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Original article

Occupational Heat Exposure-related Symptoms Prevalence and Associated Factors Among Hospitality Industry Kitchen Workers in Ethiopia: Wet Bulb Globe Temperature

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ABSTRACT

Background: Occupational heat stress caused by excessive environmental heat gain disrupts thermoregulatory mechanisms and harm workers' health and productivity. Kitchens are known for their thermal risks; however, research on heat stress in kitchen is limited. This study aimed to bridge this knowledge gap by assessing, the prevalence of heat-stress-related symptoms, and associated factors among kitchen workers in Gondar City, Ethiopia.
Methods: This institutional-based cross-sectional study (April to June 2023) evaluated heat stress among hospitality kitchen workers in Ethiopia. Heat exposure was measured using hygrometers. A simple random sample of 605 participants completed a survey and data was exported to Statistical Package for Social Science version 26. To assess strength and direction an adjusted odds ratio with 95% confidence interval (CI) was employed. A *p*-value of less than 0.05 was utilized to identify significant associations.
Results: Over the last 6 months 67.1% (95% CI: 63.0, 71.1), of the participants reported heat-stress symptoms. Multivariable analysis revealed that age ≥40 years [AOR: 2.28; 95% CI (1.08, 4.82)], high workload [AOR: 1.89; 95% CI (1.04, 3.49)], poor heat mitigation practice [AOR: 2.39; 95% CI (1.58, 3.59), wood fuel [AOR: 2.60; 95% CI (1.54, 4.40)], improper ventilation [AOR: 3.28; 95% CI (1.56, 6.87)], and higher heat index value [AOR: 2.15; 95% CI (1.35, 3.42)] were factors significatly associated with heat stress related symptoms.
Conclusion: This study identified a high prevalence of heat–stress-related symptoms among kitchen workers. Mitigation strategies include improved ventilation, cooling, advanced building designs, and heat reduction technologies. Future research should utilize standard heat-stress assessment tools.

1. Introduction

Working in a hot and humid environment poses a significant health problem called heat stress [1]. Heat stress disrupts the body's ability to cool and can cause a variety of heat-related illnesses and workplace injuries each year [2,3]. Heat-related illnesses encompass a spectrum of adverse health effects arising from excessive environmental heat exposure [4]. These manifest as a diverse array of symptoms including thirst, nausea, vomiting, dizziness, excessive sweating, sweat rashes, weakness, pain, spasms, and muscle cramps [5,6].

Occupational heat exposure in the workplace significantly increases the risk of heat-related illnesses, injuries, and even mortality [4]. It demonstrably leads to performance and productivity

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decline and can threaten worker survival [5–9]. This is one of the major issues in tropical countries which is a critical challenge posed by occupational heat stress significantly impacts workers and potentially affects their health and performance [10]. A substantial portion (approximately 35%), of workers working under heat stress conditions experience adverse effects, translating to a 30% decline in their productivity, notably productivity; declines by 2.6% for every degree above 24°C according to studies [11,12]. Furthermore, high heat decreases national economic income [13,14].

While heat stress is often disregarded as a workplace hazard, a concerning prevalence of heat-related-illness has been documented in the literature, kitchen workers experience a high incidence of heat-related symptoms such as heat exhaustion, fatigue, irregular movement, dizziness, nausea, muscle spasm, and fainting (50%, 100%, 83.3%, 53.3%, 46.7%, 8.3%, and 10.0% respectively) [10]. Additionally, another study revealed that a significant proportion of workers reported symptoms such as sweating (57%), tiredness (35.3%), and headache (14.7%) [15]. The economic burden of heat-related labor loss is projected to reach 2400 billion USD by 2030 [16,17].

Despite compelling evidence that excessive heat exposure significantly increases morbidity and mortality rates, there is a knowledge gap regarding the prevalence and health effects of occupational heat exposure among kitchen workers [18]. Several environmental factors contribute to elevated air temperatures in kitchens, including ambient temperature, humidity, radiant heat, and air velocity [19]. Additionally repetitive tasks, the presence of high heat-generating ovens, inadequate ventilation, worker density, type of clothes, and insufficient rest periods all act as risk factors in this setting [20,21].

The hospitality industry is experiencing robust global growth, employs a large workforce, and contributes significantly to the national GDP [22]. However, knowledge gaps exist regarding occupational heat stress-related symptoms and contributing factors among kitchen workers in Ethiopia, particularly in Gondar city, northwest Ethiopia [23]. Therefore, this study aimed to bridge this knowledge gap by assessing the prevalence of occupational heat stress-related symptoms and associated factors in this population. By elucidating these factors, this study can serve as a valuable guide for establishing preventive strategies, ultimately enhancing kitchen productivity and worker performance.

2. Materials and methods

2.1. Study design and setting

An institutional-based cross-sectional study was conducted from "April to June 2023," among hospitality industry kitchen workers in Gondar city, Amhara Regional State, Northwest Ethiopia. Gondar City is located approximately 750 km from Addis Ababa, Ethiopia's capital. The city comprises six sub-cities (Arada, Azezo Fasil, Jantekel, Maraki, and Zobel) and boasts 350 hospitality businesses employing approximately 1,050 kitchen workers. These businesses include hotels, restaurants, cafés, and lodges that provide services to customers. The work setting was characterized by high labor intensity, high cooking fuel consumption, and congested spaces.

2.2. Population and sample

In Gondar, the research team employed a target sampling approach. The entire pool of hospitality business kitchen workers constitutes the source population. From this pool individuals encountered during the data collection period comprised the study population. It is important to note that kitchen workers with pre-existing health conditions and pregnant women were excluded from the study to mitigate potential bias and ensure accurate prevalence estimates of heat-related stress symptoms [24,25]. To ensure ethical conduct, formal approval for the research was obtained from the Institutional Review Board (IRB) of the University of Gondar, College of Medicine and Health Sciences, Institute of Public Health (reference number: IPH/2515/2023, April 12, 2023). All participants were explicitly informed of the voluntary nature of their participation and the strict confidentiality of their collected data. Written Informed consent was obtained from the participants.

2.3. Sample size determination and sampling technique

The sample size of 633 was determined using a single population proportion formula. This calculation incorporates the following assumptions: a hypothesized proportion of (50%), a significance level (α) of 0.05 (corresponding to a Z-score of 1.96), a 95% confidence interval, a desired margin of error (d) of 0.05 (5%), a nonresponse rate of 10% and clustering effect of 1.5 (Because individuals within the same cluster are not independent of each other, the analysis must account for this lack of independence). In our context workers within the same kitchen likely experience similar heat exposure, so the variability between the same work sections is lower than the variability in different work sections. If not addressed this clustering effect could lead to underestimation of the true variability in occupational heat exposure across the entire population. Consequently, statistical analysis might produce unreliable estimates and misleading conclusions about the impact of heat exposure. Temperature and Humidity measurements were conducted over 40 days in hundreds of kitchens. A random sampling technique was used to select individual participants. The sample size was allocated proportionally across sub-cities. Kitchen workers from selected hospitality establishments who met the inclusion criteria and were present during the data collection period were interviewed (Fig. 1).

2.4. Operational definitions

2.4.1. Occupational heat exposure

The American Conference of Government Industrial Hygienists (ACGIH) defines heat stress as occurring when the Wet-bulb globe temperature (WBGT) index surpasses a specific threshold limit. These thresholds vary based on work intensity: 31.0°C for light work, 28.0°C for moderate work, and 27.5°C for heavy work intensities—of continuous work [4,26]. Workers whose WBGT exposure exceeded these limits were classified as the exposed group while those below the thresholds were considered unexposed.

2.4.2. Heat stress-related symptoms

Heat stress-related symptoms were determined through self-reported experience of experiencing one or more heat-related symptoms in the past six months. These heat-stress-related symptoms include heavy sweating, muscle cramps, nausea or vomiting, tiredness, dizziness, headache, and fainting [9,22,26].

The workload was characterized based on physical demands. Light work involves sitting, standing, performing light arm/hand work, or occasional walking. Moderate work encompasses tasks requiring a normal walking pace and moderate material lifting. Finally, heavy work includes activities such as heavy material handling and fast walking [27].

2.4.3. Data collection tools and procedure

Data collection on heat-related symptoms experienced over the past six months employed a combination of structured interview questionnaires and a structured observational checklist. The

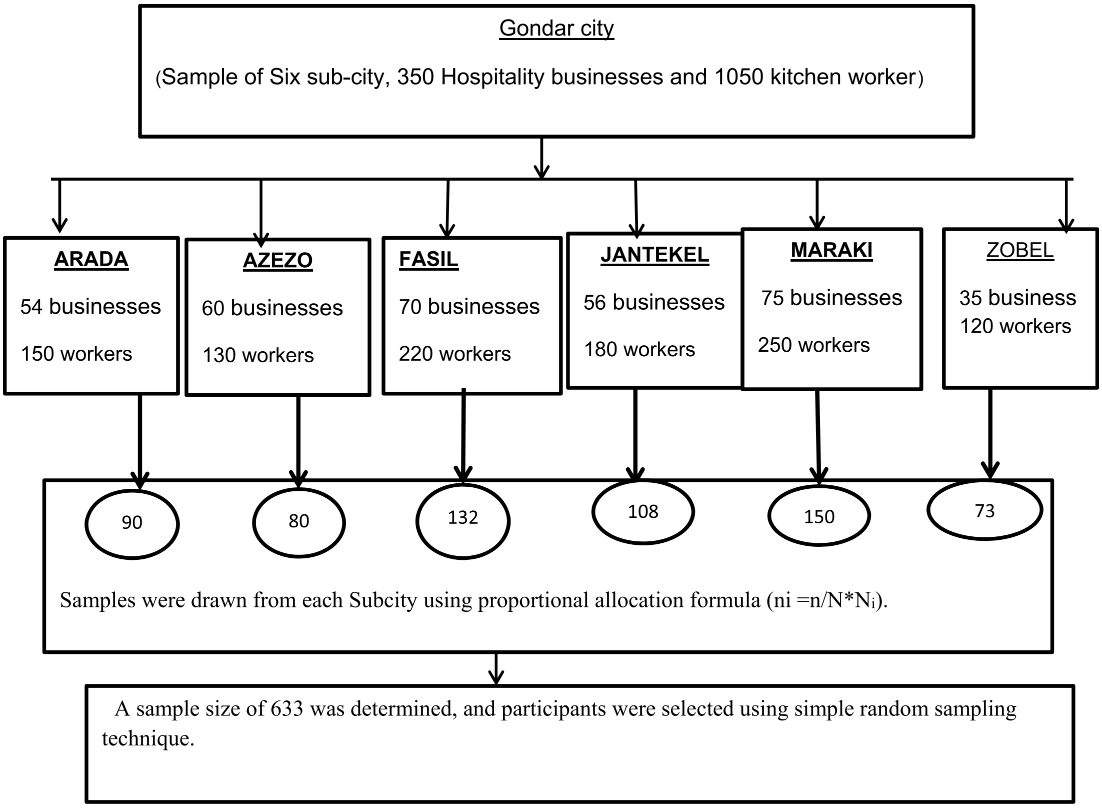

Fig. 1. Schematic representation of sampling procedure.

questionnaire, adapted from the High Occupational Temperature; Health and Productivity Suppression (HOTHAPS) tool [28] with some modifications, comprises four sections [29]. The first section explored sociodemographic and individual factors, including age, sex, salary, job category, body mass index (BMI), educational level, and work experience. The second section assessed behavioral and psychosocial factors, including alcohol consumption, cigarette smoking, physical exercise, heat stress-related knowledge, attitudes and practices, coping mechanisms, and job satisfaction. The third section encompasses work organization-related aspects such as working hours, distance to heat source, commuting methods, work shifts, workdays, and previous heat exposure. The structured observational checklist focused on environmental factors potentially influencing heat stress, such as fuel source ventilation system efficiency, workload demands, clothing color, and the presence of heat-absorbent material.

2.4.4. Temperature and humidity measurement and heat-related symptom assessment

A waterproof thermo-hygrometer, specifically HYGROMETER PWT-411, was employed to record the temperature and humidity in 100 kitchens over 40 d. The instrument has an accuracy of (RH) ±2% relative humidity within the 10–90% RH range and ±0.8°C for both dry bulb temperature and humidity. Measurements were taken at midday coinciding with peak activity and positioned near the workstations where personnel were actively engaged. The workload for each individual was categorized as light, medium, or heavy based on the ACGIH standards. Subsequently, the WBGT was calculated using the average recorded values according to the following formula:

$$WBGT = 0.567 \times Ta + 0.393 \times e + 3.94 \quad (1)$$

where:

- ➢ Ta = Dry bulb temperature (°C)
- ➢ e = Water vapor pressure (hPa) [humidity]

And

$$e = (rh \div 100) \times 6.105\ EXP \frac{17.27TA}{237.7 + TA} \quad (2)$$

where: rh = relative humidity (%)

2.4.5. Data quality control

Adherence to the manufacturer's protocols ensured the meticulous calibration of the device by a trained expert. Data were collected using a structured questionnaire administered by interviewers. The questionnaire was initially drafted in English and was rigorously translated. First, it was meticulously rendered in Amharic, a local language. Subsequently, a back-translation process was implemented, returning the Amharic version to English to confirm consistency and preserve the original intent. To assess the instrument's efficacy and refine the questionnaire, a pre-test was conducted in Debre Tabor town with 33 kitchen workers mirroring the target work setting. Based on the pretest results, the instrument was consciously adjusted to optimize data collection. The reliability of the tool has been rigorously validated and evaluated. Three trained data collectors equipped with three days of intensive training were responsible for data acquisition. Each day, both the principal investigator and supervisor carefully reviewed the questionnaires for completeness, ensuring the data integrity.

2.4.6. Data management and analysis

Data collection was performed using the Kobo toolbox, a specialized software platform. Following data acquisition, the data were exported to the Statistical Package for Social Sciences (SPSS) version 26 for in-depth analysis. Descriptive statistics were calculated to summarize the collected data and elucidate key characteristics presented through narration, tabulation, and figures. The reliability analysis ensured internal consistency. Cronbach's alpha was used to assess respondent consistency for theoretically similar items. Prior to the bi-variable multivariable logistic regression analysis, normality, outliers, and multicollinearity were checked. The variance inflation factor (VIF) confirmed no significant multicollinearity (all VIF <1.294).

Binary logistic regression (bi-variable and multivariable binary logistic regression) analysis identified statistically significant associations between the independent and outcome variables. In the binary analysis, variables with a p-value <0.2 (statistically significant associations with the dependent variable) were considered candidates for the multivariable analysis to control for potential confounding factors. Within the multivariable binary logistic regression model (p-value <0.05 for significance) the adjusted odds ratio (AOR) with a 95% confidence interval was used to quantify the strength and direction of association between significant variables and the outcomes. The final model was reassessed for normality, outliers, and multi-collinearity. The Hosmer–Lemeshow test (p-value >0.05) was confirmed as a well-fitted model.

3. Results

3.1. Socio-demographic and individual factors

Of the 633 workers who initiated the survey, 605 (95.6%) completed it. The participant pool leaned females, with 551 women constituting 91.1% of the sample. Nearly half 49.1% ($n = 297$) were aged between 18 and 29 years. Regarding body mass index (BMI), approximately 67.8% ($n = 410$) had normal BMI. Work experience in the hospitality kitchen business revealed that over half 57% ($n = 345$) had two or fewer years of service. Cook positions were the most prevalent, making up 90.6% ($n = 548$) of the workforce (Table 1).

3.2. Behavioral and psychosocial characteristics of the participants

The survey revealed that 10.6% ($n = 66$) of the respondents were alcohol drinkers and none reported cigarette smoking. Regarding physical activity, a relatively low proportion 14%, ($n = 85$) engaged in regular exercise. Over half (54.9%, $n = 332$) exhibited poor knowledge of heat-related stress. Similarly, unfavorable attitudes towards heat stress precautions were identified in 51.9% ($n = 314$) of the respondants. Furthermore, concerning practices related to heat stress mitigation 64% ($n = 387$) of the respondents displayed poor practices. However, a positive finding emerged regarding common coping mechanisms. More than half of the participants 58.8% ($n = 356$) reported using showers to manage heat stress (Table 2).

3.3. Work-organizational characteristics of respondents

The majority of workers 60.5% ($n = 366$) reported experiencing heavy workloads and physically demanding jobs. Additionally, nearly half 48.3% ($n = 292$) of the participants had previous exposure to heat. In terms of experience, 43% ($n = 260$) of participants had been working for more than two years in the hospitality business. Furthermore, most of the workers 63% ($n = 383$) reported more than eight hours per day. None of the participants received training on heat stress. Regarding commuting methods, almost half of the participants 49.8% ($n = 301$) walked to the workplace. Shift work was also relatively common, with 34.5% ($n = 209$) of the participants working in this manner. Finally, a significant majority, (67.4%, $n = 408$) of the workers were reported in kitchens equipped with ventilation systems (Table 3).

Table 1
Socio-demographic and individual characteristics of participants ($N = 605$)

Socio demographic and individual variables		Frequencies (n)	Percent (%)
Sex	Female	551	91.0
	Male	54	8.9
Age	18–29	297	49.1
	30–39	231	38.2
	≥40	77	12.7
Marital status	Single	223	36.9
	Married	278	46.0
	Divorced	68	11.2
	Widowed	36	6.0
Educational level	Unable to read and write	40	6.6
	Primary (1–8)	453	58.3
	Secondary (9–12)	149	24.6
	Diploma/Degree	63	10.4
Body mass index	Underweight	97	16.0
	Normal	410	67.8
	Overweight	98	16.2
Length of service	≤2 year	345	57.0
	>2 year	260	43.0
Number of workers present	≤3 workers	278	46
	>3 workers	327	54.0
Job category	Chef	34	5.6
	Assistant chef	23	3.8
	Cooks	548	90.6

Table 2
Behavioral and psychosocial variables of participants ($N = 605$)

Behavioral and psychosocial variables		Frequency (n)	Percent (%)
Alcohol consumption	Yes	118	19.5
	No	487	80.5
Frequency of consumption	≤2 days	52	8.6
	>2 days	66	10.9
Physical exercise	Yes	85	14
	No	520	86
Frequency of exercise	<2 days for 30 min	0	0
	≥days for 30 min	85	14
Do you use tea/coffee to cool down	Yes	260	43
	No	345	57
Knowledge about heat stress	Good	273	45.1
	Poor	332	54.9
Attitude towards heat stress	Favorable	291	48.1
	Unfavorable	314	51.
Practice to mitigate heat stress	Good	218	36
	Poor	387	64
Individual concern of heat	Concerned	376	62.1
	Not concerned	229	37.9
Coping mechanism for heat related stress	Shower	356	58.8
	Rest in a cool area	230	38
	Wearing light cloths	19	3.1
Job satisfaction	Satisfied	179	29.6
	Unsatisfied	426	70.4

Table 3
Work organizational characteristics of participants ($N = 605$)

Work organizational variables		Frequency (*n*)	Percent (%)
Workload	Light	98	16.2
	Moderate	141	23.3
	Heavy	366	60.5
Previous exposure to heat	Yes	292	48.3
	No	313	51.7
Daily Working Hours	≤8 HRs	222	36.7
	>8 HRs	383	63.3
Are there additional break offered in summer?	Yes	319	52.7
	No	286	47.3
Distance from heat source	≤0.6 metres	325	52.7
	>0.6 meters	280	47.3
Drinking of Water during work	Yes	352	58.2
	No	253	41.8
Commute methods	Walk	301	49.8
	Taxi	95	15.7
	Both	209	34.5
Is there shift Work shift	Yes	209	34.5
	No	396	65.5
Number of Working days in a week	≤5 days	80	13.2
	>5 days	525	86.8
Colors of dress material	Light	173	28.6
	Dark	180	29.9
	Other	252	41.7
Access to place to cool down	Yes	242	40
	No	363	60
Ventilation system	No ventilation	197	32.6
	Natural	240	39.7
	Mechanical	113	18.7
	Mixed	55	9.1
Source of fuel	Wood	233	38.5
	Wood and stove	176	29.1
	Gas	51	8.4
	Electric city	145	24.0
Type of dress material	Natural fibers (Cotton)	189	31.2
	Blend (Cotton & polyester)	161	26.6
	Synthetic (Polyester)	200	33.1
	Other	55	9.1
Presence of Reflective shield in room	Yes	32	5.3
	No	573	94.7
Heat stress index (WBGT index)	≥TLV	318	52.6
	<TLV	287	47.4

3.4. Occupational heat-related symptoms

The findings of this study indicate a high prevalence of heat stress-related symptoms among kitchen workers in the hospitality business in Gondar City. Over two-thirds (67.1%, 95% CI: 63.0, 71.1) of participants reported experiencing at least one heat stress-related symptom within the last six months. Heavy sweating emerged as the most frequent symptom, affecting (43%, 95% CI: 38.7, 47.1) of the workers. Other commonly reported symptoms included tiredness (41.5%, 95% CI: 37.4, 45.3), dizziness, (37.5%, 95% CI: 33.9, 41.5) muscle cramp, (35.9%, 95% CI: 32.1, 39.8), headache (34.9%, 95% CI: 31.1, 38.5) nausea/vomiting, (21.0%, 95% CI: 17.7, 24.3), and fainting (6.6%, 95% CI: 4.6, 8.7) were reported less frequently (Fig. 2).

3.5. Environmental variables and heat exposure

A Significant proportion (52%, 95% CI: 48.8%, 56.7%) of hospitality business kitchen workers exceeded the occupational heat exposure limits established by the ACGIH. The average environmental conditions within those kitchens were: 32.34 (°C) dry bulb temperatures, 30.7% relative humidity; and a mean WBGT of 28.5 ± 2.5 (°C) (95% CI: 28.35, 28.74). Notably, WBGT scores ranged from 24 (°C) to 36 (°C) across the kitchens studied.

3.6. Factors associated with heat stress-related symptoms and heat exposure

An initial binary logistic regression analysis revealed that older age, high body mass index (BMI), physical inactivity, insufficient water consumption, poor practice to mitigate heat stress, heavy workload, wood heat source, absence of ventilation system, absence of shift work, inaccessibility to cool rest areas, and heat stress index above the TLV were significantly associated with heat stress-related symptoms. Additionally, the absence of a cool room, absence of ventilation system, unavailability of heat-absorbent, heavy workload, insufficient water intake, and wood fuel source were significantly associated with occupational heat exposure.

However, subsequent multivariable binary logistic regression analysis revealed a more nuanced picture, only older age group, poor practice to mitigate heat stress, heavy workload, wood heat source, absence of ventilation system, and heat stress index above the TLV were significantly associated with heat stress-related symptoms (Table 4). Notably absence of ventilation, unavailability of heat absorbents, and heavy workload were significant factors for heat exposure (Table 5).

4. Discussion

This groundbreaking investigation is the first to explore the prevalence of heat exposure-related symptoms among Ethiopian hospitality kitchen workers. Our findings revealed high burden of heat-related symptoms in this workforce. The observed prevalence was lower than that reported in a similar study conducted in India (82%) [30]. This discrepancy could be attributed to several factors. One possibility is the disparity in sample size, with the Indian study potentially having a smaller sample size than the present study. Furthermore, climatic disparities between the two countries, with India generally experiencing higher temperatures than Ethiopia could contribute to the observed differences in prevalence [31]. In addition, the timing of the study period may have played a role [32].

In contrast, this study revealed a significantly higher prevalence of heat stress-related symptoms compared to previous reports from Malaysia (50%) [10] and Durban (44%) [15]. Several factors could explain this discrepancy. First, the small sample sizes employed in previous studies could limit their generalizability. Second, the purposive sampling technique used in these studies may have introduced selection biases. Finally, unlike the present study, workers in the earlier study may have received heat stress mitigation training, potentially influencing their reported symptoms. Notably, the current investigation identified distinct determinant factors associated with symptoms related to occupational heat exposure.

Our study demonstrated a significantly elevated risk of heat stress symptoms among workers aged ≥40 years compared to their counterparts (18–29 years old). This finding aligns with previous studies conducted in Iran [21] and Japan [33], suggesting a potential age-related increase in physiological susceptibility to heat stress [34]. Alternatively, younger workers might demonstrate superior heat acclimatization than their older colleagues [35].

Furthermore, workers engaged in heavy workloads exhibited a greater propensity for heat stress symptoms than those engaged in lighter workloads [36]. This finding corroborates studies from southern India [26], New York City [18], and Finland [37]. A plausible explanation lies in the elevated metabolic heat load experienced by workers performing arduous tasks, increased heat strain, and heightened risk of heat stress [36,38].

Addtionally, this study revealed that workers utilizing wood as fuel exhibited a higher likelihood of developing heat-related symptoms. This can be attributed to the significant heat

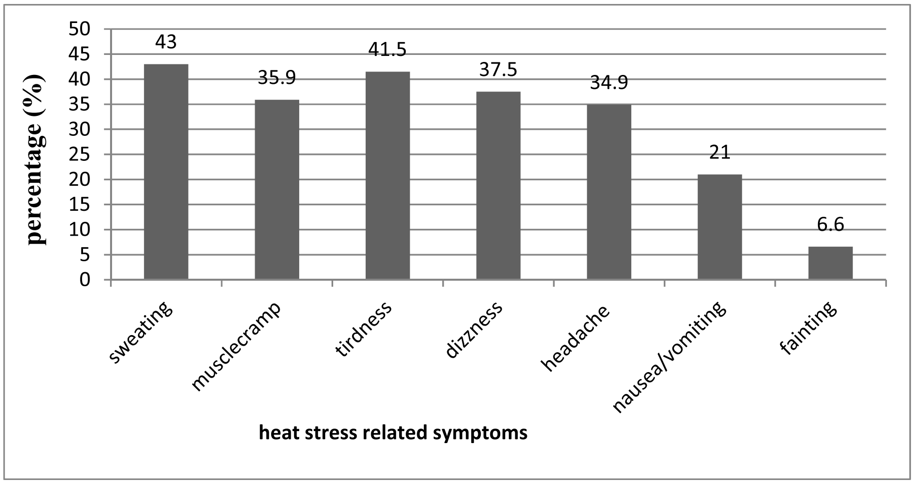

Fig. 2. Proportion of occupational heat-stress-related symptoms among kitchen workers ($n = 605$).

Table 4
Bivariable and multivariable binary logistic regression analyses of factors associated with heat stress-related symptoms ($N = 605$)

Variables		Heat stress symptoms		COR (95% CI)	AOR (95% CI)
		YES	NO		
Age	18–29	199	98	1	1
	30–39	142	89	0.78 (0.54,1.12)	0.86 (0.570,1.32)
	≥40	65	12	2.67 (1.37,5.16)	2.28 (1.08,4.82)***
BMI	Underweight	54	43	1	1
	Normal weight	284	126	1.79 (1.14,2.82)	1.58 (0.93,2.70)
	Overweight	68	30	1.81 (1.00,3.25)	1.79 (0.89,3.60)
Physical exercise	Yes	49	36	1	1
	No	357	163	1.60 (1.00,2.57)	1.47 (0.85,2.54)
Water consumption	Yes	225	127	1	1
	No	181	72	1.419 (1.00,2.01)	1.29 (0.85,1.95)
Practice to mitigate heat stress	Poor	292	95	2.80 (1.97,3.98)	2.39 (1.58,3.59)***
	Good	114	104	1	1
Workload	Light	54	44	1	1
	Moderate	78	63	1.00 (0.01,1.69)	0.94 (0.508,1.75)
	Heavy	274	92	2.42 (1.52,3.85)	1.89 (1.04,3.49)*
Is position Shift work	Yes	129	80	1	1
	No	277	119	1.44 (1.01,2.05)	1.38 (0.91,2.10)
Source of fuel	Wood	187	46	3.03 (1.91,4.81)	2.60 (1.54,4.40)***
	Wood and electric city	120	56	1.60 (1.01,2.52)	1.87 (1.00,3.20)
	Electric city	16	35	0.34 (0.17,0.67)	0.30 (0.14,0.65)
	Gas	83	62	1	1
Is there a way to cool down?	Yes	151	91	1	1
	No	255	108	1.423 (1.00,2.00)	1.00 (0.66,1.51)
Ventilation system	No ventilation	154	43	2.77 (1.47,5.21)	3.28 (1.56,6.87)*
	Natural	140	94	1.20 (0.60,21750)	1.10 (0.55,2.19)
	Mechanical	75	38	1.52 (0.78,2.95)	1.81 (0.84,3.92)
	Mixed	31	24	1	1
WBGT index	Above the TLV	250	68	3.08 (2.16,4.40)	2.15 (1.35,3.42)*
	Blow the TLV	156	131	1	1

Keys: - 1 Reference *statistically significant at $p < 0.05$; in multivariable analysis.
***statistically significant at $p < 0.0001$; in multivariable analysis.

generated by wood combustion and the associated high flue energy [9,39].

Moreover, Kitchen workers who reported practicing poor heat prevention behaviors exhibited a higher prevalence of stress symptoms compared to those who reported good practices. This aligns with a previous study conducted in northeast Italy [40]. The Occupational Health and Safety Administration (OSHA) highlights that workers with inadequate heat mitigation strategies are more susceptible to heat stress [41]. Alternatively, workers with poor practice might inadvertently expose themselves to more heat, which could involve staying closer to a heat source such as ovens or neglecting hydration breaks, thereby loading the overall heat load on their bodies [42]. To minimize individual exposure time consider using shorter exposures rather than a few longer ones, scheduling more workers, or performing hot jobs during cooler parts of the day when heat-generating systems can be shut down. Additionally, increases the rest periods and restricts them over time [43].

Our investigation revealed a significant prevalence of heat stress symptoms among workers working in kitchens devoid of

Table 5
Bivariable and multivariable logistic regression analysis of factors associated with heat stress exposure ($N = 605$)

Variables		Heat-exposure		COR (95% CI)	AOR (95% CI)
		Exposed	Not exposed		
Is there a way to cool down?	Yes	106	136	1	1
	No	212	151	1.801 (1.297,2.50)	1.420 (0.942,2.143)
The ventilation system	Has no ventilation	128	86	2.98 (1.48,5.97)	4.857 (2.13,11.09)***
	Mechanical	129	109	2.367 (1.19,4.72)	3.627 (0.99,4.19)
	Natural	47	64	1.47 (0.69,3.00)	2.73 (0.89,6.60)
	Mixed	14	28	1	1
Availability of heat absorbent in kitchen room	Yes	5	27	1	1
	No	313	260	6.50 (2.46,17.12)	6.01 (1.90,18.96)**
Source of fuel in the kitchen	Wood	159	74	1.50 (1.00,22.3)	1.46 (0.89,2.571)
	Wood and electric city	50	120	0.329 (0.208,0.52)	0.227 (0.131,0.391)
	Gas	18	33	0.38 (0.198,6.747)	0.245 (0.11,0.58)
	Electric city	85	60	1	1
The workload of the kitchen	Light	9	89	1	1
	Moderate	59	82	7.11 (3.31,15.25)	10.06 (4.465,22.64)
	Heavy	250	116	21.31 (10.37,43.7)	4.28 (1.85,7.25)**
Presence Reflective shield in room	Yes	10	22	1	1
	No	308	265	2.557 (1.189,5.49)	1.56 (0.64,5.43)
Do you take sufficient water during work	Yes	176	176	1	1
	No	142	111	1.27 (0.92,1.77)	1.18 (0.79,1.78)

Keys: -1 Reference, *statistically significant at $p < 0.05$, in multivarible analysis.
**Statistically significant at $p \leq 0.01$. ***Statistically significant at $p < 0.0001$. In multivariable analysis.

ventilation systems compared to their ventilated counterparts. This finding aligns with a prior study conducted in southern India [26]. First, kitchens lacking ventilation systems are likely to experience a significant rise in ambient temperature owing to the heat emitted by cooking and fuel sources [44]. Ventilation plays a crucial role in eliminating excess heat through convection and introducing refreshed air to replace exhausted air [45]. Second, the OSHA emphasizes ventilation as a cornerstone among engineering controls for mitigating heat stress-related issues [46]. In general Ventilation contributes to a healthier workplace environment [47].

Our investigation yielded an occupational heat exposure level (28.5 ± 2.5 °C) comparable to that reported in the Malaysia kitchen environment, where workers were demonstrably exposed to heat stress (28.2 ± 0.8°C) [10]. However, the observed ex-occupational heat exposure among workers within our study was provably lower compared to a study conducted in India (31.1 ± 0.2.7°C) [30], Egypt (31.6°C) [19], and Malaysia (29.66 ± 0.8°C) [34]. This discrepancy could potentially stem from variations in the climatic conditions across the study locations [31]. Additionally, it is possible that this study employed hygrometer readings and calculations to determine heat exposure levels which might not always be the complete picture compared to direct measurements [5].

Our study revealed a considerably higher occupational heat exposure level compared to that reported in New York City at 25.0°C [18]. This disparity can be attributed to two key factors. First, Ethiopia might have a lower prevalence well-functioning air-conditioning systems compared to the setting of a previous study [48]. Second, the predominant use of wood as a fuel in our study might have contributed to a significantly warmer environment as wood combustion generates more heat compared to alternative fuel sources [39].

Likewise, our study revealed a significantly elevated risk of heat exposure among kitchen workers lacking ventilation systems compared to their ventilated counterparts. This finding aligns with the results obtained in southern India [26]. First ventilation systems remove sufficient excess convective heat even at minimal airflow rates and introduce fresh air to replace the exhausted hot air, promoting air circulation and cooling [45]. Second this crucial process fosters a healthy workplace environment by facilitating heat dissipation [47].

Our investigation revealed a significantly increased risk of heat exposure among kitchens lacking heat absorbents compared with their counterparts. This finding is attributed to the absence of materials that capture and dissipate radiant heat emitted within the kitchen environment [49]. Additionally, the study demonstrated a positive correlation between heavy workloads and the likelihood of heat exposure. A plausible explanation for this result is the elevated metabolic heat load experienced by workers engaged in strenuous tasks increased heat production within the body coupled with external heat stress can lead to heightened heat strain and a magnified risk of heat stress [36,38].

Generally, in our findings, lack of adequate kitchen ventilation system posed a greater risk of heat stress than other factors. This is due to a synergistic effect: trapped heat from appliances and occupants elevates ambient temperature, while hindered moisture removal from cooking processes impedes evaporative cooling, significantly amplifying heat stress for staff regardless of the exertion level. The implementation of a new ventilation system effectively improves the thermal environment in the kitchen [49–51].

5. Conclusion and recommendations

Our investigation in Gondar City, Ethiopia, revealed that the prevalence of occupational heat exposure and heat-related symptoms was high among kitchen workers in the hospitality business. This translates to a significant risk of heat illness and reduced productivity. Several factors emerged as potential contributors to these symptoms, including inadequate heat mitigation practices, strenuous workloads (workers engaged in physically demanding tasks), kitchens utilizing wood fuel sources, absence of functional ventilation systems in the kitchen, higher ambient heat level indices, and older workers.

These identified factors highlight the need for multi-pronged interventions. In the immediate term, implementing effective heat mitigation strategies such as improved ventilation, provision of cooling solutions, and adjustment of work-rest schedules is crucial. Additionally, incorporating advanced building design principles and heat reduction technologies during kitchen construction can significantly improve the thermal comfort of workers. The reduction in hard manual labor and increased mechanization can significantly influence the heat stress level in the workplace.

Future research efforts would benefit from employing standardized heat stress assessment tools such as the Predictive Mean Value (PMV), Predicted Percentage Dissatisfaction (PPD), and Required Clothing Insulation (RCI). These tools provide comprehensive information regarding the thermal strain experienced by the human body, enabling researchers to develop more precise and effective heat stress mitigation strategies to protect kitchen workers in Ethiopia's hospitality sector.

CRediT authorship contribution statement

Christian Melaku: Writing – original draft. **Giziew Abere:** Methodology, Supervision. **Yifokire T. Zele:** Supervision, Validation. **Yimer Mamaye:** Formal analysis, Methodology. **Tadiwos A. Mekonen:** Data curation, Methodology, Supervision. **Anmut E. Bezie:** Validation, Visualization. **Amensisa H. Tesfaye:** Formal analysis, Supervision, Visualization. **Eshetu A. Worede:** Methodology, Validation, Visualization, Writing – review & editing.

Conflicts of interest

We declare that there are no conflicts of interest that could have influenced the design, conduct, or reporting of this study.

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