

Anxiety, fatigue, physiological stress, and safety behavior among free nutritious meal kitchen workers: A cross-sectional study in Majene, Indonesia

Kecemasan, kelelahan, stres fisiologis, dan perilaku keselamatan di kalangan pekerja dapur makanan bergizi gratis: Studi potong lintang di Majene, Indonesia

Rizky Maharja^{*1}, Yusniar Anggraeny², Bambang Hermawan³, Jihan Faradisha⁴,
Andi M. F. Panggeleng⁵, Ade W. L. Latief⁶

^{1, 2, 3, 5} Department of Occupational Safety and Health, Faculty of Health Sciences, Universitas Sulawesi Barat, Majene, Indonesia

⁴ Department of Occupational Safety and Health, Vocational School, Universitas Sebelas Maret, Surakarta, Indonesia

⁶ Department of Industrial Hygiene, Occupational Health and Safety, Sekolah Tinggi Ilmu Kesehatan Makassar, Makassar, Indonesia

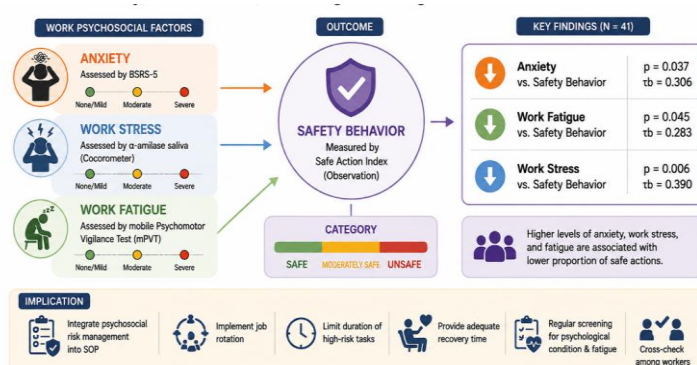
Abstract

The Free Nutritious Meal (Makan Bergizi Gratis [MBG]) Program is a major initiative to strengthen human capital in Indonesia, yet evidence on psychosocial and physiological factors influencing kitchen workers' safety behavior remains limited, making this study novel in integrating psychological, physiological, neurobehavioral, and observational measures. This cross-sectional analytical study examined the relationships of anxiety, physiological work stress, and work fatigue with safety behavior among MBG kitchen workers in Majene, Indonesia. Forty-one of 50 workers from one MBG kitchen were selected using purposive sampling. Anxiety was assessed using the BSR5-5, physiological stress through salivary α -amylase measured with a Cocorometer, fatigue using a mobile Psychomotor Vigilance Test, and safety behavior through direct observation using the Safe Behavior Index. Kendall's Tau-b was used for bivariable analysis. Most participants were female (63.4%), aged 26–35 years (56.1%), worked >8 hours/day (53.7%), and had 6–12 months of employment (80.5%). Anxiety was significantly associated with safety behavior ($\tau_b = 0.306$; $p = 0.037$), as were fatigue ($\tau_b = 0.283$; $p = 0.045$) and physiological stress ($\tau_b = 0.390$; $p = 0.006$). Higher levels of these factors were associated with less safe behavior. These findings support integrating psychosocial risk management, fatigue control, recovery periods, worker rotation, periodic screening, and peer cross-checking into MBG occupational safety procedures to strengthen worker protection and program sustainability.

Abstrak

Program Makan Bergizi Gratis (MBG) merupakan salah satu inisiatif utama untuk memperkuat kualitas sumber daya manusia di Indonesia, namun bukti mengenai faktor psikososial dan fisiologis yang memengaruhi perilaku keselamatan pekerja dapur masih terbatas. Penelitian ini memiliki kebaruan karena mengintegrasikan pengukuran psikologis, fisiologis, neurobehavioral, dan observasional. Studi analitik dengan desain *cross-sectional* ini bertujuan menganalisis hubungan kecemasan, stres kerja fisiologis, dan kelelahan kerja dengan perilaku keselamatan pada pekerja dapur MBG di Majene, Indonesia. Sebanyak 41 dari 50 pekerja pada satu dapur MBG dipilih menggunakan teknik *purposive sampling*. Kecemasan diukur menggunakan BSR5-5, stres fisiologis melalui α -amilase saliva menggunakan Cocorometer, kelelahan melalui *mobile Psychomotor Vigilance Test*, dan perilaku keselamatan melalui observasi langsung menggunakan *Safe Behavior Index*. Analisis bivariat menggunakan Kendall's Tau-b. Sebagian besar responden adalah perempuan (63,4%), berusia 26–35 tahun (56,1%), bekerja >8 jam/hari (53,7%), dan memiliki masa kerja 6–12 bulan (80,5%). Kecemasan berhubungan signifikan dengan perilaku keselamatan ($\tau_b = 0,306$; $p = 0,037$), demikian pula kelelahan ($\tau_b = 0,283$; $p = 0,045$) dan stres fisiologis ($\tau_b = 0,390$; $p = 0,006$). Tingkat kecemasan, kelelahan, dan stres yang lebih tinggi cenderung berkaitan dengan perilaku yang kurang aman. Temuan ini mendukung integrasi manajemen risiko psikososial, pengendalian kelelahan, waktu pemulihan, rotasi kerja, skrining berkala, dan pemeriksaan silang antarpekerja ke dalam prosedur keselamatan kerja MBG guna memperkuat perlindungan pekerja dan keberlanjutan program.

Graphical Abstract



Keyword

anxiety; fatigue; occupational stress; program evaluation; risk management

Artikel History

Submitted : 29 June 2026
In Reviewed : 30 July 2026
Accepted : 30 August 2026
Published : 31 August 2026

Correspondence

Jl. Baharuddin Lopa, Tande, Banggae
Timur, Majene Regency, West Sulawesi
91413, Indonesia
✉ rizkymaharja@unsulbar.ac.id



©2026 The Authors

This is an Open Access article distributed under the terms of the Creative Commons Attribution License (<https://creativecommons.org/licenses/by-nc-sa/4.0/>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

INTRODUCTION

Human capital development is fundamental to sustainable national progress, and adequate nutrition is central to producing a healthy, cognitively capable, and productive population (Hassen et al., 2026; Yakubu et al., 2026). In Indonesia, the Free Nutritious Meal (*Makan Bergizi Gratis* [MBG]) Program is a strategic national initiative intended to improve nutritional intake, particularly among school-aged children, while supporting the long-term vision of Indonesia Emas 2045. The program may also strengthen local food systems through the participation of micro, small, and medium enterprises (Shiddiq & Effendi, 2025). Its implementation depends substantially on kitchen workers responsible for menu preparation, food procurement, processing, portioning, and distribution. Protecting their health and safety is therefore essential to food-service quality, operational continuity, and program sustainability. This priority aligns with Sustainable Development Goal (SDG) 3 on health and well-being and SDG 8, particularly Target 8.8 on safe and secure working environments.

Institutional and mass-production kitchens are demanding work environments characterized by physical, ergonomic, organizational, and psychosocial hazards. Workers routinely encounter hot surfaces and liquids, open flames, steam, sharp utensils, wet floors, electrical equipment, repetitive movements, manual handling, prolonged standing, and heat exposure under high production volumes and strict deadlines (Wassif et al., 2024; Garcia-Gomes et al., 2024; Rey-Merchán & López-Arquillos, 2026). A study of 1,909 kitchen workers in Korea showed that intensive manual work, repetitive movements, non-ergonomic postures, long working hours, and inadequate rest increased the risk of work-related musculoskeletal disorders, particularly among women (Park et al., 2021). These conditions indicate that occupational safety in MBG kitchens should address not only physical hazards but also workers' psychological and physiological capacity to perform tasks safely.

Safety behavior is particularly important in kitchen environments because injuries may occur during routine interaction with knives, hot surfaces, ovens, stoves, electrical equipment, heavy loads, and slippery areas. Unsafe behaviors such as rushing, distraction, inadequate use of personal protective equipment, poor communication, and normalization of hazards can increase the likelihood of cuts, burns, falls, and other incidents. Behavioral interventions, including focused safety training, verbal safety communication, and interactive learning, have been

shown to improve hazard awareness and safer practices in kitchen and comparable occupational settings (Saad et al., 2022; Anderson et al., 2023; Atagbuzia et al., 2024). Comprehensive risk assessment, ergonomic improvement, management commitment, and sustained behavioral training are therefore important for accident prevention (Saad et al., 2024; Abebaw et al., 2024).

Psychosocial hazards commonly arise from high workload, prolonged or irregular working hours, production deadlines, repetitive tasks, limited recovery, staffing constraints, and pressure to meet service targets (Sorensen et al., 2021). These demands may produce psychological strain and cumulative fatigue, particularly when opportunities for rest are insufficient. Qualitative evidence shows that time pressure may become closely linked with bodily exhaustion and normalized endurance despite sustained strain (Yemişçi et al., 2026). Repetitive work and prolonged standing have also been associated with musculoskeletal complaints among kitchen workers, illustrating how organizational demands can translate into both psychological and physical consequences (Abebaw et al., 2024).

Anxiety is particularly relevant because it can alter cognitive processes required for safe performance. Increased anxiety may heighten perceived risk while reducing attentional capacity, concentration, and working memory needed for hazard detection and sequential task execution (Coventry, 2022; Wang et al., 2022). Under time pressure, anxiety may also bias decision-making toward rapid and less deliberative responses, reducing the ability to evaluate hazards and follow safe procedures consistently (Shi et al., 2023; Okan & Hallquist, 2025). Field evidence from high-risk workplaces further suggests that anxiety is associated with unsafe actions and lower safety compliance, although these relationships may be influenced by safety climate and managerial support (Guo et al., 2025). Emotional exhaustion and ineffective risk communication may further impair risk perception and adaptive responses (Yang et al., 2022).

Fatigue and physiological stress may further compromise safety behavior by reducing vigilance, slowing responses, and impairing sustained attention. In high-throughput kitchens, these effects are particularly important because workers must coordinate multiple tasks while maintaining speed and accuracy. Psychomotor vigilance provides an objective indicator of reduced alertness, whereas salivary α -amylase can serve as a non-invasive physiological indicator of sympathetic stress responses. Combining

psychological, physiological, and behavioral measurements may therefore provide a more comprehensive assessment of worker safety than relying solely on self-reported stress or accident history.

Despite the strategic importance of MBG workers, evidence regarding psychosocial and physiological factors associated with their safety behavior remains limited. Previous kitchen studies have predominantly examined physical hazards, musculoskeletal complaints, ergonomics, safety practices, or general psychosocial working conditions (Park et al., 2021; Sorensen et al., 2021; Abebaw et al., 2024). Few studies have simultaneously evaluated anxiety, objectively measured physiological stress, fatigue-related vigilance, and directly observed safety behavior among workers engaged in large-scale nutritious meal preparation.

Accordingly, this study addresses this gap among MBG kitchen workers in Majene, Indonesia. Its novelty lies in integrating psychological, physiological, neurobehavioral, and observational measures within a single occupational safety assessment: anxiety using the Brief Symptom Rating Scale-5 (BSRS-5), physiological stress using salivary α -amylase measured with a Cocorometer, fatigue using a mobile Psychomotor Vigilance Test, and safety behavior through direct observation using the Safe Behavior Index. Using a cross-sectional analytical design, this study aimed to analyze the relationships of anxiety, physiological stress, and fatigue with safety behavior among MBG kitchen workers. The findings are expected to support occupational health and safety management within the MBG Program through integration of psychosocial risk assessment, fatigue management, and behavioral safety strategies.

METHODS

Study design and setting

This study employed an analytical observational design with a cross-sectional approach to examine the relationships of anxiety, physiological work stress, and work fatigue with safety behavior among workers in the Free Nutritious Meal (*Makan Bergizi Gratis* [MBG]) Program in Majene, Indonesia. The target population comprised all MBG kitchen workers in Majene. However, in accordance with the research authorization granted for data collection, the study was conducted at one MBG kitchen employing 50 workers.

Population, sample, and sampling technique

Participants were selected using purposive sampling. Of the 50 workers at the selected kitchen, 41 met the study criteria, agreed to participate, and were included in the analysis. Eligible participants were active MBG kitchen workers at the selected site, available during the data-collection period, and willing to provide informed consent. Participation was voluntary.

Study variables and data collection

The study variables were anxiety, physiological work stress, work fatigue, and safety behavior. Data were collected using a combination of questionnaires, physiological measurements, psychomotor reaction-time testing, and direct behavioral observation. Anxiety, physiological stress, and fatigue were measured once between 10:00 and 15:00 Central Indonesia Time (WITA), whereas safety behavior was observed during routine kitchen activities over two working days.

Anxiety assessment

Anxiety was assessed using the *Brief Symptom Rating Scale-5* (BSRS-5). The instrument consists of five items assessing psychological symptoms related to tension or anxiety, depression, irritability, feelings of inferiority, and sleep disturbance. Responses were summed to obtain a total score ranging from 0 to 20. Scores were classified as normal (0–5), mild anxiety (6–9), moderate anxiety (10–14), and severe anxiety (15–20).

Physiological work stress assessment

Physiological work stress was assessed objectively using salivary α -amylase (α -amylase) activity measured with a Cocorometer. Salivary α -amylase was used as a physiological indicator of the stress response (Vaswani et al., 2020). A saliva test strip was placed beneath the participant's tongue for 30 seconds and subsequently analyzed using the Cocorometer according to the standardized measurement procedure. The resulting salivary α -amylase concentration was expressed in kU/L and categorized as no stress symptoms (0–30 kU/L), initial stress (30–45 kU/L), stress (45–60 kU/L), and severe stress (>60 kU/L).

Work fatigue assessment

Work fatigue was assessed objectively using a mobile Psychomotor Vigilance Test (mPVT). The test measured participants' reaction times to visual stimuli

Table 1
Characteristics of Study Participants (N = 41)

Characteristic	n	%
Sex		
Male	15	36.6
Female	26	63.4
Age group (years)		
16–25	5	12.2
26–35	23	56.1
36–45	5	12.2
≥46	8	19.5
Educational attainment		
Primary school	5	12.2
Junior high school	3	7.3
Senior high school/vocational/Islamic senior high school	18	43.9
Diploma I–III	1	2.4
Diploma IV/Bachelor's degree	14	34.1
Daily working hours		
≤8 hours/day	19	46.3
>8 hours/day	22	53.7
Job tenure		
0–5 months	8	19.5
6–12 months	33	80.5

Note: Data are presented as frequency (n) and percentage (%). Diploma IV is considered equivalent to an applied bachelor's degree in Indonesian higher education system.

presented 20 times at unpredictable intervals. Mean reaction time was automatically generated upon completion of the test and used as an indicator of fatigue-related reduction in vigilance.

Mean reaction times were classified as normal (0–240 ms), mild fatigue (240–410 ms), moderate fatigue (410–580 ms), and severe fatigue (>580 ms). Higher reaction times indicated greater impairment in psychomotor vigilance and a higher level of work fatigue.

Safety behavior assessment

Safety behavior was measured using the *Safe Behavior Index* (SBI) through direct observation with a *Critical Behavior Checklist* (CBC) adapted from the behavior-based safety approach developed by Geller (Moon, 2024). Observations were conducted during routine MBG kitchen activities over two working days.

The behavioral indicators included appropriate use of personal protective equipment, working while ill, handwashing before work, rushing during tasks, excessive manual lifting, using chairs as substitutes for ladders, stacking materials excessively high, adopting non-ergonomic working postures, compliance with work procedures, joking during work, using mobile phones while working, using equipment according to its intended function and procedures, maintaining a safe and orderly work area, and appropriately addressing unsafe conditions. For each observed worker, safe and unsafe acts were recorded. The SBI was calculated using the following Formula 1:

$$SBI (\%) = \frac{\text{Number of safe acts}}{\text{Number of safe acts} + \text{Number of unsafe acts}} \times 100 \dots\dots\dots (1)$$

The Safe Behavior Index (SBI) percentage was calculated based on the observation results and subsequently classified into three categories: safe (≥85%), moderately safe (60–84.9%), and unsafe (≤59.9%). This classification has been applied in previous occupational safety studies using the Safe Behavior Index to evaluate workers' safety behavior (Rahman & Dwiyantri, 2020; Agustin & Dwiyantri, 2023).

Data analysis

All study variables were treated as ordinal variables for inferential analysis. Univariable analysis was used to describe participant characteristics and study variables using frequencies and percentages, supplemented by means and standard deviations where appropriate. Bivariable analysis was performed using Kendall's Tau-b correlation to examine the relationships of anxiety, physiological work stress, and work fatigue with safety behavior. Statistical significance was determined at $p < 0.05$.

Ethical considerations

Ethical approval was obtained from the Research Ethics Committee of the Faculty of Health Sciences, Universitas Sulawesi Barat with no. 01-10.a/KEPK FIKES/2026. All participants received information regarding the study objectives, procedures, confidentiality, voluntary participation, and

Table 2

Distribution of study variables among mbg kitchen workers (n = 41)

Variable	n	%	Mean	SD
Anxiety			2.15	0.937
Normal	15	36.6		
Mild	5	12.2		
Moderate	21	51.2		
Work fatigue			2.88	1.077
Normal	5	12.2		
Mild	11	26.8		
Moderate	9	22		
Severe	16	39		
Physiological work stress			1.88	1.187
No stress symptoms	24	58.5		
Initial stress	5	12.2		
Stress	5	12.2		
Severe stress	7	17.1		
Safety behavior			1.44	0.709
Safe	28	68.3		
Moderately safe	8	19.5		
Unsafe	5	12.2		

Note: Data are presented as frequency (n), percentage (%), mean, and standard deviation (SD). Anxiety was assessed using the BSRS-5; work fatigue using the mobile Psychomotor Vigilance Test; physiological work stress using salivary α -amylase; and safety behavior using the Safe Behavior Index.

their right to withdraw at any time without consequences. Informed consent was obtained before data collection, and participant information was kept confidential throughout the study

RESULTS

Table 1 present that the characteristics of the 41 respondents showed that most were female, accounting for 26 participants (63.4%). In terms of age, the majority were 26–35 years old (56.1%). Regarding educational attainment, the largest proportion had completed senior high school/vocational high school/Islamic senior high school (SMA/SMK/MA), comprising 18 respondents (43.9%). With respect to daily working hours, 22 respondents (53.7%) worked for more than 8 hours per day. Meanwhile, based on length of employment, most respondents had worked for 6–12 months, comprising 33 individuals (80.5%). Overall, the respondents were predominantly female, of productive age (26–35 years), had an upper-secondary educational background, tended to work more than 8 hours per day, and had relatively short job tenure.

Table 2 shows that most respondents had moderate anxiety, accounting for 21 individuals (51.2%). In addition, 16 respondents (39.0%) experienced severe fatigue, 24 respondents (58.5%) showed no symptoms of work stress, and 28 respondents (68.3%) demonstrated safe behavior.

Based on Table 3, among respondents with normal anxiety levels, 12 individuals (80.0%) were categorized as having safe behavior, while 3

individuals (20.0%) were categorized as moderately safe. Among respondents with mild anxiety, all five individuals (100%) were categorized as having safe behavior. In contrast, among respondents with moderate anxiety, 11 individuals (52.4%) were categorized as safe, while 5 individuals (23.8%) were categorized as moderately safe and 5 individuals (23.8%) as unsafe.

This distribution indicates that respondents with moderate anxiety had the lowest proportion of safe behavior (52.4%) and the highest proportion of unsafe behavior (23.8%) compared with those with normal or mild anxiety. Statistical analysis showed a p-value of 0.037 ($p < 0.05$), indicating a significant association between anxiety and safety behavior. In addition, the positive correlation coefficient (+0.306) indicates that higher levels of anxiety tended to be associated with a greater distribution toward less safe behavior categories. The strength of the association was weak to moderate.

Table 3 show that among respondents with normal fatigue levels, 4 individuals (80.0%) were categorized as safe and 1 individual (20.0%) as moderately safe. Among those with mild fatigue, 9 individuals (81.8%) were categorized as safe and 2 individuals (18.2%) as moderately safe. Among respondents with moderate fatigue, 7 individuals (77.8%) were categorized as safe, 1 individual (11.1%) as moderately safe, and 1 individual (11.1%) as unsafe.

Table 3
Associations of anxiety, work fatigue, and physiological stress with safety behavior among MBG kitchen workers

Variable	Category	Safe (%)	Moderately safe (%)	Unsafe (%)	Total (%)	Kendall's τ_b	p-value	95% CI
Anxiety	Normal	12 (80.0)	3 (20.0)	0 (0.0)	15 (100.0)	0.306	0.037	0.025–0.529
	Mild	5 (100.0)	0 (0.0)	0 (0.0)	5 (100.0)			
	Moderate	11 (52.4)	5 (23.8)	5 (23.8)	21 (100.0)			
Work fatigue	Normal	4 (80.0)	1 (20.0)	0 (0.0)	5 (100.0)	0.283	0.045	0.012–0.519
	Mild	9 (81.8)	2 (18.2)	0 (0.0)	11 (100.0)			
	Moderate	7 (77.8)	1 (11.1)	1 (11.1)	9 (100.0)			
	Severe	8 (50.0)	4 (25.0)	4 (25.0)	16 (100.0)			
Physiological work stress	No stress symptoms	20 (83.3)	4 (16.7)	0 (0.0)	24 (100.0)	0.39	0.006	0.079–0.676
	Initial stress	3 (60.0)	1 (20.0)	1 (20.0)	5 (100.0)			
	Stress	1 (20.0)	3 (60.0)	1 (20.0)	5 (100.0)			
	Severe stress	4 (57.1)	0 (0.0)	3 (42.9)	7 (100.0)			

Note: Values are presented as frequency and percentage, n (%). Associations were assessed using Kendall's Tau-b (τ_b). Positive coefficients indicate that increasing anxiety, fatigue, or physiological stress levels were associated with a shift toward less safe behavior categories. CI = confidence interval; MBG = Makan Bergizi Gratis (Free Nutritious Meal). Statistical significance was defined as $p < 0.05$.

Among respondents with severe fatigue, 8 individuals (50.0%) were categorized as safe, 4 individuals (25.0%) as moderately safe, and 4 individuals (25.0%) as unsafe. Statistical analysis yielded a p-value of 0.045 ($p < 0.05$), indicating a significant association between work fatigue and safety behavior. The positive correlation coefficient (+0.283) indicates that greater work fatigue tended to be associated with a greater distribution toward less safe behavior categories. The strength of the association was weak.

Table 3 present that among respondents with no symptoms of work stress, 20 individuals (83.3%) were categorized as safe and 4 individuals (16.7%) as moderately safe. In the early-stage stress group, 3 individuals (60.0%) were categorized as safe, while 1 individual (20.0%) was categorized as moderately safe and 1 individual (20.0%) as unsafe. In the stress group, only 1 individual (20.0%) was categorized as safe and 1 individual (20.0%) as unsafe, while 3 individuals (60.0%) were categorized as moderately safe. Among respondents with severe stress, 4 individuals (57.1%) were categorized as safe and 3 individuals (42.9%) as unsafe.

Statistical analysis showed a p-value of 0.006 ($p < 0.05$), indicating a significant association between work stress and safety behavior. In addition, the positive correlation coefficient (+0.390) indicates that higher levels of work stress tended to be associated with a greater distribution toward less safe behavior categories. The strength of the association was moderate.

DISCUSSION

The This study demonstrated significant associations of anxiety, work fatigue, and physiological stress with safety behavior among Free Nutritious Meal (*Makan Bergizi Gratis* [MBG]) kitchen workers in Majene, Indonesia. Higher levels of anxiety, fatigue, and stress were consistently accompanied by a greater distribution toward less safe behavior categories, although the strength of these associations ranged from weak to moderate. Physiological stress showed the strongest relationship with safety behavior (Kendall's Tau-b = 0.390; $p = 0.006$), followed by anxiety ($\tau = 0.306$; $p = 0.037$) and fatigue ($\tau = 0.283$; $p = 0.045$). These findings indicate that worker safety in high-demand food-production environments is influenced not only by equipment, procedures, and physical hazards but also by workers' psychological and physiological capacity to maintain attention, judgment, and procedural compliance.

Anxiety and safety behavior

Anxiety was significantly associated with safety behavior. Workers with moderate anxiety showed the lowest proportion of safe behavior (52.4%) and the highest proportion of unsafe behavior (23.8%), whereas safe behavior remained predominant among workers with normal or mild anxiety. This pattern suggests that mild anxiety may not necessarily impair safety performance, but increasing anxiety may progressively consume cognitive resources required for safe task execution. Anxiety can narrow attention, increase threat-focused thinking, and reduce working-memory capacity, thereby limiting the ability to monitor

hazards and follow multi-step procedures consistently (Coventry, 2022; Wang et al., 2022). Under time pressure, it may also promote faster and less deliberative decision-making, increasing susceptibility to errors (Shi et al., 2023; Okan & Hallquist, 2025).

Sleep difficulty, tension, restlessness, and irritability were prominent anxiety-related complaints among respondents. These symptoms are particularly relevant because poor sleep has been associated with impaired vigilance, reduced cognitive performance, occupational errors, and increased injury risk (Hittle et al., 2022; Nwaogu et al., 2025). Recent evidence also indicates that disturbed sleep may substantially increase occupational injury risk (Bezie et al., 2025). In an MBG kitchen, where workers handle knives, hot surfaces, boiling liquids, electrical equipment, and slippery environments, reduced concentration or emotional regulation may directly compromise safe performance. Previous studies among kitchen and food-service workers similarly reported that psychological stress and anxiety were associated with burns, cuts, and deficiencies in safe food-handling practices (Adzinyo et al., 2024; Song et al., 2025). The present findings therefore extend this evidence to MBG kitchen workers and indicate that psychological well-being should be considered within occupational safety management.

Work fatigue and safety behavior

Work fatigue was also significantly associated with safety behavior. Safe behavior remained high among workers with normal and mild fatigue, at 80.0% and 81.8%, respectively, but declined to 50.0% among those with severe fatigue. Conversely, 25.0% of workers with severe fatigue were classified as unsafe. This distribution suggests a deterioration in workers' functional reserve as fatigue accumulates. At lower fatigue levels, workers may retain sufficient cognitive and physical capacity to compensate for tiredness, whereas severe fatigue may reduce their ability to sustain attention and procedural consistency.

The finding is biologically and operationally plausible. Fatigue reduces psychomotor vigilance, slows reaction time, increases attentional lapses, and impairs working memory and executive control (Kunasegaran et al., 2023; Karim et al., 2024). These functions are essential throughout MBG food production, from receiving and preparing ingredients to cutting, cooking, portioning, packaging, and distribution. Severe fatigue may increase the likelihood of missed safety checks, inappropriate equipment use, poor manual-handling techniques, or delayed

responses to spills, heat exposure, and other hazards. Evidence from safety-sensitive occupations likewise demonstrates that fatigue and extended working hours are associated with impaired vigilance, procedural errors, and occupational injuries (Cunningham et al., 2022; Reinganum et al., 2024). Given that 53.7% of respondents worked more than eight hours per day, fatigue management should be regarded as an organizational rather than purely individual responsibility.

Physiological stress and safety behavior

Physiological work stress showed the strongest association with safety behavior. Among workers without stress symptoms, 83.3% demonstrated safe behavior. In contrast, only 20.0% of workers classified as stressed were categorized as safe, while 60.0% were moderately safe. Among those with severe stress, 42.9% demonstrated unsafe behavior. This progressive pattern indicates that increasing physiological stress may reduce the consistency with which workers maintain safe practices.

Stress in MBG kitchens may originate from simultaneous demands for productivity, timeliness, food hygiene, portion accuracy, coordination, and occupational safety. Food production follows a sequential and interdependent process; delays at receiving or preparation stages may intensify pressure during cooking, portioning, packaging, and distribution. Under these conditions, sympathetic activation may increase while cognitive resources available for sustained attention and controlled decision-making decline. Physiological arousal has been linked to changes in attention, executive control, and task performance relevant to occupational safety (Perelló-March et al., 2022; Savur & Sahin, 2023). The use of salivary α -amylase in the present study is therefore an important strength because it complements subjective psychological assessment with an objective physiological indicator.

Integration of islamic values

The findings may be interpreted within the Islamic principles of preserving human life (*hifz al-nafs*) and ensuring that food is *halal* and *tayyib*. As one of the fundamental objectives of *maqasid al-shariah*, *hifz al-nafs* emphasizes the responsibility to prevent avoidable harm and protect physical and psychological well-being. The Qur'an states in Surah Al-Baqarah verse 195:

"Do not let your own hands throw you into destruction."

In the context of this study, the significant associations of anxiety, fatigue, and physiological stress with less safe behavior indicate that occupational safety should encompass not only control of physical hazards but also protection of workers' psychological and physiological capacity. Excessive workload, inadequate recovery, and unmanaged stress may impair vigilance, concentration, and safe decision-making, thereby increasing the risk of unsafe practices during food preparation.

This responsibility is also closely related to the Islamic concept of *tayyib*, which requires food to be wholesome, safe, and beneficial. The Qur'an states in Surah Al-Baqarah verse 168:

"Eat from what is lawful and good on the earth."

Within the MBG Program, maintaining safe working conditions for kitchen workers is therefore inseparable from ensuring the *tayyib* quality of food delivered to beneficiaries. Adequate rest, appropriate workload distribution, fatigue management, psychosocial support, and adherence to occupational safety procedures can be understood as practical measures that simultaneously protect workers and support the preparation of safe and wholesome meals. Thus, safeguarding worker well-being and maintaining food quality represent interconnected responsibilities consistent with the Islamic values of preserving life and providing *halal* and *tayyib* food.

Occupational health and safety implications

Collectively, these findings suggest that anxiety, fatigue, and physiological stress represent interconnected human-factor risks within MBG kitchen operations. Safety management should therefore extend beyond traditional controls such as personal protective equipment and standard operating procedures. Practical measures should include psychosocial risk screening, appropriate workload distribution, adequate staffing, protected rest periods, management of excessive working hours, sleep-health promotion, and periodic assessment of fatigue and stress. Strengthening supervisory support and safety communication may further help workers maintain safe behavior during periods of high production demand.

The study has important implications for the sustainability of the MBG Program because worker safety is closely linked to operational continuity, food quality, and service reliability. A key strength of this study is its multimodal assessment of occupational safety, integrating psychological, physiological,

neurobehavioral, and directly observed measures through the BSRS-5, salivary α -amylase, mobile Psychomotor Vigilance Test, and Safe Behavior Index, thereby providing a more comprehensive evaluation than reliance on self-reported data alone. However, several limitations should be considered. The cross-sectional design precludes causal inference, the small sample from a single MBG kitchen limits generalizability, and purposive sampling may introduce selection bias. Anxiety and safety behavior measurements may also be susceptible to reporting or observer-related bias, while single-time physiological and fatigue assessments may not capture day-to-day variability. Future multicenter longitudinal studies with larger samples and repeated measurements are needed to clarify temporal relationships and determine whether organizational interventions can improve worker well-being, safety behavior, and occupational outcomes.

CONCLUSIONS

This study concludes that anxiety, work fatigue, and physiological work stress are significantly associated with safety behavior among Free Nutritious Meal (*Makan Bergizi Gratis* [MBG]) kitchen workers in Majene, Indonesia. Workers with moderate anxiety, severe fatigue, and higher stress levels tended to show lower proportions of safe behavior and greater proportions of moderately safe or unsafe behavior. These findings indicate that psychosocial risk, fatigue, and physiological stress should be integrated into occupational health and safety management within MBG kitchens rather than addressed as separate individual concerns. This study contributes empirical evidence relevant to SPPG managers, local and national governments, and the National Nutrition Agency in strengthening occupational safety systems and supporting the sustainability of the MBG Program.

Risk-management strategies should include fatigue management through micro-breaks during high-demand tasks, job rotation for repetitive or high-risk activities, identification of tasks associated with excessive fatigue, limits on prolonged exposure to high-risk work, and adequate recovery periods. Periodic screening of fatigue and psychological conditions may also be implemented, particularly before or during periods of intensified workload. Peer cross-checking can further support compliance with safe work procedures. Because this study used a cross-sectional design with a small single-site sample, causal relationships cannot be established and

generalizability is limited. Future studies should involve larger multisite samples, repeated measurements, and longitudinal designs to evaluate whether psychosocial and fatigue-management interventions improve safety behavior and reduce occupational incidents in MBG kitchens.

ACKNOWLEDGEMENT

The authors would like to express their sincere gratitude to the Head of SPPG for granting permission to conduct this study and to all respondents for their valuable participation. The authors also gratefully acknowledge the Directorate of Research and Community Service (DPPM), Ministry of Higher Education, Science, and Technology of the Republic of Indonesia, for providing financial support for this research.

FUNDING

This study was funded by a research grant from the Directorate of Research and Community Service (DPPM), Ministry of Higher Education, Science, and Technology of the Republic of Indonesia.

AUTHORS' CONTRIBUTIONS

Rizky Maharja: Conceptualization, study design, data analysis, and writing—original draft. Yusniar Anggraeny: Conceptualization, study design, data analysis, and writing—original draft. Bambang Hermawan: Data collection, data analysis, and field investigation. Andi Mifta Farid Panggeleng: Data collection, data analysis, and field investigation. Jihan Faradisha: Writing—original draft and writing—review and editing. Ade Wira Lisrianti Latief: Writing—review and editing and manuscript revision. All authors read, critically reviewed, and approved the final version of the manuscript.

AUTHORS' INFORMATION

Rizky Maharja, S.KM., M.KKK is an Assistant Professor and Researcher in the Department of Occupational Safety and Health, Faculty of Health Sciences, Universitas Sulawesi Barat, Majene, Indonesia. Yusniar Anggraeny, S.KM., M.KKK is a senior lecturer in the Department of Occupational Safety and Health, Faculty of Health Sciences, Universitas Sulawesi Barat, Majene, Indonesia. Bambang Hermawan is a Researcher in the Department of Occupational Safety and Health, Faculty of Health Sciences, Universitas Sulawesi Barat, Majene, Indonesia. Jihan Faradisha is a Researcher in the Department of Occupational Safety and Health, Vocational School, Universitas Sebelas Maret, Surakarta, Indonesia. Andi Mifta Farid Panggeleng is a Researcher in the Department of Occupational Safety and Health, Faculty of Health Sciences, Universitas Sulawesi Barat, Majene, Indonesia. Ade Wira Lisrianti Latief is a Researcher in the Department of Industrial Hygiene, Occupational Health and Safety, Sekolah Tinggi Ilmu Kesehatan Makassar, Makassar, Indonesia.

COMPETING INTERESTS

The author(s) declare no potential conflict of interest with respect to the research, authorship, and/or publication of this article.

REFERENCES

- Abebew, T., Destaw, B., Yenealem, D. G., Tesfaye, A. H., Melaku, C., Mamaye, Y., Bezie, A. E., & Abere, G. (2024). Work-related musculoskeletal disorders: prevalence, associated factors, and impact on quality of life among kitchen workers in hospitality industry, Bahir Dar City, Northwest Ethiopia, 2023. *Frontiers in Public Health*, 12. <https://doi.org/10.3389/fpubh.2024.1358867>
- Adzinyo, O. A., Frempong, F., Appaw, E. T. A., Antwi, A. B., & Nkrow, J. E. (2024). Assessing occupational health and safety practices among kitchen staff of selected senior high schools in the Ho Municipality, Ghana. *Cogent Food & Agriculture*, 10(1), 2392404. <https://doi.org/10.1080/23311932.2024.2392404>
- Agustin, C., & Dwiyantri, E. (2023). The correlation between awareness, motivation, and perception with safe behavior at Ngadiredjo Sugar Factory. *The Indonesian Journal of Occupational Safety*

- and *Health*, 12(1), 30–41. <https://doi.org/10.20473/ijosh.v12i1.2023.30-41>
- Anderson, B. A., Kim, N., Grégoire, L., Yan, N., & Ahn, C. R. (2023). Attention Failures Cause Workplace Accidents: Why Workers Ignore Hazards and What To Do About It. *Policy Insights From the Behavioral and Brain Sciences*, 11(1), 27–35. <https://doi.org/10.1177/23727322231218190>
- Atagbuzia, C., Ng, E. H., & Natarajan, G. (2024). Improving Behavioral-Based Safety Training in Using Verbal Commands Through a Theory-Driven and Feedback-Based Nonimmersive Virtual Reality Game: Development and Usability Study. *Jmir Formative Research*, 8, e48080. <https://doi.org/10.2196/48080>
- Bezie, A. E., Yirdaw, A. A., Tilahun, E., Yohannes, L., Abere, G., & Keleb, A. (2025). The role of sleep disorder and disturbance in the occurrence of occupational injuries among industry workers in Ethiopia : A systematic review and meta-analysis. *SAGE Open Med*, 13(20503121251353280). <https://doi.org/10.1177/20503121251353280>
- Coventry, P. (2022). Occupational Health and Safety Receptivity towards Clinical Innovations That Can Benefit Workplace Mental Health Programs: Anxiety and Hypnotherapy Trends. *International Journal of Environmental Research and Public Health*, 19(13), 7735. <https://doi.org/10.3390/ijerph19137735>
- Cunningham, T. R., Guerin, R. J., Ferguson, J., & Cavallari, J. (2022). Work-related fatigue: A hazard for workers experiencing disproportionate occupational risks. *Am J Ind Med*, 65(11), 913–925. <https://doi.org/10.1002/ajim.23325>. Work-related
- Garcia-Gomes, A. dos S., PINTO, E. de O., CAMPOS, D. R., Silva, D., & Filho, S. T. (2024). Occupational risks and food contamination: Assessment of the work environment of an industrial kitchen using the GUT matrix. *Food Science and Technology*, 44. <https://doi.org/10.5327/fst.17123>
- Guo, N., Yu, S., Xia, B., & Cong, W. (2025). Examining the Role of Psychological Symptoms and Safety Climate in Shaping Safety Behaviors Among Construction Workers. *Behavioral Sciences*, 15(1), 66. <https://doi.org/10.3390/bs15010066>
- Hassen, D. M. (2026). Nutrition as the Foundation of Human Capital: Pathways to Holistic Development. *Maternal & Child Nutrition*, 22(3), e70196. <https://doi.org/10.1111/mcn.70196>
- Hittle, B. M., Norrell, R. M., Omololu, S. O., & Gresham-Ulrich, M. (2022). Retirement Center Worker Sleep Health Assessment During the COVID-19 Pandemic. *Workplace Health & Safety & Safety*, 7(6). <https://doi.org/10.1177/21650799211054863>
- Karim, E., Pavel, H. R., Nikanfar, S., Hebri, A., Roy, A., Nambiappan, H. R., Jaiswal, A., Wylie, G. R., & Makedon, F. (2024b). Examining the Landscape of Cognitive Fatigue Detection: A Comprehensive Survey. *Technologies*, 12(3), 38. <https://doi.org/10.3390/technologies12030038>
- Kunasegaran, K., Ismail, A. M. H., Ramasamy, S., Gnanou, J., Caszo, B. A., & Chen, P. L. (2023). Understanding mental fatigue and its detection: a comparative analysis of assessments and tools. *PeerJ*, 11, e15744. <https://doi.org/10.7717/peerj.15744>
- Moon, K. (2024). Effect of a Safety Leadership Training Including Coaching on Safety Performance and Climate in Wood-processing Companies. *Safety and Health at Work*, 15(3), 310–316. <https://doi.org/10.1016/j.shaw.2024.05.005>
- Nwaogu, J. M., Chan, A. P. C., & Naslund, J. A. (2025). The Interplay Between Sleep and Safety Outcomes in the Workplace : A Scoping Review and Bibliographic Analysis of the Literature. *International Journal of Environmental Research and Public Health*, 22(4), 533. <https://doi.org/10.3390/ijerph22040533>
- Okan, A., & Hallquist, M. N. (2025). Negative affect-driven impulsivity as hierarchical model-based overgeneralization. *Trends in cognitive sciences*, 29(5), 407–420. <https://doi.org/10.1016/j.tics.2025.01.002>

- Park, S., Lee, J., & Lee, J. (2021). Insufficient Rest Breaks at Workplace and Musculoskeletal Disorders Among Korean Kitchen Workers. *Safety and Health at Work*, 12(2), 225–229. <https://doi.org/10.1016/j.shaw.2021.01.012>
- Perelló-March, J., Burns, C., Birrell, S., Woodman, R., & Elliott, M. T. (2022). Physiological Measures of Risk Perception in Highly Automated Driving. *Ieee Transactions on Intelligent Transportation Systems*, 23(5), 4811–4822. <https://doi.org/10.1109/its.2022.3146793>
- Rahman, A. V., & Dwiyantri, E. (2020). The analysis of worker safe behaviour based on the Antecedent Behaviour Consequence (ABC) behaviour model. *The Indonesian Journal of Occupational Safety and Health*, 9(3), 309–317. <https://doi.org/10.20473/ijosh.v9i3.2020.309-317>
- Reinganum, M. I., Rausch-Phung, E. A., & Thomas, J. (2024). *Shift work hazard*. National Library of Medicine. <https://www.ncbi.nlm.nih.gov/books/NBK589670/>
- Rey-Merchán, M. del C., & López-Arquillos, A. (2026). Analysis of risk factors in occupational injuries among hotel catering workers. *Work a Journal of Prevention Assessment & Rehabilitation*, 84(4), 1131–1141. <https://doi.org/10.1177/10519815261428097>
- Saad, M., Najib, M. D. H. M., & Pratt, T. J. (2022). Valid Virtual Reality Applications for Commercial Kitchen Safety Training. *Environment-Behaviour Proceedings Journal*, 7(19), 403–409. <https://doi.org/10.21834/ebpj.v7i19.3207>
- Saad, M., Sahrir, M. S., Abdullah, N. H. H., Jainie, M. H., & Mokhtar, M. K. (2024). A mapping review of challenges in existing technology-based occupational safety training in the tourism and hospitality industry: Research potential in commercial kitchens. *International Journal of Occupational Safety and Health*, 14(3), 412–423. <https://doi.org/10.3126/ijosh.v14i3.52660>
- Savur, C., & Sahin, F. (2023). Survey on Physiological Computing in Human–Robot Collaboration. *Machines*, 11(5), 536. <https://doi.org/10.3390/machines11050536>
- Okan, A., & Hallquist, M. N. (2025). Negative affect-driven impulsivity as hierarchical model-based overgeneralization. *Trends in Cognitive Sciences*, 29(5), 407–420. <https://doi.org/10.1016/j.tics.2025.01.002>
- Shi, K., Weng, J., Fan, S., Yang, Z., & Ding, H. (2023). Exploring seafarers' emotional responses to emergencies: An empirical study using a shiphandling simulator. *Ocean & Coastal Management*, 243, 106736. <https://doi.org/10.1016/j.ocecoaman.2023.106736>
- Shiddiq, F., & Effendi, G. N. (2025). Strategic challenges and optimization strategies for human resource development through Indonesia's free nutritious meal program. *Society*, 13(2), 1037–1055. <https://doi.org/10.33019/society.v13i2.943>
- Song, Q., Huang, M., Ren, Z., Lin, X., Li, S., Sun, B., & Li, Y. (2025). User well-being in kitchen environment design from a positive psychology perspective: A quantitative and qualitative literature analysis. *Buildings*, 15(6), 845. <https://doi.org/10.3390/buildings15060845>
- Sorensen, G., Peters, S. E., Nielsen, K., Stelson, E., Wallace, L., Burke, L. A., Nagler, E. M., Roodbari, H., Karapanos, M., & Wagner, G. R. (2021). Implementation of an organizational intervention to improve low-wage food service workers' safety, health and wellbeing: findings from the Workplace Organizational Health Study. *BMC Public Health*, 21(1). <https://doi.org/10.1186/s12889-021-11937-9>
- Vaswani, V., Shah, S., LakshmiPriyanka, M., Wanknis, P., Gupta, D., & Jain, K. (2020). Comparative evaluation of salivary alpha amylase level for assessment of stress during third molar surgery with and without piano music and co-relation with pain catastrophizing scale: An in vivo study. *Journal of the Korean Association of Oral and Maxillofacial Surgeons*, 46(4), 235–239. <https://doi.org/10.5125/jkaoms.2020.46.4.235>
- Wang, Y., He, Y., Sheng, Z., & Yao, X. (2022). When Does Safety Climate Help? A Multilevel Study of COVID-19 Risky Decision Making and Safety Performance in the Context of Business Reopening. *Journal of Business and Psychology*, 37(6), 1313–1327. <https://doi.org/10.1007/s10869-022-09805-3>
- Wassif, G. O., Abdelsalam, A., Eldin, W. S., Abdel-Hamid, M. A., & Damaty, S. I. (2024). Work-related injuries and illnesses among kitchen workers at two major students' hostels. *Journal of Egyptian Public Health Association*, 99(1). <https://doi.org/10.1186/s42506-024-00163-x>
- Yakubu, S. O., Akparibo, R., Morgan-Fallah, C., Ranjan, A., Karim, Z., Adesanmi, B., & Bundy, D. (2026). Investing in nutrition throughout the first 8000 days of life: a multisectoral approach to supporting well-being and creating future human capital. *BMJ global health*, 11(4), e019620. <https://doi.org/10.1136/bmjgh-2025-019620>
- Yang, Z., Wang, X., Su, C., & Li, B. (2022). The Relationship between Employee Risk Communication and Non-Adaptive Evacuation Behavior in Chinese Hazardous Chemical Companies: The Mediating Role of Emotional Exhaustion and Risk Perception. *International Journal of Environmental Research and Public Health*, 19(18), 11432. <https://doi.org/10.3390/ijerph191811432>
- Yemişçi, D. A., Shipman, Z. D., İlhan, N., & İlhan, Ü. D. (2026). Heat Beyond the Kitchen: Embodied Strain, Time Poverty, and the Life-Embedded Nature of Employee Experience in Culinary Labour. *Behavioral Sciences*, 16(6), 905. <https://doi.org/10.3390/bs16060905>