such as excessive workload, nutritional status exacerbate fatigue and have a negative impact on work productivity. The purpose of this study was to analyze the effect of workload, nutritional status with fatigue in workers on work productivity at PT Semen Tonasa located in Pangkep Regency, South Sulawesi.

**Methods:** This analytical survey study with a cross-sectional design was conducted at PT Semen Tonasa, a cement factory in Pangkep Regency, South Sulawesi Indonesia, involving 144 workers. Data on workload, nutritional status, fatigue, and productivity were collected using questionnaires, body mass index and oximeter, and structured interviews. Path analysis was used to examine the direct and indirect effects of these variables on productivity.

**Results:** The results showed that there was a significant positive effect of workload on work fatigue (2,496 > 1.96). there is a positive effect of nutritional status on work productivity (2,228 > 1.96), there is a positive effect of work fatigue on work productivity (3,938 > 1.96), Based on the intervening test, the indirect effect of workload on work productivity through work fatigue is -0.091 (negative effect).

**Conclusions**: In addition, there is a significant influence between workload, on work productivity through Work Fatigue and there is an insignificant influence of nutritional status on work productivity through Fatigue. It is expected that further research will be conducted on additional variables that can affect eye fatigue complaints in addition to the independent variables above.

***Keywords:*** *Physical Workload, Nutritional Status, Occupational Fatigue, Work Productivity*

## 1. INTRODUCTION

Work fatigue is a condition in which an individual's productivity and endurance in carrying out tasks decrease. Fatigue refers to the situation of reduced energy of workers in carrying out activities, which has an impact on reducing work capacity and endurance (Pamuja, 2024). In the modern industrial era, where production is faster and more efficient, the risk of workplace accidents is increasing, demanding more attention to safety (Taşdelen and Özpınar 2020) And a common problem that often occurs in the workplace is occupational fatigue (Caldwell et al, 2019) Such a situation has the potential to reduce productivity at work (Fatmawati et al, 2024) Based on data from the International Labor Organization (2018), every day around 7,600 lives are lost due to occupational diseases or accidents in the workplace (Chenarboo et al, 2022). And according to the International Labor Organization (2021), every year around 2 million workers lose their lives due to work accidents triggered by fatigue at work (WHO/ILO, 2021). If a person's physical workload is not in accordance with work capacity, it can cause fatigue, which is caused by the higher the energy required at work, the muscles will work longer to overcome the workload they receive (Narpati et al, 2019).

A workload that is too light can lead to idle time, which in turn wastes time and costs the company money. Conversely, excessive workload can have a negative impact on employees, such as increased fatigue, decreased productivity, and health risks (Özkaya et al, 2018). Continuous workload with static body posture as one of the main risk factors that trigger work fatigue (Aziz et al. 2015). The ILO noted that of the 58,115 workers surveyed, 32.8% experienced fatigue, which had a direct impact on their productivity (Thamrin, 2020). Based on information obtained, in 2020, BPJS Employment (BPJamsostek) recorded 397 cases of work accidents in the South Sulawesi region. (Mirsan, 2021). Nationally, in 2023, the Ministry of Manpower recorded 370,747 cases of work accidents, up from 298,137 cases in 2022. By October 2024, the number of cases reached 356,383 that 80 percent of labor accidents were caused by human error (Nurhidayanti, 2025).

Occupational nutrition is one aspect of occupational health that has an important role in increasing work productivity. (Desmarta et al. 2023). Workers with suboptimal nutritional status are more prone to fatigue at work. Meanwhile, obesity can inhibit agility and make it difficult for them to carry out work activities. (Eum and Jung 2020). Pergizi Pangan Indonesia in 2018 suggested that both well-off and poor people in Indonesia have insufficient knowledge about balanced nutrition. So that the fulfillment of balanced nutrition is not achieved, people who can also experience malnutrition or excess nutrition (Florence 2017). Potential hazards of the work environment. From direct observations made by researchers as initial data on workers, it turns out that the work is enough to cause fatigue, such as moving objects, lifting objects, repairing objects, or welding and so on. Several studies have shown that workload, nutritional status are the main factors that cause fatigue. Occupational fatigue is a serious problem for worker safety and health, and should not be ignored because the workforce is a company asset that has a direct effect on productivity. Therefore, it is necessary to make efforts to reduce work fatigue by paying attention to workload, as well as nutritional status within the company.

The purpose of this study was to analyze the effect of workload, nutritional status with job fatigue on the work productivity of workers in cement factories.

## 2. MATERIALS AND METHODS RESEARCH

Workload is measured using the Finger Pulse Oximeter tool which is used to measure heart rate (HR) and blood oxygen levels ($SpO_2$). In the context of workload measurement, this tool is used to assess the physiological response of workers to the activities performed. Measurement of nutritional status in this study is the anthopometric method. Anthopometric indicators used include body weight (BW) and height (TB). Measurements of body weight and height are then calculated and produce a body mass index (BMI) figure. Body Mass Index (BMI) is the division of body weight (in kilograms) to the square of body weight (in meters). Measurement of work fatigue with the Subjective Self-Rating Method which is a subjective assessment-based approach from workers on the level of fatigue they feel. Measurement of work productivity with the LUR (Labor Utilization Ratio) method to analyze the efficiency of labor use in a production or work process. LUR is the value of labor effectiveness obtained from the summation of observations between effective activities and ¼ contributory activities, then divided by the total observations made. Productivity is self-reported by employees based on their work output and perceived work efficiency.

## 3. POPULATION AND SAMPLE

The research population consists of 231 working at PT Semen Tonasa. Probability sampling technique that will be used is Stratified Random Sampling, which is a sampling technique taken by stratified random sampling. Which means 144 workers are included in the study. This method was chosen to obtain a proportional sample in each subpopulation.

## 4. DATA PROCESSING AND ANALYSIS

In this study, data processing was carried out using computerized techniques through the SmartPLS program. Univariate analysis was used to process data on workload, nutritional status, fatigue, and work productivity to provide a summary of the frequency distribution and percentage of the research variables. Meanwhile, multivariate analysis was used to determine the effect of two variables by controlling for other variables and to measure how much influence the variables had purely. According to Dillon and Goldstein (1984), multivariate analysis is also used to analyze several measurements (variables) contained in each object in one or many samples simultaneously.

## 5. RESULTS

This research was conducted at PT Semen Tonasa from October to November 2024 involving 144 workers in the Clinker Production Unit. Data were collected through direct observation and questionnaires regarding workload and nutritional status with job fatigue on work productivity, with analysis using SPSS and Smart PLS 4, resulting in specific findings.

**Analisis Univariat**

**Table I. Distribution of Physical Workload of Respondents of PT Semen Tonasa (Persero) Pangkep Regency, South Sulawesi**

| Workload | n | % |
|---|---|---|
| High | 83 | 57.6 |
| Low | 61 | 42.4 |
| **Total** | **144** | **100** |

Distribution of Respondents' Physical Workload at PT Semen Tonasa Pangkep Regency, South Sulawesi. Based on the table above shows that out of 144 respondents, it can be seen that in general employees feel heavy workload as many as 83 respondents (57.6%) and feel light workload as many as 61 respondents (42.4%).

**Table II. Distribution of nutritional status of respondents of PT Semen Tonasa (Persero) Pangkep Regency, South Sulawesi**

| Nutritional Status | n | % |
|---|---|---|
| Abnormal | 85 | 59,0 |
| Normal | 59 | 41,0 |
| **Total** | **144** | **100** |

Distribution of Nutritional Status of Respondents at PT Semen Tonasa Pangkep Regency, South Sulawesi. Based on the table above shows that out of 144 respondents, it can be seen that in general employees with abnormal nutritional status were 85 respondents (59.0%), and normal nutritional status was 59 respondents (41.0%).

**Table III. Distribution of Work Fatigue of Respondents of PT Semen Tonasa (Persero) Pangkep Regency, South Sulawesi**

| Work Fatigue | n | % |
|---|---|---|
| Fatigue | 97 | 67,4 |
| Not Fatigue | 47 | 32,6 |
| **Total** | **144** | **100** |

Distribution of Respondents' Work Fatigue at PT Semen Tonasa Pangkep Regency, South Sulawesi. Based on the table above shows that out of 144 respondents, it can be seen that in general employees experience fatigue as many as 97 respondents (67.4%), and not tired as many as 47 respondents (32.6%).

**Table IV. Distribution of Work Productivity of Respondents of PT Semen Tonasa (Persero) Pangkep Regency, South Sulawesi**

| Work Productivity | n | % |
|---|---|---|
| Low | 29 | 20,2 |
| Sufficient | 100 | 69,4 |
| High | 15 | 10,4 |
| **Total** | **144** | **100** |

Distribution of Respondents' Work Productivity at PT Semen Tonasa Pangkep Regency, South Sulawesi. Based on the table above shows that out of 144 respondents, it can be seen that in general employees experience low work productivity as many as 29 respondents (20.1%), sufficient work productivity as many as 100 (69.4%) and high work productivity as many as 15 respondents (10.4%).

**Analisis Bivariat**

**Table V. Relationship between Physical Workload and Work Fatigue in Workers of PT Semen Tonasa (Persero) Pangkep Regency, South Sulawesi**

| Workload | Work Fatigue | | | | Total | | *P value* |
|---|---|---|---|---|---|---|---|
| | Fatigue | | Not Fatigue | | | | |
| | n | % | n | % | n | % | |
| High | 71 | 49,3 | 12 | 8,3 | 83 | 57,6 | **0.000** |
| Low | 26 | 18,1 | 35 | 24,3 | 61 | 42,4 | |
| **Total** | **97** | **67,4** | **47** | **32,6** | **144** | **100** | |

Relationship between Physical Workload and Work Fatigue of Workers at PT Semen Tonasa, Pangkep Regency, South Sulawesi. The data shows that 49.3% of workers with heavy physical workload experience fatigue and 8.3% do not experience fatigue. In contrast, in workers with light physical workload, 18.1% experienced fatigue, while 24.3% did not experience fatigue. Chi-Square test showed a significant relationship between physical workload and fatigue, with a p value of 0.000 ($p < 0.05$) in PT Semen Tonasa workers.

**Table VI. Relationship between Physical Workload and Work Productivity among Workers of PT Semen Tonasa (Persero) Pangkep Regency, South Sulawesi**

| Workload | Work Productivity | | | | | | Total | | *P value* |
|---|---|---|---|---|---|---|---|---|---|
| | Low | | Sufficient | | High | | | | |
| | n | % | n | % | n | % | n | % | |
| High | 19 | 13,2 | 63 | 43,8 | 1 | 0,7 | 83 | 57,6 | **0.000** |
| Low | 10 | 6,9 | 37 | 25,7 | 14 | 9,7 | 61 | 42,4 | |
| **Total** | **29** | **20,1** | **100** | **69,4** | **15** | **10,4** | **144** | **100** | |

Relationship between Physical Workload and Work Productivity of Workers at PT Semen Tonasa, Pangkep Regency, South Sulawesi. The data shows that 13.2% of workers with heavy physical workload have low work productivity, 43.8% have moderate work productivity and 0.7% have high work productivity. In contrast, in workers with light physical workload, 6.9% had low work productivity and 25.7% had moderate work productivity, while 9.7% had high work productivity. Chi-Square test showed a significant relationship between physical workload and work productivity, with a p value of 0.000 ($p < 0.05$) in PT Semen Tonasa workers.

**Table VII. Relationship between Nutritional Status and Work Productivity among Workers of PT Semen Tonasa (Persero) Pangkep Regency, South Sulawesi**

| Nutritional Status | Work Productivity | | | | | | Total | | *P value* |
|---|---|---|---|---|---|---|---|---|---|
| | Low | | Sufficient | | High | | | | |
| | n | % | n | % | n | % | n | % | |
| Abnormal | 14 | 9,7 | 58 | 40,3 | 13 | 9,0 | 85 | 59,0 | **0.046** |
| Normal | 15 | 10,4 | 42 | 29,2 | 2 | 1,4 | 59 | 41,0 | |
| **Total** | **29** | **20,1** | **100** | **69,4** | **15** | **10,4** | **144** | **100** | |

Relationship between nutritional status and work productivity of workers at PT Semen Tonasa Pangkep Regency, South Sulawesi. The data shows that 9.7% of workers with abnormal nutritional status have low work productivity, 40.3% have moderate work productivity and 9.0% have high work productivity. In contrast, in workers with normal nutritional status, 10.4% had low work productivity and 29.2% had moderate work productivity, while 1.4% had high work productivity. Chi-Square test showed a significant relationship between nutritional status and work productivity, with a p value of 0.046 ($p < 0.05$) in PT Semen Tonasa workers.

**Table VIII. The Relationship between Occupational Fatigue and Work Productivity in Workers of PT Semen Tonasa (Persero) Pangkep Regency, South Sulawesi**

| Work Fatigue | Work Productivity | | | | | | Total | | *P value* |
|---|---|---|---|---|---|---|---|---|---|
| | Low | | Sufficient | | High | | | | |
| | n | % | n | % | n | % | n | % | |
| Fatigue | 22 | 15,3 | 73 | 50,7 | 2 | 1,4 | 97 | 67,4 | **0.000** |
| Not Fatigue | 7 | 4,9 | 27 | 18,8 | 13 | 9,0 | 47 | 32,6 | |
| **Total** | **29** | **20,1** | **100** | **69,4** | **15** | **10,4** | **144** | **100** | |

Relationship between job fatigue and Worker Productivity at PT Semen Tonasa Pangkep Regency South Sulawesi. The data shows that 15.3% of workers with job fatigue experience low work productivity, 50.7% have moderate work productivity and 1.4% have high work productivity. In contrast, in workers with no job fatigue, 4.9% had low work productivity and 18.8% had moderate work productivity, while 9.0% had high work productivity. Chi-Square test showed a significant relationship between job burnout and work productivity, with a p value of 0.000 ($p < 0.05$) in PT. Semen Tonasa workers.

**Multivariate Analysis**

**Table IX, Direct Effect Significance Test**

| Direct Effect | Original Sample | Sample Mean (M) | Standard Deviation | T Statistics | *P Value* |
|---|---|---|---|---|---|
| Workload -> Work Fatigue | 0.274 | 0.295 | 0.110 | 2.496 | 0.013 |
| Nutritional Status -> Work Productivity | 0.161 | 0.160 | 0.072 | 2.228 | 0.026 |
| Work Fatigue -> Work Productivity | -0.334 | -0.328 | 0.085 | 3.938 | 0.000 |

1. Physical Workload and Work Fatigue: Workload has a significant effect on job fatigue (t Statistic 2.496 > 1.96) with a positive effect of 0.274, which indicates that heavy physical workload can experience job fatigue.
2. Nutritional Status and Work Productivity:Nutritional Status has a significant effect on Work Productivity (t Statistic 2.228 > 1.96) with a positive effect of 0.161, which indicates that good nutritional status affects the increase in work productivity.
3. Work Fatigue and Work Productivity:Nutritional Status has a significant effect on Work Productivity (t Statistic 3.938 > 1.96) with a negative effect of -0.334, which indicates that excessive fatigue affects the decrease in work productivity.

**Table X, Significance Test of Indirect Influence**

| Indirect Effect | Original Sample | Sample Mean (M) | Standard Deviation | T Statistics | *P Value* |
|---|---|---|---|---|---|
| Workload -> Work Fatigue -> Work Productivity | -0.091 | -0.095 | 0.041 | 2.219 | 0.027 |

Based on Table XI, we can see the indirect effect of independent variables on work productivity.
1. The effect of Workload on Work Productivity through Job Fatigue obtained a coefficient value of -0.091 with a p value (0.027) <0.05. which means there is a significant effect of Workload on work productivity through job fatigue.

## 6. DISCUSSION

After describing the research results in the previous section, it will be discussed and reviewed references and sources of previous research on the factors studied such as workload, nutritional status, fatigue and work productivity.

**Effect of Physical Workload on Work Fatigue in Workers of PT Semen Tonasa Pangkep Regency South Sulawesi.**

Workload is an indicator that measures the extent to which the limited capacity or ability of the human body is required in completing a task. As many as 57.6% of workers (83 respondents) experienced heavy physical workloads, high workloads without optimal arrangements can have a direct impact on worker health, safety and productivity. The workload that must be faced is adjusted to the capacity or physical ability of workers to receive the load (Sarmini 2021). Chi-Square analysis showed a significant relationship between physical workload and job fatigue ($p = 0.000$, $p < 0.05$), which indicates that heavy physical workload can increase the level of job fatigue. To reduce job fatigue, management must balance the workload with the ability of workers and prevent workers from doing heavy work continuously at one time, especially on tasks that involve high physical loads.

**Effect of Nutritional Status on Work Productivity of PT Semen Tonasa Workers in Pangkep Regency, South Sulawesi.**

Chi-Square analysis revealed a significant relationship between nutritional status and work productivity at PT Semen Tonasa Pangkep Regency ($p = 0.046$, $p < 0.05$). Nutritional status significantly affects productivity, optimal nutritional conditions are associated with increased work productivity. Adequate nutrition can help concentration and endurance so that it has a positive impact on productivity ($p = 0.026$, coefficient value of 0.161). Many employees report fatigue due to poor nutrition, especially during periods of intensive work. In the cement industry, production and operational divisions require high physical and mental endurance. Facing a large workload, employees in these divisions require optimal nutritional status to maintain stamina, focus and safety while working. Therefore, evaluating the nutritional adequacy of employees is crucial to prevent a drop in productivity and ensure the smooth operation of the company.

**The Effect of Occupational Fatigue on Work Productivity in Workers of PT Semen Tonasa Pangkep Regency South Sulawesi.**

Workers' job fatigue negatively impacts their performance and productivity, it reduces the ability to focus, increases the likelihood of errors, and slows down task completion. Data analysis showed a significant relationship between work fatigue and work productivity ($p = 0.000$), and with a t-statistic value of 3.938, and a negative effect of -0.334, it can be concluded that excessive work fatigue contributes to decreased work productivity. Other research reveals that fatigue in the work environment is a major factor in work accidents and decreased productivity levels (Sensa et al, 2022). High levels of fatigue can reduce productivity and increase the risk of errors at work. Therefore, a balanced schedule of work and rest is essential to prevent fatigue and maintain safety. Effective fatigue management plays an important role in ensuring work efficiency and reducing the negative impact on productivity.

## 7. CONCLUSION

Research on workers at PT Semen Tonasa Pangkep Regency concluded that workload has a significant effect on fatigue. Increased workload is positively correlated with fatigue (t statistic 2.496). In addition, with adequate and balanced nutritional status, workers can have optimal energy, increase concentration and endurance which can increase work productivity (t statistics 2.228), finally, excessive fatigue can decrease work productivity (t statistics 3.938).

**ETHICAL APPROVAL :**This study was conducted following ethical guidelines after obtaining approval from the University Research Ethics Commission, Faculty of Public Health, Hasanuddin University, Makassar, with registration number (1964/UN4.14.1/TP.01.02/2024).

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