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A Review on Heat Stress Issues Among Workers at Automotive Service Centre

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ABSTRACT

Heat stress is a common occupational hazard workers experience in industries requiring outdoor and indoor activities. This article reviews the risk exposure occurrence of heat stress at automotive service centres for indoor and outdoor settings. The review article aims to investigate the problems and propose solutions that can be implemented to alleviate the symptoms of heat stress experienced by workers at automotive service centres that specialise in repairing tyres. The causes and symptoms of heat stress, such as dehydration, heat exhaustion, and heat stroke, are discussed at the beginning of this review. Generally, workers in automotive service centres must contend with various industrial adversities, including exposure to hot environments, machinery, and radiant heat.

1. Introduction

Climate change involves increased heat exposure [1] due to increasing world temperatures or global warming. This unbecoming climate change negatively impacts the daily activities of human life [2]. The increase in heat exposure levels is one of the most subtle effects of climate change [3], consequently affecting housing and indoor environments [4]. Working in hot weather is a hazard that can lead to serious illness [5]. Heat is a natural hazard, and much is known about the effects of high temperatures on the human body. Extreme temperatures can significantly impact health and burden public health and civil protection services [3]. Heat is a work environment factor that is very closely related to the health of workers [6] and must be seriously addressed since it strains the body, which may lead to discomfort, heart disease and even death [7,8]. Workers in various industries, such as mining, construction, manufacturing, and agriculture, are exposed to health hazards [9].

Moreover, the study found that warmer and sunny outdoor conditions can quickly increase indoor temperature and humidity [4]. The study also unveils the relationship between indoor temperature and heat-related health problems in the elderly. It is shown that the indoor environment could pose higher health risks than the outdoor environment [9]. Workers engaged in jobs involving

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operations under elevated air temperatures and humidity, or demanding physical activities, are at significant risk of experiencing heat stress [10]. Working in a hot environment or exposure to high temperatures can cause stress to the body [11].

Workers exposed to extreme heat or work in hot environments may be at risk of heat stress, and exposure to extreme heat may result in occupational illnesses and injuries. Outdoor workers and those working in hot environments are at risk of heat stress [12]. Heat stress is the total heat burden an employee may encounter, resulting from the combined effects of metabolic heat production, environmental conditions, and clothing demands. Heat stress occurs when the body's means of controlling its internal temperature starts to fail, i.e., the body fails to regulate internal temperature [11]. This review examines the evidence of risk exposure to heat stress among workers and investigates the potential interactions between the risk factors in the workplace related to the automotive service centres.

2. Methodology

2.1 Identify of Heat Stress Factors

Heat stress can significantly impact human health and well-being, particularly in an occupational setting or while engaging in physical activity in a hot environment. This study aims to identify the factors contributing to heat stress in the workplace by analysing data from previous studies. The review is limited to indoor jobs such as workshops and automotive service centres. Outdoor jobs like construction are excluded from the study.

2.2 Selection of Literature from Database

The selection of literature was made using an electronic database. This database included PubMed, Science Direct, Scopus, Springer Link, and Google. The materials involved in the study were published between 2000 and 2022. Keywords including risk factors, health disorders, radiation, environmental temperature, and heat stress were identified. These terms were then cross-searched with the keywords. Several databases were used for searches related to the keyword "heat stress" to find published research. If the work reports new data or performs a systematic review, its full papers will be acquired.

2.3 Extraction of Data

The next step is classifying the factors contributing to workers' heat stress. The factors affecting heat stress can be categorised into environmental and non-environmental factors. These factors may be independent but contribute to an employee's heat stress [11]. Variables considered in the assessment of heat exposure include individual characteristics such as Age, gender, body mass index (BMI), physical conditioning, clothing, illnesses, alcohol intake, smoking status [13] and obesity, chronic illness, and hydration status variables [6]. Data extraction was done independently, and disagreements were discussed and resolved. Research findings are summarised in a table before a detailed discussion.

3. Analysis of Previous Research

Based on previous studies, it can be concluded that the identified risk factors were categorised based on Age, weight, health conditions, hydration, clothing, work rate, air temperature, and relative humidity. Collecting data for each variable will assist in determining the availability of risk, the level of evidence, notes, citing references, and the measurement method. Table 1 shows the factors of heat stress among workers.

Table 1
The factors of heat stress among workers

Type of factors			Variable	Risk /No risk	Level of evidence	Noted	References
Non-Environmental Factors	Personal Factors	Age	≥ 40 years old	Risk			[6]
			< 40 years old	No risk			[14]
		Gender	Male and female		Male > female		[14] [15]
		Weight	Obesity ≥ 25 Body mass index (BMI)	Risk			[6]
			Not obese < 25 Body mass index (BMI)	No risk			
		Health Conditions	Chronic illness: Chronic Diseases	Risk			[6]
			Chronic illness: No chronic diseases	No risk			
		Hydration	Dehydration	Risk			[16]
		Clothing	Thick clothes (Not suitable)	Risk		Clothing which results in incremental heat storage in the body.	[16]
	Work Factors	Work Rate	Take rest	No risk			[10]
			Not rest	Risk			
		Temperature	Hot working place	Risk			
Environmental Factors		Air Temperature	≥ 38℃	High risk		The average normal body temperature is generally accepted as 37°C	[11] [17]
			< 38℃	Moderate risk			
		Relative Humidity	20% to 29%		Little discomfort		[18]
			30% to 39%		Some discomfort		
			40% to 45%		Great discomfort, avoid exertion		
			Above 45%		Dangerous, heat stroke possible		
Method of measurement			Wet-bulb globe temperature (WBGT)	Wet-bulb globe temperature (WBGT) is the most widely used index of heat stress			[19]

4. Discussion

Based on the results obtained, heat stress is one of the most hazardous agents in workplaces [2]. Many factors cause a person to get heat stress, comprising non-environmental, environmental, and management factors. The environmental temperature is the heat from outside the body, and the environment's temperature changes due to various factors [20,21].

4.1 Non-Environmental Factors

Individual risk factors can decrease heat tolerance and play an important role in the occurrence of heat stress disorders [22]. Personal factors such as Age, weight, health conditions, hydration, clothing, and work factors are frequently associated with heat stress at work. These are classified as non-environmental factors. Generally, men are more likely to do physically demanding jobs and undertake jobs in harsh environments, which puts them at higher risk in hot weather [15].

Based on previous studies, Age is also a significant risk factor for developing heat stress. It shows that the risk increases with increasing Age above 50 [23]. Workers at greater risk of heat stress include those 65 or older [12]. In general, subjective ratings of climate, perceived exertion and thirst were more noticeable in older workers than younger ones [24]. Furthermore, obese adults will develop a higher core temperature when exposed to heat. The elevation of core temperature is due to their higher fat thickness which causes an increase in thermal resistance between the core and skin, thereby obstructing heat dissipation [25]. Obese individuals may have lower thermal sensitivity to heat stimuli [26].

Subsequently, when exposed to heat strains, workers with chronic diseases would face the highest health risks among other workers [6]. However, there is no significant relationship between chronic diseases with heat strains, probably due to other more compelling, unknown factors. Another study highlighted that the risks of acquiring chronic diseases are anticipated to rise due to climate change [27]. Information from the previous review paper shows that workers with good hydration status were attained by consuming ≥ 8 glasses of water daily [28]. This finding shows that drinking sufficient water can help to prevent heat stress at work. Most of the workers that did not experience heat strains are among those who are well hydrated [6]. The research suggested ample water intake [29] to stay hydrated in a damp environment.

4.2 Environmental Factors

The most direct indicator of heat stress is air temperature. However, evaluating air temperature alone cannot accurately represent heat stress. Other environmental and personal factors should be considered, too [11]. Human health impacts depend on both temperature and humidity [42]. Air temperature is the leading factor in the heat exchange between the human body and the environment [30,31]. The warmer and sunny outdoor conditions quickly increased the temperature and humidity indoors [4]. If the humidity is sufficiently high, the sweat will be difficult to be released, hindering the body's ability to dissipate heat effectively. The human body core temperature of 37℃ can ensure optimal physiological conditions and tolerate small deviations in the mean of ± 1℃ without adverse health consequences [31]. The study also found that heat strain was linked to not taking enough breaks, not having access to shade, and not having enough water. Workers at the workshop generally complained of being tired, having headaches, and being thirsty [6].

Heat stress is a harmful physical agent in many industries. It can cause fatigue, lethargy, decreased productivity, increased errors, accidents, and heat-related diseases [32]. Heat stress can be managed by providing education and health promotion related to heat-related illnesses [33]. This research also shows the importance of regularly assessing workers' heat stress and giving them enough training to manage and prevent it. This heat exposure is worsened by inadequate rest breaks and a lack of welfare facilities [34]. Companies should carefully assign workloads in heat-stress areas for new workers and provide more drinking water in certain areas [6]. This provision is essential, particularly for workers with moderate and heavy workloads at risk of heat stress [35]. Heat stress can affect individuals differently; some people are more susceptible to it than others [11]. Examples of typical symptoms are listed as follows, and they could be fatal if no considerable medical attention is addressed.

i. Muscle cramps
ii. Heat rash
iii. Severe thirst - a late symptom of heat stress
iv. Fainting
v. Heat exhaustion – fatigue; giddiness; nausea; headache; moist skin
vi. Heat stroke - hot dry skin; confusion; convulsions; and eventual loss of consciousness

4.3 Method of Measurement

A measure of heat stress being used more frequently to index heat stress is [36] the wet-bulb temperature [37]. Most international federations use the WBGT for summarising environmental conditions [38]. WBGT is measured in conditions of direct solar radiation and is partially mitigated by wind speed, making it an appealing measure for estimating thermal conditions experienced by outdoor workers [39]. Hazard identified in confined space needs to be eliminated or reduced to acceptable condition before entry [49]. In order to effectively mitigate excessive heat strain, numerous industries rely solely on environmental parameters, specifically the Wet-bulb Globe Temperature (WBGT), to assess the level of heat stress [40]. Lastly, safety, health and risk assessment are the most important elements to be applied [41]. This research evidences the importance of enforcing safety measures, such as giving workers places to rest in the shade, ensuring they have enough water, and changing work schedules to avoid the hottest parts of the day. Sufficient water intake is imperative in preventing dehydration, which can result in heat stress-induced ailments. Providing drinking water stations or facilitating easy access to water within the workplace can promote hydration among workers.

5. Conclusions

Overheating in the summer is a common problem for automotive workshops, causing the workers to be exposed to hot environments, which can pose health risks [42]. Based on the available information, workplace heat stress is a well-known occupational health hazard [43-48] and can cause fatigue, decreased productivity, and heat-related diseases. Various factors, including individual, environmental, and management factors, will lead to this worrying occupation safety. Age, weight, health conditions, hydration, clothing, and work are non-environmental factors that can increase the risk of heat stress. Men are more likely to be at risk due to their physically demanding jobs and harsh working environments. Obese individuals, older workers, and those with chronic diseases are more vulnerable to heat stress. Workers should be well-hydrated and provided with regular breaks, access to shade, and sufficient drinking water to minimise heat stress. The most popular indicator of heat stress is air temperature, but it should always be considered with other factors. The wet-bulb temperature (WBGT) measures heat stress and is used more frequently to index heat stress. Management should provide education and health promotion related to heat-related illnesses, and workers should be given regular training to manage and prevent heat stress.

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