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Work Stress and Load as Predictors of Fatigue in Bakery Workers: Implications for Ergonomic Interventions

Yuliani Setyaningsih[1], Ekawati Ekawati[2*], Ida Wahyuni[3], Hanifa Maher Denny[4], Dina Lusiana Setyowati[5]
[1]Occupational Safety and Health Department, Faculty of Public Health, Universitas Diponegoro, Indonesia
[2]Occupational Safety and Health Department, Faculty of Public Health, Universitas Diponegoro, Indonesia
[3]Occupational Safety and Health Department, Faculty of Public Health, Universitas Diponegoro, Indonesia
[4]Occupational Safety and Health Department, Faculty of Public Health, Universitas Diponegoro, Indonesia
[5]Occupational Safety and Health Department, Faculty of Public Health, Mulawarman University, Indonesia

***Corresponding Author**: E-mail: ekawatifkmundip@gmail.com

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ABSTRACT

Introduction: Work-related fatigue poses a significant challenge to worker productivity and well-being, particularly in physically demanding sectors such as the bakery industry. This study investigates the association between psychological stress, physical workload, and work-related fatigue among informal bakery workers in Batang, Indonesia.
Methods: A cross-sectional study was conducted involving 52 workers over a two-month period (July–August 2022). Data were collected through direct observation, physiological measurements, and structured questionnaires covering worker characteristics, stress levels, workload (measured via heart rate monitoring), heat stress (WBGT index), and fatigue (measured using a reaction timer). Bivariate analysis (Fisher's Exact Test) and multivariate logistic regression were performed to identify significant predictors of fatigue.
Results: Multivariate analysis showed that both work stress and workload were significantly associated with work-related fatigue. Workers experiencing psychological stress had nearly three times the odds of fatigue (OR = 2.901; p = 0.047), while those with heavy workloads had over nine times the risk (OR = 9.446; p = 0.007). In contrast, heat stress and work tenure were not statistically significant predictors.
Conclusion: These findings highlight the critical role of stress and workload in contributing to occupational fatigue. Interventions such as mental health support, ergonomic task redesign, and workload management are essential for improving well-being and safety among informal bakery workers. Future studies should explore additional mediating factors, including coping mechanisms and workplace social support, to inform holistic fatigue prevention strategies.

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INTRODUCTION

Occupational health risks in the informal sector have garnered significant attention due to their impact on worker well-being and productivity. Among these, bakery workers are particularly exposed to various hazards, primarily due to the high-temperature environments in which they operate. In Central Java, Indonesia, specifically in Batang Regency, a small bakery industry employs around 60 workers. According to surveys, this industry produces various types of bread, including plain bread, donuts, sweet bread, and cakes. Production operates daily to fulfil orders from customers or bakeries collaborating with the industry. Preliminary studies indicate that workers in the bakery industry face potential hazards from the hot working climate. The heat in bakery environments is generally caused by dough-cooking activities such as frying and baking.

High temperatures can cause excessive sweating in workers, and without sufficient fluid replacement, workers may experience fatigue and dehydration. These conditions inevitably lead to reduced work performance and lower productivity. Heat exposure has long been a major concern for the health and well-being of workers. The bakery industry is known for its extreme working environment, where workers often face high temperatures from ovens and other baking equipment. The informal nature of many bakery operations exacerbates these risks, as regulatory oversight and protective measures are usually lacking (1,2). Consequently, bakery workers frequently encounter conditions that can lead to severe health issues, including heat stress, respiratory problems, and musculoskeletal disorders.

The literature extensively documents the adverse effects of occupational heat exposure. High ambient temperatures in bakeries contribute to heat stress, which can manifest through symptoms such as dehydration, heat exhaustion, and, in severe cases, heat stroke (3). Additionally, prolonged exposure to high temperatures can lead to oxidative stress, impacting hematological parameters and overall health (1). Other studies report that 23% of workers in Lebanon experience severe pain in the upper body (4). Further research indicates that bakery workers face various hazards in their work environment. These hazards can lead to occupational injuries or illnesses (5). High temperatures can cause excessive sweating among workers, and without adequate fluid replacement, workers may experience fatigue and dehydration, leading to reduced performance and productivity (6). Despite these known risks, there is a lack of comprehensive strategies to mitigate these health hazards in many informal bakery settings.

The main research problem addressed in this study is the health risks faced by bakery workers due to occupational heat exposure. These risks include heat stress-related symptoms, respiratory issues from flour dust and other allergens, and physical fatigue. Studies have highlighted the adverse effects of heat stress on bakery workers, leading to various health issues such as fatigue, heat stress-related symptoms, and impacts on hematological parameters (1,7,8). Additionally, excessive heat exposure can lead to long-term health issues, including cardiovascular disorders and internal organ damage. Heat stress, in particular, has been shown to affect hematological parameters, leading to increased oxidative stress and potential long-term health complications (2).

Bakery workers are also exposed to other occupational hazards, including physical, ergonomic, and allergenic factors. These can lead to various injuries and illnesses, such as musculoskeletal disorders, respiratory issues, and allergic reactions (9,10). Bakery workers are also at higher risk of respiratory diseases. Inhaling flour dust and exposure to wheat allergens have been linked to respiratory symptoms such as asthma and allergic rhinitis (10,11). Additionally, the physically demanding tasks required in bakery operations contribute to ergonomic health issues, exacerbating work-related fatigue and increasing the likelihood of chronic musculoskeletal problems (12). The physical demands of bakery work, including prolonged standing and exposure to high temperatures, contribute to work-related fatigue and increase the risk of occupational illnesses (13). Prolonged work-related fatigue reduces productivity and increases the risk of accidents and occupational diseases (13).

Several studies have proposed solutions to mitigate the health risks associated with bakery work. One approach focuses on improving workplace conditions through better ventilation and temperature control systems. Implementing effective heat stress management strategies, such as cooling vests and adequate hydration, has shown promise in reducing heat-related symptoms among workers (14). Additionally, periodic health monitoring and timely medical interventions can help manage the impact of heat exposure on hematological parameters (15). Heat exposure in bakeries has also been linked to oxidative DNA damage, highlighting the genetic risks associated with hot working environments (15). Oxidative DNA damage can increase the risk of genetic mutations and chronic diseases, adding to the health burden on bakery workers.

To address respiratory risks, several studies recommend using personal protective equipment (PPE) such as masks and respirators to minimize inhalation of flour dust and allergens. Regular cleaning and maintenance of bakery equipment and workspaces can also reduce the presence of airborne particles, thereby lowering the risk of respiratory issues (16). Furthermore, worker education programs focused on properly handling ingredients and the importance of PPE can enhance compliance and effectiveness (17). Ergonomic interventions, such as redesigning workstations and introducing mechanical aids for heavy lifting, are critical in addressing physical fatigue. Implementing structured work-rest schedules can also help mitigate the effects of prolonged physical exertion. Comprehensive training programs that emphasize proper lifting techniques and posture can further reduce the risk of musculoskeletal disorders (9). This study aims to determine the relationship between work stress, working climate, workload, work duration, and the incidence of work-related fatigue among bakery industry workers.

To address this, the current study adopts the Job Demands-Resources (JD-R) model as a theoretical framework. According to this model, high job demands (e.g., workload, physical effort, psychological stress) can lead to burnout or fatigue, particularly when job resources (e.g., support, rest, autonomy) are limited. In the context of informal bakery work, where both demands are high and resources scarce, this framework is particularly relevant.

While studies have examined environmental and ergonomic hazards in bakery work, few have integrated both subjective (stress) and physiological (fatigue, heart rate) assessments within a theoretical framework like the JD-R model. Moreover, evidence is lacking in low- and middle-income country (LMIC) contexts, especially in the informal sector.

Therefore, this study aims to examine the relationship between work stress, workload, working climate, and work tenure with the incidence of work-related fatigue among bakery workers in Batang Regency. To guide this investigation, we propose the following hypotheses:

H1: Higher levels of work stress are significantly associated with increased work-related fatigue.

H2: Heavier workload is significantly associated with increased work-related fatigue.

H3: Heat stress and work tenure are not significantly associated with work-related fatigue.

METHOD

This study employs a clear and systematic approach to ensure the reliability and validity of the findings. Below are the components of the methodology:

Research Type

This study applied a quantitative approach using a cross-sectional survey design. The research was conducted over a two-month period, from July to August 2022, in the bakery industry located in Batang Regency, Central Java, Indonesia. The study aimed to examine the relationship between work stress, workload, heat exposure, and work-related fatigue among bakery workers.

Population and Sample/Informants

The study population included all workers in the selected bakery industry. A total sampling technique was used to ensure broad representation and avoid selection bias. In total, 52 workers met the inclusion criteria and voluntarily participated in the study.

Research Location

The research was conducted on-site in the bakery production facilities located in Batang Regency. Observations and measurements were taken in the actual working environment to reflect real-time conditions and workload.

Instrumentation or Tools

Data collection in this study involved direct observation and field measurements. Respondent characteristics and tenure were obtained using a structured questionnaires. Work fatigue was measured using a reaction timer before and after work. A reaction timer, a tool commonly used in occupational health to measure cognitive and psychomotor performance. Measurements were taken both before and after work shifts. Previous research supports the validity of reaction timers in detecting early signs of fatigue, particularly in high-temperature environments(18). Environmental

heat exposure was measured using a Questemp series heat stress monitor, which provides Wet Bulb Globe Temperature (WBGT) readings, in accordance with Threshold Limit Values (TLV) guidelines. Physiological workload was measured using a pulse oximeter, recording heart rate before and after work. The heart rate method is a reliable indicator of physical workload and energy expenditure, often used in ergonomics and occupational physiology studies (19). Stress levels were measured using the Stress Diagnostic Survey-30 (SDS-30), a validated instrument consisting of 30 items that assess emotional, physical, and behavioral symptoms of stress. The SDS-30 has demonstrated high reliability in workplace settings (Cronbach's $\alpha > 0.80$) (18). The data collection process included direct observation and measurement of workers in their work environment to gather information on their tenure, characteristics, and work environment. Additionally, work fatigue, workload, and stress were measured using specific tools and questionnaires to ensure a comprehensive assessment of these aspects among bakery industry workers in Batang.

Data Collection Procedures

Data collection involved direct observation, field measurements, and questionnaire administration conducted during working hours. The combination of real-time physiological data and self-reported responses enabled a comprehensive assessment of the relationships between working conditions and fatigue outcomes.

Data Analysis

Data were analyzed using IBM SPSS Statistics version 25. Bivariate analysis was conducted using Fisher's Exact Test, appropriate for the categorical nature of the variables. Significance was determined at a threshold of $p < 0.05$. In addition, multivariate logistic regression analysis was employed to identify the dominant factors influencing work-related fatigue while adjusting for potential confounders. Odds ratios (Exp(B)) and 95% confidence intervals were reported to assess the strength of associations.

Ethical Approval

Ethical considerations were paramount in this research, with the Research Ethics Committee of the Faculty of Public Health, Universitas Diponegoro, providing ethical approval with reference number 142/EA/KEPK-FKM/2022, demonstrating adherence to strict ethical standards throughout the study. This approval underscored the researchers' commitment to ethical research practices and dedication to upholding the highest standards of integrity in their work.

RESULTS

Respondents' Characteristics

The demographic and occupational characteristics of the 52 respondents are presented in Table 1. The majority were young adults (90.4%), with only 9.6% classified as older workers. Male respondents comprised 67.3% of the sample, while females accounted for 32.7%. Work tenure was nearly evenly distributed, with 48.1% being new workers and 51.9% having long service durations.

Table 1. Baseline characteristics of respondents (n=52)

No	Variable	n	%
1	Age (years)		
	Young	47	90.4
	Old	5	9.6
2	Gender		
	Male	35	67.3
	Female	17	32.7
3	Years of service		
	New	25	48.1
	Long	27	51.9
4	Education Level		

	Undergraduate	1	1.9
	Senior High School	34	65.4
	Junior High School	13	25.0
	Elementary School	3	5.8
	Uneducated	1	1.9
5	BMI		
	Severe underweight	3	5.8
	Mild Underweight	7	13.5
	Normal	34	65.4
	Overweight	3	5.8
	Obesity	5	9.6
6	Occupational Stress		
	Did not experience stress	33	63.5
	Mild stress	13	25.0
	Severe stress	6	11.5
7	Heat Stress		
	< TLV	43	82.7
	<TLV	9	17.3
8	Workload		
	Light workloads	24	46.2
	Moderate workloads	24	46.2
	Heavy workloads	4	7.7

Source: Primary Data

Most respondents had completed secondary education (65.4%), followed by junior high school (25%), while a small number had elementary education or lower. Only 1.9% of the respondents held a university degree. In terms of nutritional status, most respondents had a normal BMI (65.4%), though 19.3% were underweight, and 15.4% were overweight or obese.

Regarding occupational conditions, 63.5% of respondents did not report work stress, while 25% experienced mild stress and 11.5% experienced severe stress. Most workers (82.7%) operated under acceptable heat stress conditions (below TLV), and workload levels were predominantly light or moderate (each at 46.2%), with only 7.7% experiencing heavy workloads.

Multivariate Analysis

The results of the multivariate analysis are presented in Table 2, highlighting the relationship between stress levels, work climate, workload, and tenure with work-related fatigue among bakery workers. The table shows the distribution of respondents across different categories and the associated statistical values.

Table 2. Multivariate Analysis Results

No	Variable	Category	n (%)	B	Wald	Sig.	Exp (B)	95% C.I for EXP(B)	
								Lower	Upper
1	Level of Stress	Did not experience stress	26 (50)	1.065	3.936	.047*	2.901	1.013	8.311
		Mild stress	20 (38.5)						
		Severe stress	6 (11.5)						
2	Heat Stress	< TLV	43 (82.7)	1.888	2.302	.129	6.608	.576	75.775
		>TLV	9 (17.3)						
3	Workload	Light workloads	31 (51.6)	2.246	7.393	.007*	9.446	1.872	47.670
		Heavy workloads	21 (40.4)						
4	Years of service	New	25 (48.1)	.842	1.344	.246	2.320	.559	9.624
		Long	27 (51.9)						

Source: Primary Data

Based on the results of the multivariate analysis, it was found that work stress levels are associated with the incidence of work-related fatigue (p = 0.047; OR = 2.901; CI 95% = 1.013-8.311), indicating that work stress is a risk factor for work-related fatigue among bakery workers. Workers experiencing work stress have a 2.901 times higher risk of experiencing work-related fatigue compared to workers without work stress. Workers experiencing severe stress (6%) are more likely to report work-related fatigue compared to workers experiencing mild stress (20%) and no stress (26%). This suggests that working conditions causing severe stress can impact work-related fatigue.

Similarly, workload showed a strong and significant association with work-related fatigue (p = 0.007; OR = 9.446; CI 95% = 1.872-47.670), indicating that workload is a risk factor for work-related fatigue among bakery workers. Workers with high workloads have a 9.446 times higher risk of experiencing work-related fatigue compared to those without work stress. Workers with heavy workloads (21%) are more likely to report health complaints than those with lighter workloads (31%). This suggests that high workloads can affect work-related fatigue.

By contrast, heat stress not significantly associated with the incidence of work-related fatigue but is a risk factor for work-related fatigue (p = 0.129; OR = 6.608; CI 95% = 0.576-75.775). Likewise, work tenure is not significantly associated with the incidence of work-related fatigue but is a risk factor for work-related fatigue (p = 0.246; OR = 2.320; CI 95% = 0.559-9.624). Additionally, working posture is not a risk factor for work-related fatigue (p = 0.196; OR = 0.371; CI 95% = 0.083-1.668). Workers who feel comfortable with their work environment (43%) are likelier to report work-related fatigue complaints than those who feel uncomfortable (9%). This suggests that a positive work environment can influence work-related fatigue. Although their odds ratios suggest they may still function as contributory risk factors. Notably, the wide confidence intervals indicate potential variability and warrant further investigation with larger samples.

Regarding work of service, new workers (25%) are more likely to report work-related fatigue complaints compared to those with more work experience (27%). New workers may have difficulty adjusting to work conditions, potentially impacting their work-related fatigue.

These findings emphasize that psychosocial and physical workload demands, rather than environmental or tenure-related factors alone, are the primary drivers of fatigue in this population. This aligns with the Job Demands-Resources model, which posits that fatigue emerges when high job demands are not counterbalanced by adequate resources.

DISCUSSION

Work stress and work-related fatigue among Bakery Workers

The study results indicate that stress levels are significantly related to work fatigue. Specifically, workers experiencing mild and severe stress are likelier to report work fatigue than those who do not experience stress (Exp(B) = 2.901, p = 0.047). This finding is consistent with the literature emphasizing the impact of psychological stress on physical fatigue and overall well-being (9). Stress can increase muscle tension, accelerate fatigue, and reduce workers' ability to perform tasks effectively. Stress is the inability to cope with threats faced by an individual's mental, physical, emotional, and spiritual aspects, which can ultimately affect health (19).

This relationship is also well-explained by the Job Demands–Resources (JD-R) model, which posits that excessive job demands such as emotional pressure or cognitive overload contribute to fatigue when not balanced by adequate resources such as support or control over work tasks. In informal bakery settings where support systems and stress-coping resources are often minimal, this imbalance becomes more pronounced.

These findings emphasize the need for stress management interventions that are context-sensitive. Practical strategies include providing access to mental health counseling, conducting regular stress assessments, and training supervisors to identify early signs of psychological strain. In resource-limited informal sectors, even low-cost peer-support programs can be effective in mitigating chronic work stress.

Workload and work-related fatigue among Bakery Workers

Heavy workload shows a very significant relationship with work fatigue, where workers with a heavy workload have almost ten times the risk of experiencing fatigue compared to those with a light workload. The significant relationship between stress levels and work fatigue (Exp(B) = 2.901, p = 0.047) highlights the need for effective stress management strategies in the workplace. Implementing mental health support and stress reduction programs can mitigate the adverse effects of stress on workers' physical health and productivity. Additionally, the

strong relationship between heavy workload and fatigue (Exp(B) = 9.446, p = 0.007) indicates that addressing workload through ergonomic interventions and efficient task distribution is crucial to reducing physical strain and preventing fatigue. Similarly, workers with a heavy workload are significantly more likely to experience work fatigue than those with a light workload (Exp(B) = 9.446, p = 0.007).

Workload is a risk factor for work fatigue. Workload measurement can be done based on psychological and physiological aspects. Heart rate is a measure of workload based on muscle movement. Heart rate can be used to measure the physical condition of workers as a basis for the level of fatigue experienced by a worker. The greater the fluctuation in heart rate, the greater the workload of an individual. In the long term, this excessive workload impacts productivity reduction due to work fatigue (20). Physical workload had an indirect effect through stress at work to the fatigue and had an indirect effect through work capacity to the fatigue (21). Furthermore, the JD-R model reinforces this finding by classifying physical demands as a primary "job demand" capable of depleting energy and causing strain if not moderated by "resources" such as adequate rest breaks, mechanical aids, or task rotation.

Workload measurement in this study used the pulse rate method with a pulse oximeter measured twice in the morning before work and the afternoon after work. Although only a small proportion (7.7%) of respondents fell into the "heavy workload" category, the risk magnitude underscores the urgent need for ergonomic interventions. Workstation redesign, structured work-rest cycles, and employee education on energy conservation techniques could help minimize excessive physical strain and extend productivity. Meanwhile, the majority of respondents worked with light and moderate workloads. Based on the result was p-value = 0.976 (> 0.05). It can be concluded that there is no relationship between workload and work fatigue among the respondents. This is consistent with Innah's 2021 study, which stated that there is no significant relationship between workload and work fatigue among tailors at Pasar Sentral Bulukumba (22).

In this study, most respondents felt a light to moderate workload. Each workload should match the worker's physical, cognitive, and human limitations. The severity of the workload can determine how long a worker can perform their tasks with their abilities. The heavier the workload, the shorter the work time without fatigue and physiological disturbances. Working in a bakery is associated with exposure to physical workload during the bakery product-making process, affecting the risk of work-related musculoskeletal disorders (WMSDs) (23,24).

These findings highlight the importance of workload management in preventing work fatigue. Excessive workload can cause rapid physical fatigue, reduce work efficiency, and increase the risk of injury. Therefore, appropriate ergonomic interventions, efficient task distribution, and continuous workload assessment are necessary to ensure workers are not overburdened and can work optimally.

Heat stress and work-related fatigue among Bakery Workers

Conversely, work climate and tenure did not significantly correlate with work fatigue in this analysis. Although workers in an unsuitable work climate were more likely to report fatigue (Exp(B) = 6.608), this finding was not statistically significant (p = 0.129). Similarly, tenure (new vs. long-term) did not significantly predict work fatigue (Exp(B) = 2.320, p = 0.246). While the results indicate that workers in an unsuitable work climate have a higher risk of experiencing work fatigue, this finding was not statistically significant. This may be due to variations in individual perceptions of the work climate or other more dominant factors influencing work fatigue.

These results align with Andani's 2016 study, which found no significant relationship between temperature and fatigue among employees at PT. X in Jakarta (25). However, the work climate is a risk factor for work fatigue among bakery workers. This may occur because, in addition to hot air temperatures, many other factors can contribute to fatigue, such as workload, rest periods, and food and water consumption. Another reason is that workers are accustomed to working in hot temperatures, so they do not feel the difference between working in normal or abnormal temperatures. Habib et al.'s research also found that the work climate is a risk factor for fatigue (8).

Bakery workers are exposed to heat stress in the work environment, leading to various outcomes ranging from relatively mild heat cramps to heat stroke (26,27). The body quickly fatigues when the air temperature is very hot because it naturally generates heat. If the environmental heat continues to increase, it can accelerate the metabolic process, causing the body to become fatigued more quickly. Heat stress experienced by workers occurs when the body temperature exceeds 38°C, resulting in health symptoms such as dry skin, chills, high body temperature, confusion, dizziness, fainting, fatigue, weakness, nausea, and muscle cramps (8,28). Therefore, these findings suggest

that while improving the work climate is important, it may need to be combined with other, more direct interventions related to workload and stress management to reduce work fatigue effectively.

The correlation between work of service and work fatigue among Bakery Workers

Based on the research results, the p-value = 0.177, indicating that work of service does not show a significant relationship with work fatigue in this study. This may suggest that longer work experience does not automatically reduce the risk of work fatigue or that new and long-term workers face different but equal challenges in their jobs. Other factors, such as individual adaptation, physical fitness levels, and social support in the workplace, may play a larger role in influencing work fatigue than tenure itself. This is consistent with Innah's 2021 study, which found no significant relationship between tenure and work fatigue among tailors at Pasar Sentral Bulukumba (22).

In this study, the majority of respondents had long tenures, which may determine their skill levels and comfort with their jobs, reducing their experience of fatigue. Tenure tends to help workers adapt and feel comfortable in their new environment. This can occur because long tenures are not only related to work experience but must also be balanced with an individual's mental maturity, leading to both positive and negative impacts from long tenures. Additionally, tenure only describes the length of time a person has worked.

Workers with longer tenures provide positive influences through extensive experience in their jobs, making it easier for them to address any problems that arise at work quickly. Conversely, longer tenures can have negative influences if the work is done continuously or tends to be monotonous, leading to feelings of boredom or dissatisfaction (29).

Implications for Practice

The findings highlight that psychological stress and workload are the most salient drivers of fatigue in informal bakery settings. Interventions should therefore focus on these two domains as priorities. For instance:

Stress reduction: Establishing simple mental health check-ins and providing informal counseling could improve coping capacity. Workload adjustment: Introducing mechanical aids for lifting, improving production line layout, and allowing brief rest breaks may reduce fatigue levels significantly.

Given the informal nature of these workplaces, such interventions should be low-cost, easy to implement, and adaptable to worker needs. Local governments or community health workers can play a vital role in supporting such initiatives.

Limitations and Cautions

The limitations of this study are: 1) this study uses a cross-sectional design, which only captures the data at one point in time, it is impossible to identify changes in work related fatigue; 2) this study only include small sample size (n=52) limits the generalizability of the findings to broader populations or different informal labor contexts.

Recommendations for Future Research

To strengthen the evidence base, future studies should adopt longitudinal designs to track fatigue progression and causal mechanisms over time. Expanding the sample to include diverse informal industries will also help develop more context-specific interventions. Additionally, integrating qualitative approaches could uncover deeper insights into workers' lived experiences and coping strategies.

CONCLUSION

This study confirms that psychological stress and physical workload are significantly associated with work-related fatigue among bakery workers in Batang, Indonesia. These findings underscore the urgent need for integrated interventions that address both mental and physical demands in informal work settings.

While heat stress and work tenure were not statistically significant predictors of fatigue, their elevated risk estimates suggest they may still contribute under certain conditions and should not be overlooked entirely. The study reinforces the relevance of the Job Demands–Resources (JD-R) model, highlighting how high job demands, in the absence of adequate resources, contribute to worker fatigue even in informal labor systems.

To mitigate these risks, practical interventions such as stress management education, peer-support mental health initiatives, ergonomic task redesign, and structured rest breaks should be prioritized. These measures can be adapted to low-resource bakery environments with minimal cost but meaningful impact.

Future studies should consider using longitudinal or mixed-method designs to explore causal pathways, include larger and more diverse populations, and investigate the role of coping mechanisms and organizational support systems. Such approaches will help inform more effective and context-sensitive fatigue management strategies in informal labor sectors.

AUTHOR'S CONTRIBUTION STATEMENT

The contribution of each authors are: YS wrote entire original draft; EK contributed to methodology design and data analysis; IW provided data for discussion and data analysis; HMD: data analysis and manuscript editing, DLS: manuscript editing and data analysis.

CONFLICTS OF INTEREST

No author of this paper has a conflict of interest, including specific financial interests, relationships, and/or affiliations relevant to the subject matter or materials included in this manuscript.

DECLARATION OF GENERATIVE AI AND AI-ASSISTED TECHNOLOGIES IN THE WRITING PROCESS

During the preparation of this work, the authors used ChatGPT to enhance the clarity of the writing. After using the tool, they reviewed the output to ensure the accuracy and integrity of the content. The authors acknowledge that while ChatGPT assisted in improving the writing, the final responsibility for the content lies with them

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