THE EFFECT OF HEAT STRAIN AND WORKLOAD INTENSITY ON PRODUCTIVITY AMONG INDOOR FACTORY WORKERS IN LAHORE, PAKISTAN: ASSESSING SUSTAINABLE PRACTICES AT THE WORKPLACE

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Abstract
This study examines the effects of heat strain and work load intensity on the productivity of indoor workers in Lahore, Pakistan from the sustainability of workplace practices perspective. Lahore's indoor factories tend to be poorly ventilated, and the intense work demands cause major health and safety issues. Heat strain has been worsened by the rise in temperature from climate change, resulting in physiological stress, fatigue, and reduced productivity. Using the quantitative approach, data were collected from workers between the ages of 18 and 60 during peak summer months using structured questionnaires. The results show a high negative correlation between heat exposure with workload intensity and worker productivity. Additionally, the study finds that there are key gaps in current practice such as poor ventilation, lack of rest breaks and limited awareness of the risks surrounding heat stress. Measures such as better insulation, energy-efficient cooling systems and worker-centred policies for reducing heat strain and optimised workload management are being suggested. Although the research set is limited to indoor factories in Lahore and does not include outdoor work settings, it does call for sustainable strategies to be developed for better health of workers, improved productivity and meeting international occupational health standards. This work will provide important input for policymakers tackling heat-related occupational hazards for developing countries.

INTRODUCTION

Due to rapid industrialization and climate change, workload intensity and heat strain are having evident effect on health and safety of workers and have become a critical challenge to be addressed in industrial settings. More than 470 million workers have been employed in the manufacturing sector globally, and their health, safety and productivity are compromised due to quite a significant number of them being exposed to high temperature and physical workload

(Gilworth et al., 2025; Tetzlaff et al., 2025; Butt et al., 2022).

The capacity of workers to lead a healthy and productive life is endangered by occupational heat strain which is defined as the consequence of environmental heat stress on the body. As compared to heat stress, which is relevant to environmental factors, heat strain is focused more on the physiological effect and a strain the worker's experiences when they are exposed to heat stress. Metabolic heat generation, clothing worn and environmental factors, all causes the body to store more heat and results in the heat strain (Wijayanto, 2025; Li et al., 2025).

Workload intensity is a critical element of occupational heat strain, and is measured by calculating the metabolic rates and is expressed in watt per square meter W/m2. The metabolic heat generated by light intensity work is usually 100-165 W/m², moderate intensity is between 165-230 W/m², and high intensity labor can exceed 230-290 W/m² (ISO 8996, 2021; Oi, 2025; Zhang et al., 2025).

The increase in workload intensity causes the body's heat generation to elevate proportionally, which when combined with environmental heat results in compounding effect (Sarı et al., 2025; Peng & Watanabe, 2025). A research demonstrates that the core body temperature, hear rate and sweat production rate of workers who are engaged in moderate intensity work at temperature more than 28°C, is higher in contrast to those workers who are experiencing light intensity work in the same working conditions. When workers are exposed to high workload intensity at elevated temperature, they might experience fatigue (Dehghan et al., 2025; Parsons, 2025).

Jay et.al (2021) states that it is expected that occupational heat strain might worsen due to climate change, globally which is threatening the health and wellbeing of people. In indoor industrial setting, heat strain is significantly influenced due to the interplay of external environmental factors, internal heat produced by machinery and processes, metabolic heat resulting from physical labor, and the thermal characteristics of personal protective equipment. According to a research, when workplace temperature is higher than 32°C, the productivity decreases by 15 to 20% and the loss is even greater which is up to 40% when temperature is above 35°C for manual labor jobs (Kwaro et al., 2025; Nath et al., 2025; Ekanayaka & Dahanayake, 2025).

The occupational heat strain issue is even more pronounced in Pakistan's industrial sector, particularly in large cities like Lahore. This city residing more than 14 million residents is the 2nd largest city of Pakistan, and is an industrial hub which is home to multiple manufacturing industries including textile, pharmaceutical, processing, leather industries and other sectors. The summer temperature in the city is usually more than 45°C (113°F) which when combined with increased level of humidity, results it to be extremely difficult to work in indoor environment. In order to tackle occupational heat strain and maintain industrial productivity, the concept of sustainable working practices has become very important. These strategies comprise of putting heat mitigation measures into practice, establishing detailed heat stress management procedures, improving workplace ventilation, providing sufficient hydration facilities, and optimizing work-rest cycles based on workload intensity assessing (Notley et al., 2025; Friedrich et al., 2025; Hofmann et al., 2025).

Objectives of Study

1. To assess the level of heat strain experienced by indoor factory workers in Lahore, Pakistan.
2. To assess the effect of sustainable practices on worker productivity under heat strain conditions.
3. To identify the workload intensity effect on heat strain on indoor factory workers.
4. To compare the effects of heat strain and workload intensity on productivity between male and female indoor factory workers.

Research Questions

1. What is the extent of heat strain experienced by indoor factory workers in Lahore, Pakistan?
2. How does workload intensity influence heat strain that effects worker productivity?
3. What are the effects of sustainable practices on the productivity of workers in Lahore, Pakistan?
4. How do heat strain and workload intensity differently affect the productivity of male and female indoor factory workers?

Although heat strain is being recognized widely for having serious occupational health repercussions but there is still a little knowledge on the effect on productivity due to heat strain and workload intensity in Pakistani Industrial setting. The current system in these industries is insufficient in managing these problems which influences the productivity of workers due to enhanced illnesses, absenteeism and various health and safety concerns.

The problem is complicated and usually involves the inadequate practices and procedures for assessing and evaluating heat strain, an absence of cooling interventions, a deficiency in sustainable workplace practices that are adapted according to the localized climate, and insufficient managerial awareness of the association between heat strain and productivity. Moreover, there is limited knowledge present to identify the various effects that workload intensity and heat strain causes due to their interaction, in Pakistani industries which ultimately effects the decision making process regarding intervention strategies.

These issues are responsible for significant implications for the economy. Recent researches on occupational heat stress have shown that poor management of workload intensity has significant economic consequences. Decreased productivity, increased rates in error, absenteeism, and elevated healthcare expenditures are some of the cascade repercussions of uncontrolled heat strain (Montazer et al., 2023). According to the findings from the systematic review, these effects are highly observable in manufacturing settings where employees deal with both metabolic and thermal stressors (Abuwaer et al., 2025; Burbank et al., 2025; Su et al., 2025).

This complication has wide-ranging effects on the productivity and profitability of organizations, the health and safety of individual employees, and overall economic growth. Decreased function in cognitive ability, reduced physical capability, enhanced weariness, and a heightened risk of heat-related illnesses are all experienced by workers who are subjected to extreme heat strain; these effects are aggravated at high labor intensities. From an organizational standpoint, unregulated heat stress results in increased absenteeism, higher error rates, lower productivity, higher healthcare expenses, and possible problems with regulatory compliance. The economic burden on society as a whole includes diminished industrial competitiveness, heightened strain on the healthcare system, and possible effects on Pakistan's overall economic growth and development objectives.

This research retains major relevance for Pakistan's indoor industries stakeholders and global communities and concerned with occupational health and safety and following of sustainable practices. In this research the critical gap has been discuss that has not studied much before, and understanding the effects on workers who work in high thermal especially in South Asia industries. This research is evidence based and provide local context to help industries to develop better policies in order to enhance their health and safety for workers.

The scope of this study covers the indoor factories workers in which they work in manufacturing facilities located in Lahore, Punjab, Pakistan. The target industries are textile manufacturing, food processing, pharmaceutical manufacturing chemical processing and leather production industries. And geographically industrial areas within Lahore are Sundar Industrial Estate, Qaid e Azam Industrial Estate and Kot lakhpat Industrial Area, the research is bounded within these industrial areas.

Since this research represents the short term effects of workload intensity and heat strain on productivity, and may exclude the long term health risk over the period of time. So, this research represents that time based limitation in understanding the effect of managing workload intensity and heat strain at indoor factories.

Research Model

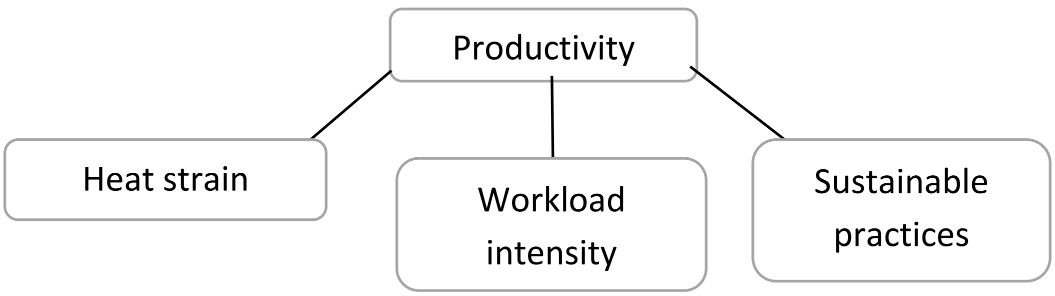

Figure 1: Flowchart of Dependent and Independent Variables

Literature Review

The concept of productivity is contingent upon the context in which it is utilized. It lacks an operational definition and a single, clear criterion. It is stated that "Productivity is an interdisciplinary approach to setting effective goals by using resources efficiently and still maintain quality" (Fang et al., 2025; Lu et al., 2025; Martin & Riley, 2025).

Labor productivity is associated with the real amount of work each employee performs for each hour they are paid, and when it is appropriate, it raises the company's quality standards (Ghozy et al., 2025; Siaw et al., 2025). Productivity, according to Wahyudi & Sunart., 2025, is a measure of production efficiency, which compares input and output. Input is frequently constrained by labor input, whilst output is quantified in numerical numbers. Productivity can be summed up as the ratio of the total resources used to the outcomes that can be obtained (output), such as the results of creating as many goods and services as feasible through efficient resource usage.

Effective and efficient productivity results can be achieved by implementing the following strategies in organizations: responsible management expertise, exceptional leadership, organizational and operational simplicity, effective staffing, challenging tasks, planning and controlling objectives, and special managerial training.

Productivity is what people can create with the least amount of work. The ability of an organization (person, industry, or nation) to transform input resources (people, materials, machinery, etc.) into goods and services is measured by a ratio called productivity (Yamang et al., 2025; Bancin et al., 2025; Arif, 2025).

Occupational heat strain has serious health and productivity consequences and should be treated as a public health issue. Given climate change and expected increases in heat stress, concerted worldwide action is required to counteract its effect (van Selm et al., 2025; Dehdashti et al., 2025). Occupational heat strain is the physiological effect of environmental heat stress on the body and it has a significant effect on the worker's ability to live healthy and productive lives; nearly 1 million work life-years are expected to be lost by 2030 due to occupational heat stroke fatalities, with 70 million work life-years lost due to reduced labor productivity (Gilworth et al., 2025; Tetzlaff et al., 2025).

Human health and well-being are at risk due to climate change, which is expected to worsen occupational health, leading to the combined effect of internal and external heat stress on the body. Finding affordable, sustainable, and efficient ways to lessen the adverse effects on employee productivity and health is, therefore, becoming more and more important. Climate change-related heat exposure and heat strain reactions have become an issue for the safety, health, and social well-being of the world's diverse population. This is particularly true for people who operate in environments that cannot be cooled by air conditioning, electric fans, or other cooling technology. (Moradi et al., 2024; Marinaccio et al., 2025; Ferrari et al., 2025).

Workload is a collection of work goals or desired outcomes that need to be accomplished in specific amount of time. In relation to this concept another view describe that the workload is an activity that requires the ability and expertise to do mandatory things in the form of physical and psychological within a particular time, it shows that workload not only task based but also depends on worker's capabilities to perform task. Workload is any work that requires muscle strength and the subject's thinking (Cao et al., 2025; Zhang et al., 2024).

Study shows that workload can cause emotional reactions including headache, dyspepsia, and irritability as well as physical and mental exhaustion. Fatigue is serious health issue that effects both mental and physical health and caused due to workload. Long-term weariness can impair cognitive function, impede productivity at work, and make one more prone to sickness. It is frequently linked to stress, unfavorable work conditions, and heavy workloads, which exacerbate chronic illnesses and lower general health. There is a considerable chance of accidents for industrial workers, which might result in lower productivity (Wahyuningsih et al., 2021). To support this, The ILO estimates that weariness plays a significant role in 2 million workers who perish in workplace accidents every year. 32.8% of the 58,115 employees polled said they were tired, a condition associated with the lower productivity (Thamrin, 2020).

The psychological effect of workload equally concerning workplace stress and workload are also important factors in influencing fatigue levels, which in turn effect productivity. Work related stress is exacerbated by heavy workloads, a lack of supervision, and monotonous duties (Steven & Prasetio, 2020). Psychological pressure and exhaustion can lead to carelessness and low morale and increase the rate of workplace accidents (Alviantika, 2020). In the meantime, employee's psychological states are typically linked to their mental state. Worker's relaxation periods are unpredictable when they have a lot of work to do and little time to do it. Employees may experience mental strain and stress as a result, which may make them more prone to acting in a dangerous manner. (Yulis et al., 2025; Sofiantika, 2020; Agustina & Mindiharto, 2024).

Generally, sustainability refers to the ability of surviving or thriving over time having significant effects whether from human perspective or in natural ecosystems. For instance, sustainability refers to the sustained efficiency as an ecological point of view whereas from a human perspective it refers to an opportunity for a long term welfare. So the very core of this approach is to meet present needs without compromising the ability of future generations to achieve their own needs. This state of balance is generally expressed through the concept of "triple bottom line" which encompasses economic, social and environment pillars (Alshebami, 2025; Florez-Jimenez et al., 2025).

When combined these findings show that sustainability is a strategic management as well as an environmental one. Sustainable practices can prevent future imbalances by prioritizing time and long term effects when making decisions. So in order to create a productive environment where workers wellbeing is prioritized by taking in account factors such as workload intensity and heat strain, sustainable practices should be implemented.

Research Methodology

Research Design

This paper employed quantitative, non-experimental research design to examine the impact of heat strain and workload intensity on the productivity of factory workers in Lahore, Pakistan, and the effect of sustainable practices on altering the impact. This design provided the possibility to statistically analyze the relationships between environmental and organizational factors and worker performance. Participants were informed and signed an agreement which was followed to the letter. The data was gathered in the months of June and July.

Research Population

The population consisted of manufacturing workers who work in various industrial sectors in the city of Lahore, but not limited to, the textile, steel, switchgear, electronic components and glass industries. These industries presented diverse working conditions and working practices.

Sampling Method and Study Sample.

Simple random sampling technique was used to provide each worker with equal opportunity to participate and thereby reduce selection bias. The ultimate sample involved 302 adult workers of ages 18 years or older (274 males and 28 females) who are at this time engaged in indoor factory employment in the city of Lahore.

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Research Tool

An online questionnaire was used to gather data by means of social networking sites, where participation was voluntary, and the aim of the study was clearly disclosed to the participants. The questionnaire was created based on adapting and paraphrasing questions in other validated instruments: seven items measuring heat strain on the Heat Strain Score Index; six items with a five-point scale on poor/excellent made up productivity; six questions based on the NASA Task Load Index (TLX) by Hart and Staveland were modified and their wording changed.

Validity and Reliability

Questionnaire items were based on already validated scales according to each variable to ensure validity. To test the reliability of the constructs being measured, Cronbach alpha was used to test the internal consistency of the constructs.

Data Collection

The data was gathered online in the summer. The procedures were conducted ethically that is having informed consent and ensuring anonymity and voluntary participation of the participants.

Data Analysis

Through the use of IBM SPSS software, it was analyzed. Descriptive statistics described demographic characteristics and primary variables. The suitability of parametric methods of testing was evaluated by analyzing skewness, kurtosis and Shapiro-Wilk statistic to check whether the data was normally distributed. The relationships among heat strain, workload intensity, sustainable practices and productivity were investigated using Pearson correlation. The predictive relationships between the independent variables on productivity were evaluated through multiple linear regression. A t-test of independent samples was used to investigate the differences between genders in productivity. The statistical significance of each test was taken as $p < 0.05$.

Demographic Analysis

Table 1: This table represents the gender distribution of participants, where the study included a total of 302 participants working in indoor factories in Lahore. Among them, 274 respondents were male, which accounts for 90.7% of the total sample. In contrast, only 28 respondents were female, representing 9.3% of the participants.

Gender of research participants

Gender	Frequency (f)	Percent (%)
Male	274	90.7
Female	28	9.3
Total	302	100.0

Table 2: This table represents the age distribution of participants in which the study involved a total of 302 participants working in indoor factories in Lahore. The age distribution shows that a majority of workers belong to the middle age categories. Specifically, the highest proportion (39.7%) of respondents were aged 30–39 years, followed by 36.8% in the 22–29 years' age group.

Workers aged 40 years and above made up 21.5% of the sample, while only a small number, 2.0%, were under the age of 20. This distribution represents that most factory workers are in their prime working age, ranging from their early 20s to late 30s.

Age group of research participants

Age	Frequency (f)	Percent (%)
Under 20	6	2.0
20-29	111	36.8
30-39	120	39.7
40 and above	65	21.5
Total	302	100.0

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Table 3: This table represent the education distribution of participant in which the study included 302 participants working in indoor factory settings in Lahore. The distribution of educational levels among these workers shows a wide range of qualifications.

The largest group of respondents, 82 individuals (27.2%), held a bachelor's degree or higher, while 69 workers (22.8%) had completed matriculation, and 66 workers (21.9%) had an intermediate-level education. A smaller number, 28 participants (9.3%), had diploma or technical training, and 57 individuals (18.9%) reported having no formal education.

Education level of research participants

Education	Frequency (f)	Percent (%)
No formal education	57	18.9
Matric	69	22.8
Intermediate	66	21.9
Diploma/technical training	28	9.3
Bachelor's degree or higher	82	27.2
Total	302	100.0

Table 4: This table represent the year of experience of 302 participants in which the data shows that the highest number of participants (76 workers, 25.2%) had more than 10 years of experience. This was followed by 68 workers (22.5%) with 4–6 years of experience, and 65 workers (21.5%) with 7–10 years of experience.

Additionally, 60 workers (22.2%) had 1–3 years of experience, while only 26 participants (8.6%) were relatively new, having less than 1 year of experience.

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Years of Experience of research participants

Years of experience	Frequency(f)	Percent (%)
less than 1 year	26	8.6
1-3 years	67	22.2
4-6 years	68	22.5
7-10 years	65	21.5
More than 10 years	76	25.2
Total	302	100.0

Table 5: This table represents the distribution of industry sectors in which the study involved 302 workers from multiple indoor factories in Lahore. The largest group of respondents, 142 workers (47.0%), were employed in other industries, including steel mills, switchgear manufacturing, and glass industries. These industries show high temperatures. The largest sector was the electronic component industry with 93

participant 38% which also involved heat tion and other industries in which textile industry with 42 workers 14.6% a common and labor-intensive sector in Lahore, smaller proportions of respondents came from packaging emitting machinery and limited ventila 2.6%, industrial materials and machinery 2.0%, petrochemical and chemical 1.3% and food and beverages 1.0% industries, the transportation and logistics sector had to respondents 0.7%.

Sectors distribution of research participants

Sectors	Frequency (f)	Percent (%)
Electronics components industry	93	30.8
Food & beverage industry	3	1.0
Industrial material & machinery industry	6	2.0
Petrochemical & chemical industry	4	1.3
Transportation & logistics industry	2	.7
Textile industry	44	14.6
Packaging industry	8	2.6
Others(Steel mill, Switchgear & Glass)	142	47.0
Total	302	100.0

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Reliability Test

Table 6: The reliability analysis for the heat strain scale, including 7 items, resulted in a Cronbach's Alpha of 0.711, showing acceptable internal consistency. This suggests that the items reliably measure the construct of heat strain in the sample.

Heat strain

Cronbach's Alpha	**N of Items**
.711	7

Table 7: The reliability analysis for workload intensity scale, which comprised 6 items, produced a Cronbach's Alpha value of 0.763, showing an acceptable level of internal consistency. This suggests that the items are sufficiently correlated and reliably measure the construct of workload intensity.

Workload Intensity

Cronbach's Alpha	**N of Items**
.763	6

Table 8: A reliability analysis was conducted to assess the internal consistency of 6 6-item scale measuring the effect of heat strain on workers' productivity. The analysis shows result of Cronbach's Alpha of 0.829, indicating good internal consistency. This shows that items are highly correlated and reliably measures the constructs of productivity.

Productivity	
Cronbach's Alpha	**N of Items**
.829	6

Table 9: A reliability analysis was conducted for the sustainability scale, including 5 items. The analysis produced a Cronbach's Alpha of 0.754, indicating acceptable to good internal consistency. This suggeststhat the items are sufficiently correlated and reliably measure the construct of sustainability in the study.

Sustainability	
Cronbach's Alpha	**N of Items**
.754	5

Correlation tests

relationship between heat strain and productivity among 302 participants. The results show a negative Pearson correlation coefficient of −0.188, which is statistically significant at the

Table 10: The correlation analysis examined the 0.01 level (p = 0.001). This shows that as heat strain increases, productivity tends to decrease. However, the strength of the correlation is weak, suggesting that while heat strain is associated with lower productivity, the effect is moderate.

Heat Strain & Productivity			
		Heat Strain	Productivity
Heat Strain	Pearson Correlation	1	-.188**
	Sig. (2-tailed)		.001
	N	302	302
Productivity	Pearson Correlation	-.188**	1
	Sig. (2-tailed)	.001	
	N	302	302

Correlation is significant at the 0.01 level (2-tailed).

Table 11: The results show a significant negative correlation (r = −0.241, p = 0.000) between heat strain and sustainability among 302 participants. This shows that higher heat strain is associated with lower sustainability scores. The relationship is weak to moderate in strength, suggesting a clear but not strong negative correlation between the two variables.

Table 12: The results show a significant positive

Heat Strain & Sustainability

		Heat Strain	Sustainability
Heat Strain	Pearson Correlation	1	-.241**
	Sig. (2-tailed)		.000
	N	302	302
Sustainability	Pearson Correlation	-.241**	1
	Sig. (2-tailed)	.000	
	N	302	302

Correlation is significant at the 0.01 level (2-tailed).

correlation ($r = 0.531$, $p = 0.000$) between workload intensity and productivity among 302 participants. This shows that higher workload intensity is linked with higher productivity. The strength of the correlation is moderate to strong, suggesting a clear and meaningful positive relationship between these two variables.

Workload Intensity & Productivity

		Workload Intensity	Productivity
Workload Intensity	Pearson Correlation	1	.531**
	Sig. (2-tailed)		.000
	N	302	302
Productivity	Pearson Correlation	.531**	1
	Sig. (2-tailed)	.000	
	N	302	302

Correlation is significant at the 0.01 level (2-tailed).

Table 13: The results show a significant positive correlation ($r = 0.268$, $p = 0.000$) between workload intensity and sustainability among 302 participants. This indicates that higher workload intensity is associated with higher sustainability scores. The strength of the correlation is weak to moderate, suggesting a positive but modest relationship between the two variables.

Workload Intensity & Sustainability

		Workload intensity	Sustainability

Workload Intensity	Pearson Correlation	1	.268**
	Sig. (2-tailed)		.000
	N	302	302
Sustainability	Pearson Correlation	.268**	1
	Sig. (2-tailed)	.000	
	N	302	302

Correlation is significant at the 0.01 level (2-tailed).

Table 14: The results show a significant positive correlation (r = 0.697, p = 0.000) between productivity and sustainability among 302 participants. This shows that higher productivity is linked with higher sustainability. The strength of the correlation is strong, suggesting a clear and strong positive correlation between the two variables.

Productivity and Sustainability

		Sustainability	Productivity
Sustainability	Pearson Correlation	1	.697**
	Sig. (2-tailed)		.000
	N	302	302
Productivity	Pearson Correlation	.697**	1
	Sig. (2-tailed)	.000	
	N	302	302

Correlation is significant at the 0.01 level (2-tailed).

Descriptive Statistics

Table 15: The descriptive statistics of the variables of the heat strain, productivity, sustainability and work load intensity among the indoor factory workers in Lahore show significant trends. Mean heat strain score is 12.18 with a median of 12.00 representing moderate level of heat stress among the majority of the workers. But the standard deviation of 5.76 indicates a wide range of differences in experiences of heat strain. Negative values are impossible so the minimum heat strain of -3 must be an error or an outlier, whereas the maximum of 27 indicates that some workers experience high heat strain.

Concerning productivity, the mean score is 20.26 and the median is 19.5 indicating moderate to high productivity levels despite the hot weather. The standard deviation of 5.07 shows variation that could be caused by the varying heat and workload exposure. The scores on productivity have wide variability, between 6 and 30, as they represent the different levels of work performance.

The mean of sustainability scores is 16.02 and median is 15, indicating that the workers overall have a medium ability to sustain work under heat and workload pressure. The standard deviation of 4.52 points indicates that there exists a variation to some extent in endurance amongst the workers. The range of scores is between 5 and 25, which indicates that some participants have a difficult time with the performance, whereas others can cope much better.

The median workload is 19 and the mean workload is 20.09, meaning that the majority of workers have a moderate to high workload. There is variation with a standard deviation of 4.59. The scores of the workloads are between 7 and 30 which represents that some workers have fewer workloads whereas others are subjected to extremely high workloads.

SD, Maximum, Minimum, Mean and Median Values

	Heat strain	Productivity	Sustainability	Workload Intensity
Mean	12.1821	20.2583	16.0232	20.0894
Median	12.0000	19.5000	15.0000	19.0000
Std. Deviation	5.76822	5.07153	4.52488	4.58750
Minimum	-3.00	6.00	5.00	7.00
Maximum	27.00	30.00	25.00	30.00

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Independent Sample T Test

Table 16: The Levene's test indicates that the assumption of equal variance was met, **p=.118**. This independent samples t-test showed that there was a statistically significant difference in productivity between male and female respondents, **t-test p =.015,** which indicates that gender has a significant effect on productivity level in this study.

Variables	Levene's Test for Equality of Variances		t-test for Equality of Means	
	F	Sig.	Sig. (2-tailed)	Std. Error Difference
Equal variances assumed	2.462	.118	.015	.99791
Equal variances not assumed			.009	.88669

ANOVA Test

Table 17: The ANOVA test for total productivity shows that gender (df = 1, F = 5.945, p = 0.015) has a significant effect, meaning men and women have different average productivity levels. Age (df = 3, F = 2.125, p = 0.089) does not have a significant effect, so productivity is fairly similar across age groups. Education (df = 3, F = 0.804, p = 0.495) also shows no significant difference, indicating people with different education levels perform about the same in terms of productivity. Years of experience (df = 3, F = 9.829, p = 0.000) has a highly significant effect, showing strong differences more experienced workers tend to be more productive. Sector (df = 2, F = 8.409, p = 0.000) also has a highly significant effect, indicating productivity varies clearly across different work sectors. Overall, this analysis suggests that companies aiming to improve productivity should focus on experience and sector differences, while gender differences may also be important to consider, whereas age and education levels seem less relevant in explaining productivity differences in this group. It is shown below:

ANOVA					
GENDER	**Sum of Squares**	**Df**	**Mean Square**	**F**	**Sig.**
Between Groups	152.448	1	152.448	6.026	.015
Within Groups	7589.406	300	25.298		
Total	7741.854	301			
AGE	**Sum of Squares**	**Df**	**Mean Square**	**F**	**Sig.**
Between Groups	167.198	3	55.733	2.193	.089
Within Groups	7574.657	298	25.418		
Total	7741.854	301			
EDUCATION	**Sum of Squares**	**Df**	**Mean Square**	**F**	**Sig.**
Between Groups	87.525	4	21.881	.849	.495
Within Groups	7654.329	297	25.772		
Total	7741.854	301			
YEARS OF EXEPRIENCE	**Sum of Squares**	**Df**	**Mean Square**	**F**	**Sig.**
Between Groups	527.349	4	131.837	5.427	.000

	Sum of Squares	Df	Mean Square	F	Sig.
Within Groups	7214.505	297	24.291		
Total	7741.854	301			
SECTOR	**Sum of Squares**	**Df**	**Mean Square**	**F**	**Sig.**
Between Groups	2614.919	7	373.560	21.421	.000
Within Groups	5126.935	294	17.439		
Total	7741.854	301			

Findings

This research study has shown that there is a great deal to learn about the connection between heat strain, the intensity of workload, sustainable practices and productivity amongst the workers in the indoor factories in the city of Lahore, Pakistan. The data of 302 participants were analyzed and it can be concluded that heat strain is statistically negatively correlated with productivity ($r = -0.188$, $p = 0.001$) meaning that the higher the heat strain experienced by workers, the lower is their productivity, but the relationship between heat strain and productivity is moderate. In the same way, there is a negative relationship between heat strain and adoption of sustainable practices ($r = -0.241$, $p < 0.001$), so the more a company is exposed to high heat levels, the lower the sustainability score, which could be due to difficulties in ensuring sustainable working conditions in cases of high heat condition.

Workload intensity, on the other hand, is positively correlated with productivity ($r = 0.531$, $p < 0.001$), proving that productivity levels are higher in the presence of more workload pressures among employees. Intensity of workload is also positively associated with sustainability ($r = 0.268$, $p < 0.001$), but to a lesser degree and thus, the result indicates that employees with increased workloads are more likely to be actively engaged in sustainable working practices. Moreover, the correlation between productivity and sustainability is highly positive ($r = 0.697$, $p < 0.001$), which explains the significance of sustainable management practices as a way of fostering productivity.

Descriptive statistics shows that the workers experience a moderate amount of heat strain (mean = 12.18) and work load intensity (mean = 20.09) and the workers productivity is moderate to high (mean = 20.26) which is good despite the challenging conditions. A further result of gender analyses is that the productivity of male and female workers is statistically different ($p = 0.015$), indicating that gender does affect productivity variation. Also, experience and industry of work are important determinants of productivity, where older and more experienced workers, as well as those in some industries, have higher productivity ($p < 0.001$), whereas age and education no longer seem to play a significant role.

Overall, our results highlight the intricate interplay of heat strain, workload intensity, and sustainable practices in determining worker productivity in indoor factory environments. They say interventions to minimize heat strain with better ventilation, rest breaks, and cooling equipment, as well as optimal workload management and promotion of sustainable practices are key to improve productivity and worker well-being in these conditions. The findings of the study indicate that effective strategies for maintaining health and a productive economy in Lahore require sustainable workplace practices that are appropriately adjusted to the local climate and industrial conditions.

Discussions

In line with global studies on climate change and its impact on occupational heat stress (Gilworth et al., 2025; Jay et al., 2021), the study shows the crucial role of occupational heat strain and workload intensity in the work productivity of indoor factory workers in Lahore, Pakistan. The moderate negative correlation between heat strain and productivity supports that higher exposure to heat negatively impacts physical and cognitive functioning, resulting in fatigue and reduced work performance (Kwaro et al., 2025; Nath et al., 2025). This is consistent with evidence that productivity decreases substantially when temperatures in the workplace exceed 32 °C, with manual laborers being particularly affected when temperatures are above 35 °C (Ekanayaka & Dahanayake, 2025).

Furthermore, the negative relationship between heat strain and sustainability observed suggests that high thermal stress undermines sustainable workplace practices, which highlights the need for environment-specific heat mitigation strategies. This relationship is aligned with the conceptual model of sustainability, which combines economic, social, and environmental aspects in order to achieve long-term organizational sustainability (Alshebami, 2025; Florez-Jimenez et al., 2025). The findings advocate for strategic interventions including improved ventilation, optimized work-rest schedules, hydration access, and energy-efficient cooling systems to address the compounded effect of heat and workload on workers' health and productivity (Notley et al., 2025; Friedrich et al., 2025).

In contrast, the positive association between workload intensity and productivity suggests that increased task demands may enhance output, reflecting the complex balance between work motivation and performance efficiency (Yamang et al., 2025; Bancin et al., 2025). Nevertheless, this should be viewed with caution, bearing in mind that too much workload may also lead to stress, fatigue, and risks of accidents, which ultimately affect long-term productivity (Wahyuningsih et al., 2021; Steven & Prasetio, 2020). The small positive relationship between workload intensity and sustainability also suggests that engaged employees might be more likely to demonstrate sustainable work behaviors, but this is worth further exploration.

Notably, the strong positive relationship between sustainability and productivity confirms that implementing sustainable practices results in a better workforce well-being and productivity (Florez-Jimenez et al., 2025). This indicates the need for organizations to implement a holistic, worker-centric approach when developing policies to minimize heat strain and properly manage workload in order to maintain productivity in adverse thermal conditions (Hofmann et al., 2025; Notley et al., 2025). Not only was there a noteworthy relationship between gender and productivity, there were observations that align with prior research which brings attention to gendered differences in tolerance to heat and occupational productivity outcomes (Gilworth et al., 2025). Moreover, the observed effects indicator of experience and sector in impacting productivity draws upon the idea that individual knowledge and expertise, as well as the sector they belong to, can relate to the outcomes of their performance when exposed to heat stress (Arif, 2025; Bancin et al., 2025).

Overall, this study provided valuable local evidence reinforcing the significant need for sustainable, and climate adaptive workplace interventions to support and maintain productivity within Lahore's industrial sector. If we address heat strain and workload intensity using sustainable tailored solutions proactively, we can not only protect workers, improve productivity, but also promote economic capacity in the face of growing climatic challenges (Montazer et al., 2023; Marinaccio et al., 2025). Future research should explore implications of long-term health outcomes as well as individual variability towards refinement of the intervention framework for occupational heat stress in other developing contexts.

Conclusion

This research indicates that heat strain is an important factor that lowers the productivity of factory workers working in closed factories in Lahore, Pakistan, and the intensity of work is positively correlated with productivity but will be hazardous to workers in the event it is not managed effectively. The study demonstrates the important role of sustainable workplace practices--particularly, proper ventilation, heat reduction strategies, and effective work-rest regimens--in lessening worker health risks and increasing productivity in high-temperature workplaces. These issues require specific types of policies and interventions in order to create safer, more efficient and sustainable manufacturing industries in developing nations such as Pakistan.

Recommendations

1. To reduce the incidence of heat strain in industries, industries in Lahore are advised to adopt heat mitigation strategies, including enhanced ventilation and installation of energy-efficient cooling systems, and sufficient hydration facilities to alleviate the burden of heat on workers, thereby enhancing health and productivity.
2. To prevent fatigue, increase sustainable work practices, and sustain high productivity levels in high-temperature environments, employers must design and implement worker-oriented policies that maximize workload management and introduce frequent rest periods as part of the workload-based assessment to determine the most appropriate workload levels.

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