



## Analysis of Ergonomic Work Fatigue Limits on Performance and Productivity Improvement

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### ABSTRACT

In work, it should not be tiring. Thus, having good performance, resulting in optimal productivity. This paper discusses that through literature. Therefore, this writing is designed descriptively, namely an exposition. Data is taken from literature consisting of various opinions and research results, known as literature studies. The data collected includes fatigue, fatigue limits, performance, and productivity. Data analysis is carried out descriptively. Then, the conclusion of the data analysis is done inductively. Conclusions: 1) that the fatigue limit in work to prevent exhaustion includes: working for 8 hours per day or 40 hours per week; when working, using 35%-50% of maximum VO<sub>2</sub>; the maximum limit of energy usage during work is 5.0 kcal/minute to 5.2 kcal/minute; and working to have good strength so as not to easily tire when a group of muscle origins moves muscle insertions. 2) that working should be within the fatigue limit to maintain good performance, and ultimately, productivity increases optimally. Recommendations: workers should not easily tire during work, therefore, use and improve work equipment. Work equipment should be provided by the industry/company

## INTRODUCTION

Working should always be in a non-fatiguing or comfortable state to ensure optimal productivity. Therefore, it is necessary to discuss work limits that make the body comfortable and ensure optimal productivity.

Work can induce fatigue, hence the need for tools to prevent excessive workload that leads to quick exhaustion. As stated by Mariani Juliana (2018), "to prevent work fatigue, PT. Arwana Anugrah Keramik, Tbk should provide transport tools to lighten the workload of employees." Additionally, excessive workload due to prolonged working hours can also lead to fatigue. As mentioned by Anisa Rahmayani Sitorus (2022), "the duration of work affects the level of work fatigue at PT. Cipta Baja Raya." Furthermore, higher physical workload leads to higher fatigue levels, as concluded by Rizky Maharja's research (2015), stating, "the higher the physical workload, the higher the level of work fatigue experienced."

Work fatigue will affect performance decline in work tasks, as indicated by Risnawati (2016), stating that "Practically, it can be said that the contribution of work fatigue to employee performance is 12.1%."

Therefore, working within fatigue limits is essential to prevent easy exhaustion. Working without fatigue will result in optimal work performance. By working with good performance, productivity in work tasks will increase optimally.

## LITERATURE REVIEW

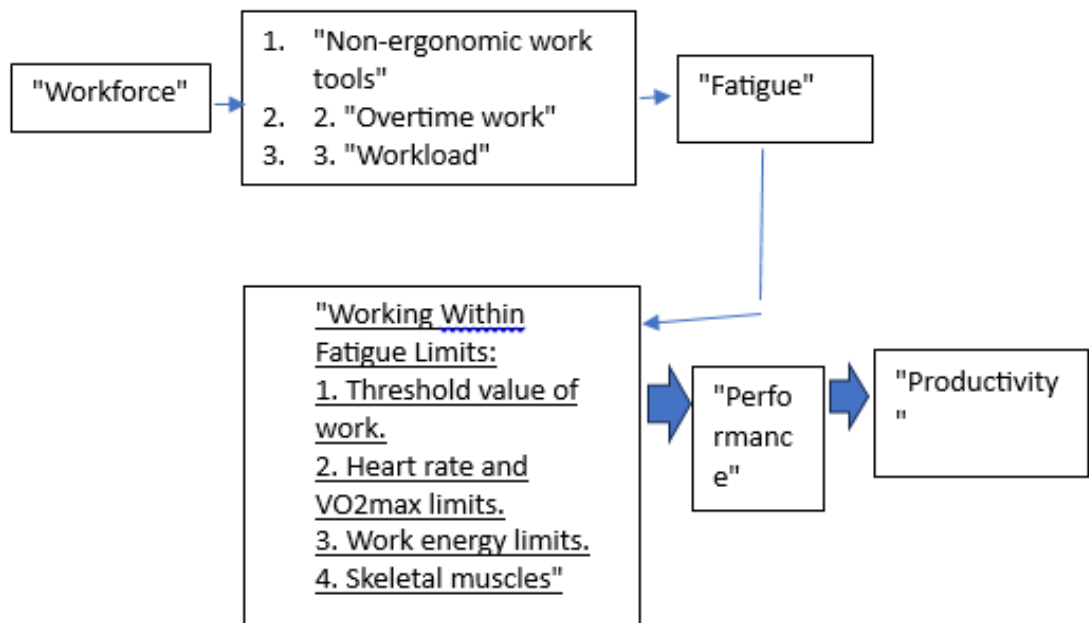


Figure 1. Literatue Review

## METHODOLOGY

The design of this writing is descriptive, namely exposition. Data is taken from several literature sources consisting of various opinions and research results, which is called literature review. The data collected includes fatigue, fatigue limits, performance, and productivity improvement. Data analysis is carried out descriptively. Subsequently, the conclusion of the data analysis is done inductively.

## RESULTS AND DISCUSSION

### "Working Within Fatigue Limits"

Working Within Fatigue Limits:

1. The threshold value of work is 8 hours per day or 40 hours per week (Law No. 13 of 2003, Article 77). According to the International Labour Organization (ILO), as written by Lusiani Julia (2017), the recommended working time is 7 hours per day or 40 hours per week for 6 working days in 1 week; or 8 hours per day or 40 hours per week for 5 working days in 1 week.
2. Overtime work also has its limits. According to Muhamad Abas et al. (2021), Law Number 13 of 2003 Concerning Manpower in Article 77 Paragraph (2) states that overtime work can only be done for a maximum of 3 hours in 1 day and 14 hours in 1 week. Exceeding this limit often results in overload, which can affect performance and cause work stress. Putri Retno Anjani (2022) in her research found that there is a significant influence of work overload on employee performance through work stress.
3. To avoid fatigue while working, it is important to follow the individual's work capacity limits. This includes maintaining a heart rate not exceeding 120 beats per minute. Riza Marlina (2024) emphasizes that a heart rate exceeding 120 beats per minute indicates a significant increase, which can be influenced by physical activity. Additionally, the physical condition of workers also affects the level of fatigue. According to Helianty, Ario, & Wahyuning (2013) as cited by Lina Dianati Fathimahhayati et al. (2019), the fluctuation of heart rate indicates the level of workload of an individual. Excessive workload in the long run can lead to decreased productivity due to work fatigue.
4. Furthermore, it is also important to pay attention to optimal energy expenditure. Maintaining work energy expenditure within the range of 35%-50% of maximum VO<sub>2</sub> can help avoid fatigue. The maximum limit of work energy expenditure is 5.2 kcal/minute (Granjean, 1986), or 5.0 kcal/minute (Durnin, Passmore, 1967). Energy expenditure above these limits can lead to increased lactic acid and body heat, as well as fatigue.
5. Lastly, consider the condition of skeletal muscles. Having good muscle strength can help reduce fatigue during work. In this context, it is important to understand the concepts of origo and insersio in muscles. Origo is the stable part of the muscle during contraction, while insersio is

the part of the muscle that moves during contraction. Understanding these aspects can help in designing work strategies that reduce muscle fatigue.

In the illustration below, you can see the depiction of origo and insersio in skeletal muscles.

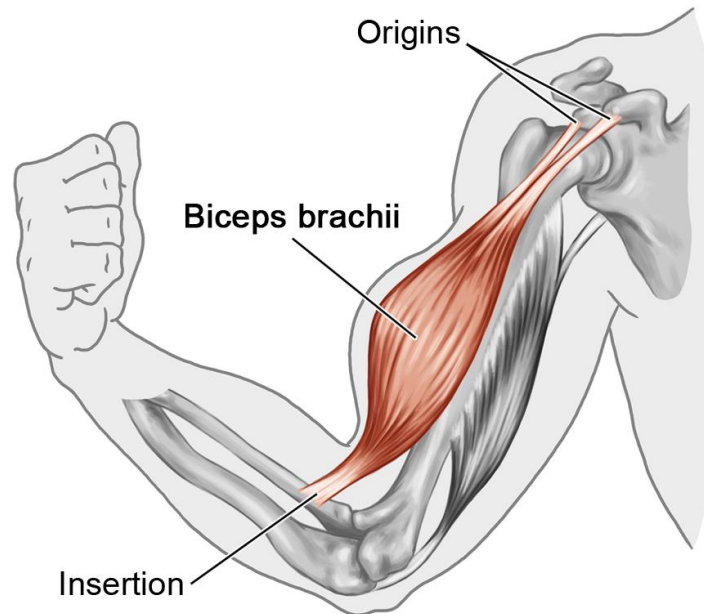


Figure 2. Picture of Origo and Insersio (Anna Woodruff, 2021)

Based on the opinions above, the work limits to avoid fatigue include working for 8 hours per day or 40 hours per week, maintaining 35%-50% of maximum VO<sub>2</sub>, maximum work energy usage limit of 5.0 kcal/minute to 5.2 kcal/minute, taking a break when the body's energy level is at 25 kcal, and ensuring good muscle strength to prevent fatigue when a group of muscle origins moves muscle insertions.

#### 1. Fatigue and Productivity

Working within the limits of work boundaries will prevent fatigue during work. Working without fatigue is closely related to productivity. Research by Ambar Silastuti (2016) indicates a relationship between fatigue and labor productivity in the sewing department of PT Bengawan Solo Garment Indonesia. Similarly, according to Lince Verawati's study (2016), there is a correlation between subjective fatigue and labor productivity among employees in the packaging department of CV Sumber Barokah, a cracker factory. Moreover, as fatigue increases during work, labor productivity decreases. Kimberly Febrina Kodrat's research (2022) shows that higher fatigue leads to lower labor productivity.

Work fatigue contributes to decreased employee performance. As stated by Risnawati (2016), "practically, it can be said that the contribution of work fatigue to employee performance is 12.1%, with the remaining 87.9% influenced by other variables." Similarly, Ferdiansyah et al. (2022) state that fatigue has a positive and significant effect on employee performance.

Therefore, based on the opinions above, work fatigue affects employee performance and ultimately leads to decreased work productivity. Thus, working within the limits is essential to prevent fatigue. Working without fatigue ensures good performance, leading to optimal productivity.

## **CONCLUSIONS AND RECOMMENDATIONS**

### **Conclusion**

- a. The work limits to prevent fatigue include working for 8 hours per day or 40 hours per week; maintaining 35%-50% of maximum VO<sub>2</sub>; maximum work energy usage limit of 5.0 kcal/minute to 5.2 kcal/minute; and ensuring good muscle strength to prevent fatigue when a group of muscle origins moves muscle insertions.
- b. Working within the limits is essential to prevent fatigue and maintain good performance, leading to optimal productivity.

### **Recommendations**

Workers should use and improve work tools to prevent fatigue. Work tools and equipment should be provided by the industry/company.

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