



Cardiovascular Responses and Oxidative-Stress Biomarkers among Bakery Workers Exposed to Indoor Heat in Kano, Nigeria

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ABSTRACT

Background: Bakery workers in Kano State, Nigeria, are routinely exposed to intense heat generated by continuous oven use in poorly ventilated environments. Occupational heat exposure may impose cardiovascular and thermoregulatory strain and influence redox balance. However, locally relevant evidence on acute physiological and oxidative responses among bakery workers in northern Nigeria remains limited.

Methods: A cross-sectional study was conducted among 50 adult male bakery workers recruited from selected bakeries in Kano metropolis. Cardiovascular parameters and body temperature were assessed before work and during peak exposure following one hour of routine bakery work. Participants were categorized into four age groups: 18–20, 21–25, 26–30, and >30 years. Serum malondialdehyde (MDA) and reduced glutathione (GSH) were assessed in a subsample of 15 bakery workers and 15 controls.

Results: During peak bakery-work exposure, significant increases were observed in heart rate (74 [61 – 103] to 85 [68 – 109], $p=0.001$), systolic blood pressure (SBP, 128[80 – 180] to 130.5[97 – 190], $p=0.002$), and body temperature (35.30 [34.5 – 36.4 to 36.60 [35.0 – 37.7], $p=0.001$), with a significant decrease in diastolic blood pressure (82 [61–100] to 81 [65 – 110], $p=0.004$). Above 30-year age group showed significant within-group increase in all four parameters (SBD, DBP, HR and body temperature). Among the biochemical subsample, serum GSH was significantly higher in bakery workers than in controls ($p=0.002$), whereas MDA showed a non-significant trend towards higher levels ($p=0.152$). MDA was positively correlated with GSH ($r=0.580$, $p=0.001$).

Conclusion: The study demonstrated significant increases in HR, SBP, and body temperature following peak bakery-work exposure, indicating substantial physiological strain. Bakery workers also had higher GSH level in the absence of a significant change in MDA, suggesting an altered redox response rather than definitive evidence of oxidative stress.

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INTRODUCTION

Occupational exposure to excessive heat remains a major public health and occupational safety challenge, particularly in low- and middle-income countries where environmental control measures are often inadequate (Amoadu *et al.* 2023; Melaku *et al.* 2024). Workers in heat-intensive industries are at increased risk of physiological strain due to sustained exposure to elevated temperatures (Khazaei *et al.* 2023). Bakery workers constitute one of the most vulnerable occupational groups, as their activities involve continuous operation of ovens and other heat-generating equipment within enclosed indoor environments (Gharibi *et al.* 2020; Khazaei *et al.* 2023). Unlike outdoor workers who may benefit from natural ventilation, bakery workers are confined to environments where heat accumulates without adequate dissipation, particularly in traditionally constructed bakeries with limited mechanical ventilation (Al-Otaibi 2022; Mirsanei *et al.* 2024).

In Kano State, northern Nigeria, high ambient environmental temperatures further exacerbate indoor heat exposure in bakeries. Northern Nigeria has been characterized as a climate hot spot due to occurrence of extreme heatwaves, and the intensity of the heatwaves is expected to increase in the future because of continuous global warming (Agada and Yakubu, 2022). Acute exposure to indoor heat during work

shifts significantly challenges the body's thermoregulatory capacity. The physiological responses to heat exposure include increased heart rate, changes in blood pressure, and redistribution of blood flow to the skin for heat dissipation. While these responses are adaptive, repeated or intense, acute heat exposure may result in cardiovascular strain and predispose workers to adverse health outcomes (Kjellstrom *et al.* 2016). The International Labor Organization estimates that at least 2.41 billion workers are exposed to excessive occupational heat globally, with nearly 23 million work-related injuries and close to 19,000 deaths annually attributed to heat exposure (Scott *et al.*, 2024).

Beyond cardiovascular effects, heat exposure is strongly associated with oxidative stress. Heat stress increases the generation of reactive oxygen species (ROS), which can overwhelm the body's antioxidant defense systems, leading to cellular and molecular damage. When ROS production exceeds antioxidant capacity, oxidative stress occurs, resulting in lipid peroxidation, protein modification, and DNA damage (Belhadj Slimen *et al.* 2014; Ding & Gao 2025). Malondialdehyde (MDA), a by-product of lipid peroxidation, is widely used as a biomarker of oxidative damage, while glutathione (GSH), the most abundant intracellular non-protein thiol, serves as a major antioxidant defending against ROS-mediated injury (Forman *et al.*, 2009;

Tsikis 2017). Individual biological characteristics may also substantially modify thermoregulatory efficiency and cardiovascular stability under heat stress. Older individuals exhibit reduced sweat production, diminished skin blood flow, and lower cardiovascular reserve, increasing their vulnerability to heat-related complications (Kenney & Munce 2003).

Despite the heat-intensive nature of bakery work, limited local empirical evidence is available on the acute physiological responses and oxidative stress associated with bakery work in northern Nigeria, particularly in Kano State, despite the large number of bakeries and bakery workers in the region. Therefore, this study aimed to assess changes in cardiovascular parameters and body temperature during peak bakery-work exposure and to evaluate oxidative-stress-related biomarkers, including malondialdehyde (MDA) and glutathione (GSH), among bakery workers in Kano State. Understanding these responses may provide relevant evidence on the physiological burden of bakery work and inform occupational heat-risk awareness and preventive measures for workers in similar settings.

MATERIALS AND METHODS

Ethical Approval and Consent

Ethical approval was obtained from Health Research Ethics Committee of Kano State Ministry of Health issued on 2nd February 2026, with reference number SHREC/2026/7220 and NHREC Approval number: NHREC/17/03/2018 prior to data collection. All participants signed a written informed consent before enrolment. Participant confidentiality was maintained throughout, and participants were free to withdraw at any stage without penalty.

Study Area and Design

This study was conducted across multiple bakery (Al-Ihsan, Lazeez, Galaxy, and Al-khairat bakery) in the Kano metropolis, Kano State, located in the north-western geopolitical zone of Nigeria. Kano State is characterized by a hot semi-arid climate, with ambient temperatures routinely exceeding 35–40°C during the dry season, creating a compounded thermal burden when combined with indoor bakery heat. A cross-sectional design was employed, incorporating pre-exposure and peak-exposure measurements of cardiovascular parameters during routine working hours.

Study Population and Sample Size

The study population consisted of adult male bakery workers employed in selected bakeries within Kano State who were routinely engaged in baking activities and directly exposed to indoor heat during their work shifts.

Inclusion and Exclusion Criteria

Inclusion criteria were adult male bakery workers aged 18 – 50 years; employed in bakery work for at least six months; directly exposed to baking activities; and willing to participate in the study. Exclusion criteria were known cardiovascular disease or chronic metabolic illness; current use of medications affecting cardiovascular function; acute febrile illness at the time of data collection and history of smoking.

Sample Size Estimation

The sample size was estimated based on the expected change in body temperature, selected as the physiological parameter with the available published effect estimates most directly relevant to the present pre-/peak-exposure design. Sample size was calculated using the formula below.

$$n = \frac{(Z_{1-\alpha/2} + Z_{1-\beta})^2 \sigma_d^2}{\Delta^2}$$

Where $\alpha = 0.05$, $Z_{1-\alpha/2} = 1.96$, power = 80%, $Z_{1-\beta} = 0.84$, expected mean change in body temperature $\Delta = 0.24^\circ\text{C}$ and the SD of the within participant difference $\sigma_d = 0.36^\circ\text{C}$. These values were derived from a previous study among bakery workers in Saudi Arabia, which reported a mean increase in oral body temperature of 0.24°C with a standard deviation of 0.36°C between measurements obtained before and at the end of the work shift (Al-Otaibi, 2022). Using these parameters, the estimated minimum sample size was 18 participants. Allowing for approximately 10% for incomplete data or non-response increased the minimum sample size to 20 participants. To provide adequate representation and increase the robustness of the assessment of multiple physiological outcomes, 50 eligible bakery workers were ultimately recruited and included in the study.

Participants Recruitment and Sampling

Eligible bakery workers were recruited consecutively from the selected bakeries until the required sample size (50) was reached. During each recruitment visit, eligible workers who were present and willing to participate were invited to take part in the study. Participants were selected by simple balloting; each eligible worker was given an equal opportunity to participate, and those who selected “Yes” were recruited, provided they fulfilled all inclusion criteria and none of the exclusion criteria and those who picked “No” were not included. Recruitment continued until a total of 50 participants had been enrolled. Following recruitment, participants were categorized into four predefined age groups for subsequent analysis: 18–20 years ($n = 8$), 21–25 years ($n = 18$), 26–30 years ($n = 11$), and >30 years ($n = 13$). Age categorization was performed after recruitment and was not used as a criterion for participant selection.

For the biochemical assessment (MDA and GSH), subsample of 15 bakery workers was randomly selected from the recruited participants using the same simple balloting procedure and a control group of 15 individuals were also recruited and selected by simple random balloting from eligible volunteers within the same predefined age range (18 – 50) and BMI range 18.5 – 24.9 with the bakery workers.

Cardiovascular Parameter Assessment

Baseline measurements of body temperature, heart rate, systolic blood pressure (SBP), and diastolic blood pressure (DBP) were obtained after a 10-minute seated rest period in an open environment before commencement of routine bakery activities in the morning. Peak-exposure measurements of the same parameters were obtained after one hour of routine indoor activity within the bakery production area. Heart rate was measured using a calibrated digital finger-tip pulse oximeter (Buerer PO 30), while SBP and DBP were measured using a standard automated digital sphygmomanometer (Omron M1- Basic). Body temperature (axillary) was measured using a digital thermometer (PLACEMADE®). Measurements were performed using the same instruments and procedures for all participants.

Oxidative Stress Biomarker Analysis

Five milliliters (5ml) of venous blood samples were collected in a plain tube from participants and controls following peak exposure cardiovascular measurements. Samples were centrifuged (1000rpm) to obtain serum and stored at -20°C . Serum MDA levels were determined using the thiobarbituric acid reactive substances (TBARS) spectrophotometric assay at an absorbance of 532 nm (Gutteridge & Wilkins 1983). Serum GSH was measured using Ellman’s colorimetric

method based on the reaction between reduced glutathione and 5,5'-dithiobis-(2-nitrobenzoic acid) (DTNB), producing a yellow chromogen measured at 412 nm (Ellman 1959). Analyses were performed in the Biochemistry Laboratory, Bayero University Kano.

Data Analysis

Data were analyzed using IBM SPSS version 25.0. Descriptive statistics were expressed as mean $\pm$ SD or median [range] as appropriate. The Wilcoxon signed-rank test was used to compare pre- and peak-exposure cardiovascular

measurements within groups and Mann-Whitney U test was used to compare MDA and GSH between subsamples of bakery workers and controls. Spearman's rank correlation was used to examine relationships between continuous variables. Statistical significance was set at $p < 0.05$.

RESULTS AND DISCUSSION

Anthropometric Characteristics of Study Participants

The mean age was 35.8 ± 10.52 years, with mean height of 1.72 ± 0.07 m, weight of 64.58 ± 6.88 kg, and BMI of 21.75 ± 1.78 kg/m², as shown in table 1 below.

Table 1: Anthropometric Characteristics of Bakery Workers (Mean $\pm$ SD, n = 50)

Parameter	Mean $\pm$ SD
Age (years)	35.8 ± 10.52
Height (m)	1.72 ± 0.07
Weight (kg)	64.58 ± 6.88
BMI (kg/m ²)	21.75 ± 1.78

BMI = Body Mass Index.

Overall Cardiovascular Responses to Acute Indoor Heat Exposure

Comparisons of cardiovascular parameters before work and at peak work exposure (after 1 hour) among the 50 bakery workers shows significant increases in heart rate (74 [61–103] to 85 [68–109]) ($p = 0.001$), systolic blood pressure (128 [88–

180] to 130.50 [97–190]) ($p = 0.002$), and body temperature ($35.30 [34.5–36.4]$ to $36.60 [35.0–37.7]$) ($p = 0.000$), alongside a significant decrease in diastolic blood pressure ($82 [61–100]$ to $81 [65–110]$) ($p = 0.004$), as shown in table 2 below.

Table 2: Cardiovascular Parameters before and at Peak Acute Indoor Heat Exposure (Median [Range], n = 50)

Parameter	Before Exposure	Peak Exposure	p-value
Heart Rate (bpm)	74 [61–103]	85 [68–109]	0.001*
SBP (mmHg)	128 [88–180]	130.50 [97–190]	0.002*
DBP (mmHg)	82 [61–100]	81 [65–110]	0.004*
Body Temperature (°C)	$35.30 [34.5–36.4]$	$36.60 [35.0–37.7]$	0.001*

*Significant at $p < 0.05$; Wilcoxon Signed-Rank Test. SBP = Systolic Blood Pressure; DBP = Diastolic Blood Pressure.

Cardiovascular Responses within Specific Age Groups: Younger Workers (Groups 1 and 2)

Pre and peak-exposure comparisons for bakery workers aged 18–20 years (Group 1) and 21–25 years (Group 2) revealed that in Group 1, only body temperature increased significantly

($p = 0.018$) following heat exposure, while heart rate, SBP, and DBP changes were not significant. In Group 2, heart rate ($p = 0.001$) and body temperature ($p = 0.001$) increased significantly, while blood pressure changes did not reach significance, as shown in table 3 below.

Table 3: Cardiovascular Parameters before and at Peak Exposure — Younger Age Groups (Median [Range]), (n = 26)

Parameter	Gp 1 Before	Gp 1 Peak	p	Gp 2 Before	Gp 2 Peak	p
HR (bpm)	70.50 (27)	77.00 (15)	0.160	74.00 (34)	86.00 (31)	0.001*
SBP (mmHg)	119.50 (30)	120.00 (50)	0.574	128.00 (28)	130.00 (33)	0.076
DBP (mmHg)	69.00 (36)	79.00 (15)	0.674	82.00 (37)	85.00 (30)	0.070
Temp (°C)	$35.90 (1.4)$	$36.75 (1.0)$	0.018*	$35.30 (1.5)$	$36.70 (1.0)$	0.001*

*Significant at $p < 0.05$; Wilcoxon Signed-Rank Test. Gp 1 = Group 1 (18–20 year), Gp 2 = Group 2 (21–25 years); HR = Heart Rate; SBP = Systolic Blood Pressure; DBP = Diastolic Blood Pressure; Temp = Body Temperature. Values in parentheses represent ranges.

Cardiovascular Responses within Specific Age Groups: Older Workers (Groups 3 and 4)

Pre and peak age group comparisons for bakery workers aged 26–30 years (Group 3) and above 30 years (Group 4) revealed that, in Group 3, only body temperature increased

significantly ($p = 0.02$) following acute indoor heat exposure. However, in Group 4, all four parameters (HR, SBP, DBP and Temp) increased significantly following the exposure: heart rate ($p = 0.002$), SBP ($p = 0.003$), DBP ($p = 0.001$), and body temperature ($p = 0.001$), as shown in table 4 below

Table 4: Cardiovascular Parameters before and at Peak Exposure — Older Age Groups (Median [Range]), (n = 24)

Parameter	Gp 3 Before	Gp 3 Peak	p	Gp 4 Before	Gp 4 Peak	p
HR (bpm)	75.00 (28)	85.00 (14)	0.242	74.00 (29)	85.00 (29)	0.002*
SBP (mmHg)	128.00 (29)	135.00 (55)	0.280	129.00 (92)	135.00 (82)	0.003*
DBP (mmHg)	82.00 (31)	78.00 (26)	0.422	79.00 (33)	85.00 (42)	0.001*
Temp (°C)	$35.30 (1.3)$	$36.00 (2.0)$	0.022*	$35.00 (1.3)$	$37.00 (1.7)$	0.001*

*Significant at $p < 0.05$; Wilcoxon Signed-Rank Test. Gp 3 = Group 3 (26-30 years), Gp 4 = Group 4 (>30 years); HR = Heart Rate; SBP = Systolic Blood Pressure; DBP = Diastolic Blood Pressure; Temp = Body Temperature. Values in parentheses represent ranges.

Serum Oxidative Stress Markers

Comparisons of serum MDA and GSH between bakery workers ($n = 15$) and non-bakery controls ($n = 15$). Serum GSH was found to be significantly higher in cases than

controls (58.32 vs. 58.00 $\mu\text{mol/L}$; $p = 0.002$), while serum MDA showed a non-significant trend toward elevation in cases (1.01 vs. 0.36 nmol/mL ; $p = 0.152$), as shown in table 5 below.

Table 5: Comparison of Serum MDA and GSH between Bakery Workers and Controls (Median [Range], $n = 15$ Per Group)

Parameter	Cases ($n=15$)	Controls ($n=15$)	p-value
MDA (nmol/mL)	1.01 [0.02–5.25]	0.36 [0.05–1.73]	0.152
GSH ($\mu\text{mol/L}$)	58.32 [57.94–58.88]	58.00 [57.86–58.25]	0.002*

*Significant at $p < 0.05$; Mann-Whitney U Test. MDA = Malondialdehyde; GSH = Glutathione.

Correlation between MDA, GSH and BMI

Spearman's correlation analysis. A significant positive correlation was found between MDA and GSH ($r = 0.580$, $p = 0.001$), indicating co-elevation of both biomarkers. No

significant correlations were observed between biomarker and BMI, ($p = 0.078$, 0.350 respectively) as shown in table 6 below.

Table 6: Spearman's Rank Correlation between MDA, GSH, and BMI ($N = 30$)

Variables	r	p-value
MDA vs GSH	0.580	0.001**
MDA vs BMI	-0.327	0.078
GSH vs BMI	-0.177	0.350

**Correlation significant at the 0.01 level (2-tailed); Spearman's rho. MDA = Malondialdehyde; GSH = Glutathione; BMI = Body Mass Index.

Discussion

Acute indoor heat exposure produced statistically significant increases in heart rate, systolic blood pressure, and body temperature, alongside a significant decrease in diastolic blood pressure in this study. The elevation in heart rate reflects the fundamental cardiovascular response to thermal challenge, wherein the hypothalamus activates the sympathetic nervous system, increasing chronotropy as the primary driver of augmented cardiac output needed to maintain both tissue perfusion and cutaneous blood flow for heat dissipation (Crandall & González-Alonso 2010). Physical baking activities within an enclosed hot environment might have further amplified this response through the exercise pressor reflex (Foster *et al.* 2021) resulting in the increase in heart rate SBP and body temperature. These findings align with (Kenney, Craighead, and Alexander 2014), who reported significantly elevated heart rates in occupationally heat-stressed workers, and with (Gharibi *et al.* 2020), who documented elevated heart rates in bakery workers whose indoor wet-bulb globe temperature (WBGT) exceeded recommended thresholds. The significant rise in systolic blood pressure reflects increased cardiac output from sympathoadrenal activation and the exercise pressor reflex, while the concurrent significant decrease in diastolic blood pressure reflects the dominant vasodilatory influence of heat stress through sympathetic cholinergic-mediated cutaneous vasodilation, substantially reducing total peripheral resistance during diastole in therefore resulting in the decreased DBP (Crandall and González-Alonso 2010). This divergent pattern is physiologically coherent and consistent with the work of (De Sario *et al.* 2023) and (Liu *et al.* 2022), who confirmed that heat-exposed workers exhibit heterogeneous cardiovascular strain patterns including divergent systolic and diastolic responses. Notably, while (Gharibi *et al.* 2020) and other earlier studies on bakery workers documented general cardiovascular strain without characterizing this hemodynamic divergence, this study uniquely captures it in a

sub-Saharan African occupational setting, contributing context-specific evidence to the global literature.

The significant rise in body temperature confirms meaningful thermal stress, reflecting a thermal imbalance in which heat gain from the bakery environment exceeds the body's heat dissipation capacity. High ambient temperature in Kano State may have contributed to the indoor heat load, reducing the efficiency of evaporative heat loss from the workers and leading to body temperature rise. Additionally, the metabolic heat produced by baking activities might have further added to this burden (Foster *et al.* 2021), resulting in net heat accumulation and increase in body temperature. However, because environmental temperature or WBGT was not quantitatively measured in the present study, the magnitude of environmental heat exposure cannot be independently determined. The findings should therefore be interpreted as physiological responses observed during work in a heat-intensive bakery environment, rather than as a direct quantitative assessment of environmental heat exposure.

The participants in the > 30-year age group demonstrated statistically significant changes in all four measured physiological parameters between the pre-exposure and peak-exposure periods. These findings may indicate variation in physiological responses across the predefined age groups. However, the present study did not directly assess age-related changes in cardiovascular regulation, vascular stiffness, endothelial function, or baroreceptor sensitivity, and the observed within-group significance in the >30-year group should not be interpreted as confirmed evidence that age amplified the physiological response. Differences in physical workload, fitness, hydration, work experience, or other individual characteristics may also have contributed to variation across age groups.

Previous studies have reported that individual characteristics, including age, may influence physiological responses to occupational heat (Kenney & Munce 2003; Larose *et al.* 2013; Kenney *et al.* 2014). However, evidence from bakery-

specific studies has generally focused on overall physiological or biochemical responses rather than detailed age-group comparisons (Gharibi *et al.* 2020; Al-Otaibi 2022). The present findings therefore provide preliminary data on physiological responses in predefined age groups among bakery workers in Kano State, but larger studies specifically designed to examine age-related differences are needed.

Serum GSH was significantly elevated in bakery workers compared to controls, while MDA showed a non-significant trend toward higher levels. The GSH elevation may represent active adaptive antioxidant upregulation in response to the increased ROS burden of occupational heat exposure. Under mild-to-moderate oxidative stress, accumulating ROS activate the Nrf2-Keap1 transcription pathway, upregulating gamma-glutamylcysteine synthetase and increasing GSH biosynthesis (Sies 2015; Redza-Dutordoir & Averill-Bates 2016). This agrees with (D'Oria *et al.* 2020) and Wu *et al.* (2016), who identified GSH upregulation as the earliest adaptive response to oxidative challenge. The non-significant increase in MDA trend may possibly suggest lipid peroxidation was in an early or compensated stage, consistent with (Gharibi *et al.* 2020), who reported statistically significant MDA elevation in bakery workers only when WBGT exceeded recommended safety thresholds, implying that greater exposure intensity may be needed to produce detectable lipid damage. A recent animal study also highlighted that heat stress could increase oxidative stress by disrupting redox balance which in turn affects thermoregulation (Ademu, Yohanna and Samuel, 2026). However, this interpretation remains speculative, especially due to the absence of a statistically significant increase in MDA further warranting cautious interpretation. MDA is a marker of lipid peroxidation, and its concentration may depend on the intensity and duration of exposure, timing of sampling, and the balance between oxidative processes and antioxidant defenses. Gharibi *et al.* (2020). In the present study, however, environmental heat exposure was not quantitatively measured, and therefore the relationship between exposure intensity and MDA cannot be established. The significant positive correlation between MDA and GSH indicates that participants with higher MDA concentrations also tended to have higher GSH concentration suggesting co-elevation of both biomarkers, characteristic of the early compensatory phase of oxidative stress wherein increasing oxidative load is actively matched by proportionate antioxidant upregulation (Powers and Jackson 2008; Sies 2015). Without appropriate occupational health interventions, continued heat exposure may eventually deplete GSH reserves, transitioning workers from compensated oxidative stress to frank oxidative damage cardiovascular risk (Ballatori *et al.* 2009). However, the present finding does not establish oxidative injury or progression towards oxidative damage. These interpretations would require additional biomarkers and longitudinal assessment of redox status.

Limitation of the Study

This study has some limitations. Environmental heat exposure was not quantitatively characterized using indices such as WBGT, and the biochemical assessment was conducted in a relatively small subsample of bakery workers and controls. In addition, the cross-sectional design limits assessment of longer-term physiological and oxidative responses to repeated occupational heat exposure. Nevertheless, the study provides important context-specific evidence on acute physiological responses and redox-related changes among bakery workers in northern Nigeria.

CONCLUSION

This study demonstrated significant changes in cardiovascular parameters and body temperature during bakery work, characterized by increases in heart rate, systolic blood pressure, and body temperature and a decrease in diastolic blood pressure. Sub sample of the bakery workers also showed significantly higher GSH levels compared with controls, suggesting an altered redox response. However, the findings do not conclusively establish oxidative damage. These findings provide context-specific evidence of physiological responses to occupational heat exposure among bakery workers in Kano State, Nigeria.

Relevant authorities and bakery owners should implement appropriate workplace heat-mitigation measures, including adequate ventilation and cooling systems, as well as structured work-rest schedules, to reduce occupational heat burden and physiological strain among bakery workers. In addition, routine monitoring of cardiovascular parameters and appropriate occupational health surveillance to facilitate early identification of adverse physiological responses and promote the health and safety of bakery workers. Longitudinal studies incorporating environmental heat indices are recommended to characterize cumulative and dose-dependent effects of occupational heat exposure on cardiovascular and oxidative stress among bakery workers and to provide stronger evidence for targeted occupational health interventions.

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