

Assessment of Workplace Stress Impacts in Omdurman Locality, Khartoum State, Sudan.

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Abstract

This study is an attempt to assess Work stress using work-related stress questionnaire (Karasek) among 241 workers and measured thermal stress using Wet Bulb Globe Temperature (WBGT) in °C taking into consideration the plight of the Sudan, hot climates, in different industrial sectors in Omdurman to improve working. This study covers food industries, oils and soap, iron and metals, plastic, cement, and derivatives. Ninety-two factories in various industrial sectors were visited to collect data on the workplace and individuals (241 workers were surveyed for possible heat stress exposure such as name, age, sex, occupation, work duration, shift, working hours, habits related to smoking, etc.). This study found that psychological demands represented the most significant causes of stress. This study showed that socio-demographics, job characteristics, and work-related and related factors were highly influential in developing high heat stress. The study shows a relation between the upper limits of heat and high workplace stress and illustrates the variation of heat stress between different industry types. Plastic, food, iron and metals, and cement, and derivatives. Socio-economic factors among workers were examined by the study to ascertain if there was a significant relationship between high-stress symptoms development among the workers; the study also inspects the association between high stress and factors such as working hours, shift system, marital status, personal hobbies, and bad habits. This present study aims to propose the guidelines for Occupational Health and Safety (OHS) for the prevention of heat stress and workplace stress.

Keywords

Workplace stress impact, Omdurman locality

INTRODUCTION

General

Due to changes like globalization, people in developing countries must deal with increasing work-related stress.

In industrialized countries, people are becoming more familiar with work-related stress and how to manage it. However, in developing countries, this may not yet be the case. Although some research has

been conducted in developing countries, there are still not enough in-depth studies to comprehensively analyze cultural differences and behaviors, which vary from country to country. Along with existing difficulties in controlling other more well-known occupational risks, such as lack of awareness of work-related stress and shortage of resources to deal with it.

The situation is made worse by the lack of occupational health services coverage. WHO estimates worldwide that only 5-10% of the workers in developing countries have access to adequate occupational health services, in addition to 20-50% in industrialized countries. However, work-related psychosocial issues are rarely dealt with by these, even where they are available.

Although we can now report an array of research on the magnitude of causes and consequences of work-related stress in developed and industrialized countries, work-related stress is still considered a problem that is far from being resolved. In turn, very little data is available from developing countries. (WHO, 2007)

Despite significant industrial developments in Sudan, there is no adequate research on work-related stress assessment, especially in factories in the Omdurman area.

This study aimed to provide baseline data on workplace-related stress assessment in Omdurman locality industrial sectors. Such data might be appropriate recommendations for future safety and health programs, which would hopefully help reduce possible work-related stress and manage it.

The industrial sectors in Sudan include food, leather, oils, and soap, building, textile, engineering, printing, and packing.

Omdurman locality is the national capital and a center of population density comprising various tribes, religious sects, customs, and cultures, and it is the most essential industrial estate of the capital.

OBJECTIVE

General Objective

To assess work-related stress in workers of industries and to propose preventive mitigation measures for management.

Specific Objectives

1. To study work-related stress causes among exposed workers.
2. To study work-related stress status according to demographic and Job Characteristics
3. To compare the obtained results between the different studied industrial sectors
4. To study work-related stress status and heat stress measurement (WBGT (0C):

LITERATURE REVIEW

Assessment of work-related stress impact in different industries is a severe issue because a safe workplace plays a vital role in the workers' health, production, and safety.

For instance, workers have the right to know about workplace hazards, including how to identify risks and protect themselves from those hazards (Zhu et al., 2016)

WORK-RELATED STRESS

Definitions

Stress is an adverse reaction to excessive pressures or demands placed on them. There is a clear distinction between pressure, which can create a 'buzz' and be a motivating factor, and stress, which can occur when this pressure becomes excessive. (Cox, et al,2000)

Work-related stress is a pattern of reactions that occurs when workers in the workplace are presented with work demands that are not matched to their knowledge, skills, or abilities and challenge their

ability to cope. When there is a perceived imbalance between demands and environmental or personal resources, reactions may include physiological, emotional, cognitive, and behavioral responses. (HSE, 2007) In addition, job stress can be defined as the harmful physical and emotional responses that occur when the job requirements do not match the worker's capabilities, resources, or needs. Job stress can lead to poor health and even injury. (Hassard, 2018)

Potential source of stress

Although individual and organizational characteristics play a role in developing work-related stress, most will agree that work-related stress results from the interaction between the worker and work conditions. Views differ, however, on the importance of worker characteristics versus working conditions as the primary cause of stress. These differences are significant since they suggest and lead to different ways to prevent the source of stress at work.

Working condition

The most common cause of stress may be work, psychosocial, or physical factors. High job demands and high work pace, time pressure, lack of control (work pace, and also related to physical risks), low participation, little support from colleagues and supervisor, poor career developments, job insecurity, long working hours, low income and sexual and psychological harassment are of psychosocial. However, physical factors include high noise levels, lighting, heat stress, etc.

Work-home interface

Work-related stress may additionally result from a poor balance at the home-work interface, with particularly severe consequences of Conflict of responsibilities and roles, particularly for women, home is the workplace, family exposure to work-related hazards, domestic violence, physical assault, rape and difficulties in daily life (Gross, 2021)

Worker personnel characteristics

One view promotes that individual differences of the worker, such as personality, age, education, experience, and coping style, are most important in predicting whether certain job specifications will result in stress. (Gross, 2021)

Consequences of work-related stress

When workers experience work-related stress, it may lead to various physiological, emotional, cognitive, and behavioral reactions.

1. Physiological symptoms:

These are due to changes in an individual's health due to stress. Stress could create changes in metabolism, increase heart and breathing rates, increase blood pressure, bring on headaches, and induce heart attack. (Soylu, 2008 Gillespie et al,2001)

2. Psychological symptoms:

Stress can cause dissatisfaction, decreased attention, anxiety, irritability, boredom, procrastination, narrowing of perception, forgetfulness, less problem-solving, and reduced learning ability.

3. Behavioral symptoms:

Behavioral-related stress symptoms include changes in productivity, increased production errors, increased sickness, absence, and turnover, as well as changes in eating habits, increased smoking, increased drug use and, or alcohol consumption, rapid speech, and sleep disorder. (Na,2018 and Giorgi, 2017)

Management of work-related stress

The Health Safety Executive (HSE) developed the management standard approach to help reduce the work-related stress reported by British workers.

The management standards are defined as an organization's characteristics or culture, where the risks from work-related stress are effectively managed and controlled.

They cover six areas of work design. These are- job demands, control, social support, workers' relationships, work roles, and organizational change. (Van der Klink, 2001 and Cousins, et al, 2004 Santos, et al 2017 and Bouillon-Minois, 2021 and Campbell, Wiernik, 2015)

1. Job Demands

The job demands include workload, work patterns, and the work environment. The standard is defined as employees' ability to cope with the needs of their local job systems to respond to individual concerns.

The organization provides employees with adequate and achievable demands for the agreed work hours. People's skills and abilities match the job demands; jobs are designed to be within employees' capabilities, and employees' concerns about their work environment are addressed. (Lecca, et al, 2020)

2. Job Control

How much say the person has in the way they do their work. The standard is that employees indicate that they can have a say in how they do their work, and systems are in place locally to respond to individual concerns.

Where possible, employees have control over their pace of work; employees are encouraged to use their skills and initiative to do their job; where possible, employees are encouraged to develop new skills to help them undertake new and challenging pieces of work.

Also, the organization encourages employees to develop their skills; employees have a say over when breaks can be taken and are consulted over their work patterns. (Hessels, 2017)

3. Organizational Social Support

Organizational social support includes encouragement, sponsorship, and resources provided by the organization, line management, and colleagues. Meanwhile, the standard means employees indicate that they are receiving adequate information and support from their colleagues, superiors, and systems in place locally to respond to individual concerns.

What should be happening /states to be achieved: the organization has policies and procedures to support employees adequately; systems are in place to enable and encourage managers to support their staff; systems are in place to allow and encourage employees to support their colleagues; employees know what support is available and how and when to access it; employees know how to access the required resources to do their job and employees receive regular and constructive feedback. (Park, et al, 2004 and Eisapareh, et al, 2020)

4. Worker's Relationship

Includes promoting positive working to avoid conflict and dealing with unacceptable behavior; the standard is that:

Employees indicate that they are not subjected to unacceptable behaviors, e.g., workplace bullying, and systems are in place locally to respond to individual concerns.

The organization promotes positive behaviors at work to avoid conflict and ensure fairness; employees share information relevant to their work; the organization has agreed policies and procedures to prevent or resolve unacceptable behavior; systems are in place to enable and encourage managers to deal with inappropriate behavior; and systems are in place to allow and encourage employees to report inappropriate behavior. (Thorsteinsson, et al, 2014)

5. Work Role

Whether people understand their roles within the organization and whether the organization ensures that the person does not have conflicting roles, the standard is that employees indicate that they know their roles and responsibilities. Systems are in place locally to respond to individual concerns.

The organization ensures that, as far as possible, the different requirements it places upon employees are compatible; the organization provides information to enable employees to understand their roles and responsibilities; the organization ensures that, as far as possible, the requirements it places upon employees are precise; and systems are in place to enable employees to raise concerns about any uncertainties or conflicts they have in their role and responsibilities. (Cousins, 2004)

6. Organizational change

How organizational change (large or small) is managed and communicated in the organization: the standard is that employees indicate that the organization engages them frequently when undergoing an organizational change. Systems are in place locally to respond to individual concerns.

The organization provides employees with timely information to enable them to understand the reasons for proposed changes; it ensures adequate employee consultation on changes and provides opportunities for employees to influence proposals, and employees are aware of the probable impact of any changes to their jobs. When necessary, employees are given training to support any changes in their jobs, are aware of timetables for changes, and have access to relevant support during changes. (Park et al.,2004)

MATERIALS AND METHODS

Study design

A cross-sectional descriptive study design was conducted to study work-related stress using (the questionnaire Karasek) in workers of industries in the Omdurman locality (2017 – 2022).

Study area

The study was conducted in different industrial sectors at Omdurman locality in Khartoum state in Sudan after getting permission from the companies.

The site of the study includes factories as house workers are exposed to high heat levels like food (29), oils and soaps (24), iron and metals (15), plastic (23), and cement and derivatives (1), about 92 factories in total.

Study population

1. Industries

The workplace assessment was conducted in 92 factories from Omdurman locality.

2. Workers

According to the records of the Occupational Health Department Omdurman locality, the total number of workers in targeted factories is 394 workers, table (3-1)

Activity	No. of workers	%
Food	118	30
Iron and metal	60	15
Plastic	95	24
Cement and derivatives	2	1
Oil & soap	119	30
Total	394	100

Table (3-1): Total number of workers in targeted factories

SAMPLE SIZE AND SAMPLING TECHNIQUES

Sample size determination

1. Industries' sample:

The present study assessed thermal stress in all 92 factories (total converge) from the Omdurman locality.

2. Workers' sample:

The study samples of workers were collected from 241 workers at a confidence 95% interval and degree of precision over 0.05 and used the following formula:

$$\text{Equation 3: } n = \frac{N}{1 + N(e)^2}$$

Where, n =sample size,

N= 394,

e= 0.04

$$934 \sqrt{1 + 394(0.04)^2} = 241$$

The sample design was Stratified Random Sampling, and stage one consisted of selecting the primary sampling unit(cluster). The selection was done through the probability proportional to size (PPS procedure), then by simple random sampling from the factory were selected.

Activity	No. of workers
Food	72
Iron and metal	36
Plastic	58
Cement and derivatives	2
Oil & soap	73
Total	241

Table (3-2): Distribution of the study sample of workers by activity.

Sampling methods

1. Workplace thermal stress assessment

Each studied factory was assessed using total coverage in terms of heat stress measurement, which was measured as Wet Bulb Globe Temperature (WBGT) in °C using a heat stress monitor.

The measurement stations were selected to cover all the heat source areas, including the passage and positions between the machines. The Wet Bulb Globe Temperature (WBGT) was calibrated daily before making measurements.

Heat stress assessment

The heat stress assessment form was designed to collect WBGT heat stress data in all the hot areas selected for this study.

	----- Work Load-----		
Work/rest regimen	Light	Moderate	Heavy
Continuous work	30.0°C	26.7°C	25.0°C

Table (3-3): Permissible heat exposure threshold limit value

These levels coincided with international and national (TLVs) that are implicated by the Administration of Occupational Hygiene, Ministry of Khartoum state.

2. The personal information questionnaire.

Each worker in the industrial sector (Industrial sectors included in this study are food, oil and soap, iron and metals, plastic, and Cement and derivatives) was visited to collect data for workers in the workplace with the aid of a predesigned questionnaire.

Each selected worker was subjected to a predesigned questionnaire to collect information about workers' personal information and health impacts resulting from heat stress exposure (name, age, sex, occupation), work duration, shift, working hours, and habits, including questions related to smoking or others.

And information about workers and health impacts from heat stress exposure, like heat exhaustion, cramps, and heat stroke.

3. Work stress questionnaire

Work stress was assessed using a predesigned work-related stress questionnaire (Karasek).

The questionnaire included the following:

- a) **Action decision:** learning new things creatively, the opportunity to do different things, take decisions, and the possibility to influence one's work
- b) **Psychological burden:** enjoys working quickly, enjoys working hard, has enough time to do work, contradicting demands, concentration, interrupted missions, and inconstant work.
- c) **Worker support:** colleague and competent, colleagues and interest, friendly colleagues, colleagues and working in a team, and colleagues' cooperation.

Statistical data analysis

Data was analyzed using SPSS software. Descriptive statistics such as proportion, quartiles, mean, and standard deviation were used. Categorical data were collected using the chi-square test.

All reputed P values are two-tailed; the significance level was set at 0.05.

RESULTS

Items	Mean	SD	Median	3 rd quartile (%)
decision latitude	24.1286	2.40053	24.0000	
Psychological demand	21.2656	2.80104	21.0000	
Social support	16.9087	1.44047	17.0000	
Total	62.3029	6.64204	62	

Table (4-1): Study population by work-related stress status

Table (4-1) illustrates the descriptive statistics of the work-related stress scale study of the factors behind workers' related –stress, showing that decision latitude represented the highest score among causes of stress (median=24), followed by Psychological demand and social support (each with a median of 21-17).

Activity	Stress			
	H		M/L	
	No.	%	No.	%
Decision latitude	48	19.9	193	80.1
Psychological demand	58	24.1	183	75.9
Social support	30	12.4	211	87.6

Table (4-2): Description of the study population by work-related stress status

Where, H= High

M/L= moderate/low

High = Total score > third quartile of sample

Table (4-2) describes the study population by work-related stress status factors behind workers-related stress after grouping stress into high, moderate, or low. As illustrated, about 12.4% of workers are subjected to high-stress levels. It clarified that the psychological burden and decision latitude represented the maximum percentage of high stress (24.1% and 19.9%, respectively), while the Support for workers expressed the minimum rate (12.4%).

Variable			Stress		Total	Chi-square	P
			H	M/L			
Gender	Male	No.	20	136	156	9.974	0.002
		%	12.8%	87.2%	100.0%		
	Female	No.	25	60	85		
		%	29.4%	70.6%	100.0%		
Age (years)	<20	No.	5	18	23	10.546	0.005
		%	21.7%	78.3%	100.0%		
	20--30	No.	30	83	113		
		%	26.5%	73.5%	100.0%		
	More 30	No.	10	95	105		
		%	9.5%	90.5%	100.0%		
Marital status	Unmarried	No.	33	116	149	9.568	0.048
		%	22.1%	77.9%	100.0%		
	Married	No.	8	70	78		
		%	10.3%	89.7%	100.0%		
	Married and dependable	No.	1	3	4		
		%	25.0%	75.0%	100.0%		
	Widowed or divorced	No.	1	6	7		
		%	14.3%	85.7%	100.0%		
	Widowed or divorced and dependable	No.	2	1	3		
		%	66.7%	33.3%	100.0%		
economic status	less than 1000	No.	13	26	39	6.599	0.37
		%	33.3%	66.7%	100.0%		
	1000--3000	No.	28	142	170		
		%	16.5%	83.5%	100.0%		
	more than 3000	No.	4	28	32		
		%	12.5%	87.5%	100.0%		
Smoking	Smoker	No.	9	16	25	5.515	0.019
		%	36.0%	64.0%	100.0%		
	Non-smoker	No.	36	180	216		
		%	16.7%	83.3%	100.0%		
Hobbies	Sports	No.	17	71	88	5.748	0.125
		%	19.3%	80.7%	100.0%		
	Reading	No.	23	99	122		
		%	18.9%	81.1%	100.0%		
	Other	No.	3	25	28		
		%	10.7%	89.3%	100.0%		
	non	No.	2	1	3		
		%	66.7%	33.3%	100.0%		

Table (4-3): Distribution of study population by work-related stress status and demographic characteristics

Where,

H= High

M/L= moderate/low

High = Total score > third quartile of sample

*P<0.05 (Significant)

Smoking* = smoking, alcohol and others

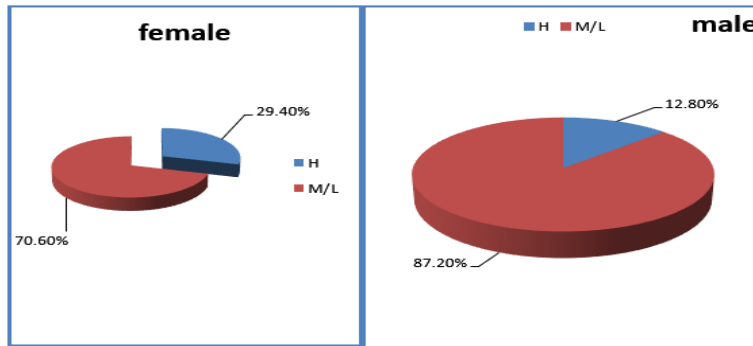


Figure (4-1): Distribution of study population by work-related stress status and gender

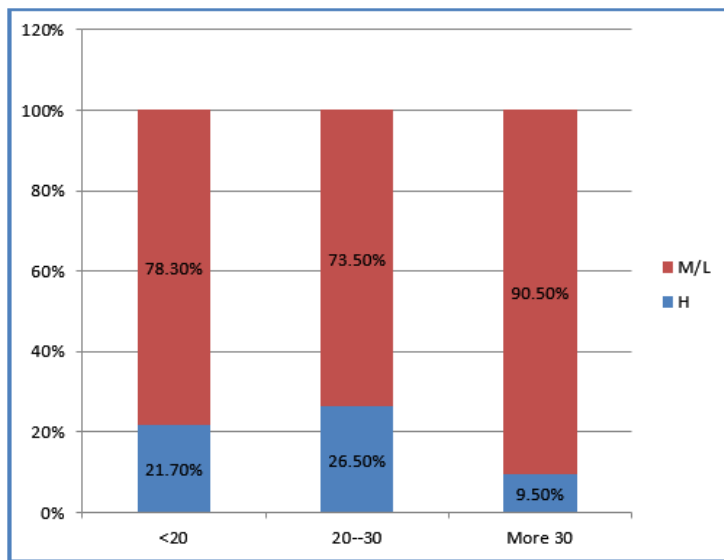


Figure (4-2): Distribution of the study population by work-related stress status and age

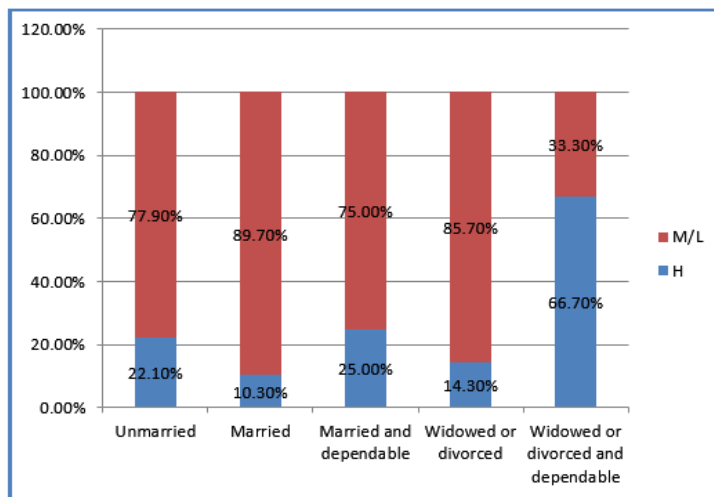


Figure (4-3): Distribution of study population by work-related stress status and marital status

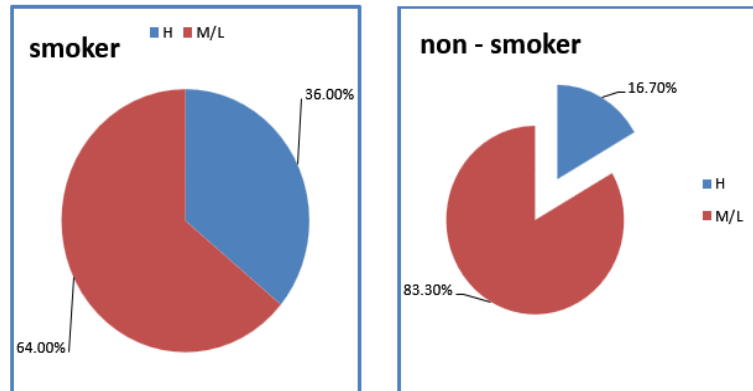


Figure (4-4): Distribution of study population by work-related stress status and smoking.

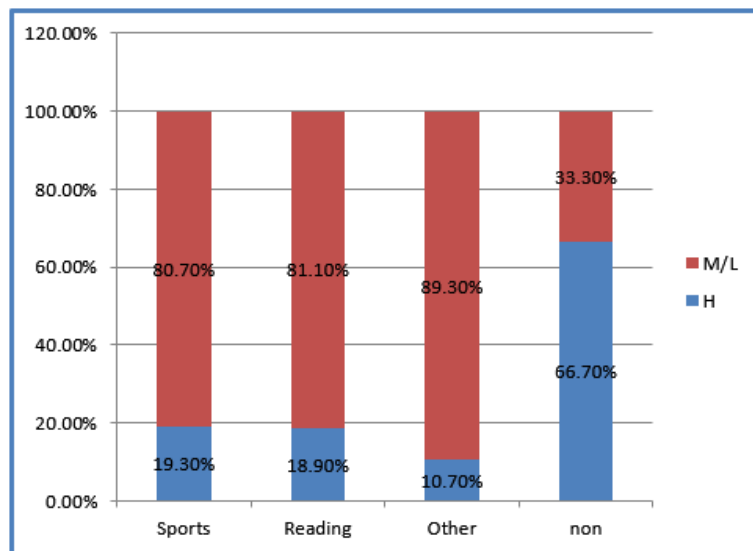


Figure (4-5): Distribution of study population by work-related stress status and hobbies.

The following information is presented in Table (4-6) and Figure (4-1) to (4-5): it displays the distribution of the study population based on their work-related stress status and demographic characteristics.

The findings show that female workers are more exposed to high stress than male workers (29.4% and 12.8%, respectively). Also, workers who are less than 20 years old and those between 20 and 30 years old are more susceptible to high stress levels than other age groups (26.5% and 21.7%, respectively).

Furthermore, the study revealed that the highest percentage of workers with high-stress levels were widowed or divorced and in the dependable group (66.7%), followed by married and reliable workers (25.0%). In contrast, the lowest percentage was among married workers (10.3%).

Regarding economic status, the study found that the highest percentage of workers with high-stress levels were from the low-income group (33.3%), followed by the middle-income group (28%).

In comparison, workers with higher income levels were less exposed to high-stress levels (15.5%).

Additionally, the study found that smoker workers had the highest percentage of high stress levels (36%). Finally, workers with no hobbies were more exposed to high-stress levels than those who engaged in hobbies (66.7% and 52.3%, respectively).

Variable			Stress		Total	Chi-square	P
			H	M/L			
Duration in job(years)	less than 5 years	No.	33	137	170	0.274	0.872
		%	19.4%	80.6%	100.0%		
	5-10 years	No.	6	27	33		
		%	18.2%	81.8%	100.0%		
	more than 10 years	No.	6	32	38		
		%	15.8%	84.2%	100.0%		
Work hours	Less than 8	No.	3	8	11	5.313	0.046
		%	27.3%	72.7%	100.0%		
	8	No.	22	114	136		
		%	16.2%	83.8%	100.0%		
	more than 8	No.	20	74	94		
		%	21.3%	78.7%	100.0%		
Shift	one	No.	37	186	223	8.509	0.004
		%	16.6%	83.4%	100.0%		
	two	No.	8	10	18		
		%	44.4%	55.6%	100.0%		

Table (4-4): Distribution of study population by work-related stress status according to the Job Characteristics

Where, H= High

M/L= moderate/low

High = Total score of > third quartile sample

*P<0.05 (Significant)

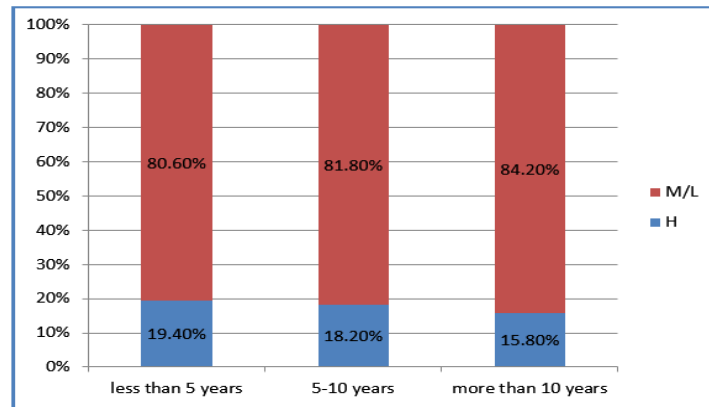


Figure (4-6): Distribution of study population by stress work-related status according to duration.

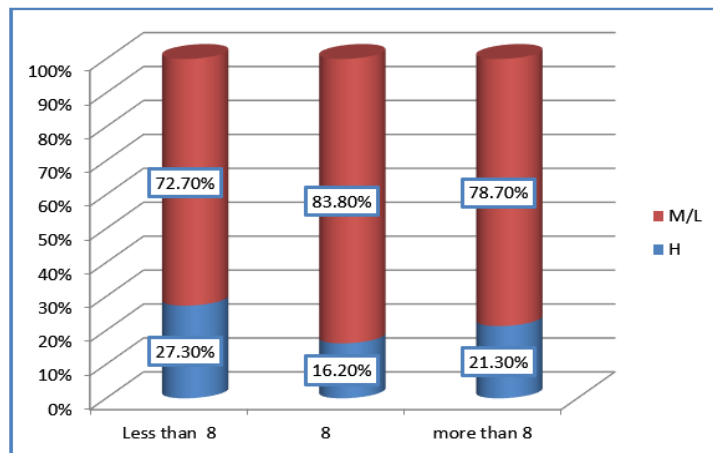


Figure (4-7): Distribution of study population by stress work-related status according to working hours

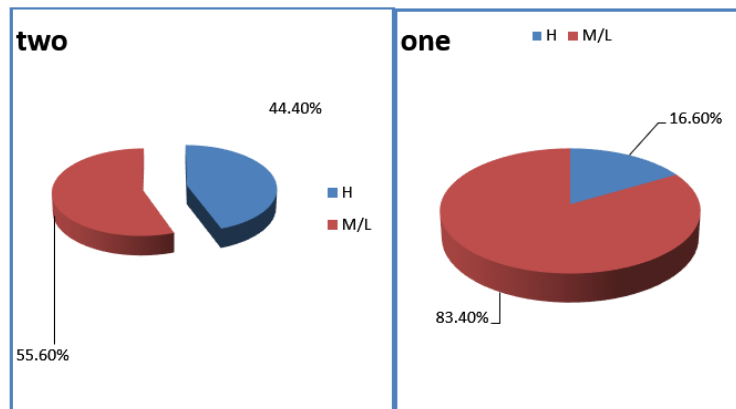


Figure (4-8): Distribution of study population by stress work-related status according to Working shift

Table (4-7) Figure (4-6)- Figure (4-8) shows the distribution of the study population by stress status according to the Job Characteristics distribution. We notice that the unskilled, semiskilled group (less than five years) was more exposed to statistically high stress than other groups, followed by Semiskilled (5-10 years) (19.4% and 18.2% respectively), while the least stressed groups are skilled (more than 10 years) (15.8%).

Regarding working day hours, it was found that those who worked less than 8 hours and more than 8 hours were more exposed to high stress than those who worked 8 hours (27.3%, 21.3%, and 16.2%, respectively).

For the shift rotation, it was found that there were significant differences in stress between those who worked two shifts only and others who worked one shift. However, those with two shifts were more exposed to high stress (44.4% and 16.6 %, respectively).

Activity		Stress		Total
		H	M/L	
Food	No	7	65	72
	%	9.7%	90.3%	100.0%
oil and soap	No	13	60	73
	%	17.8%	82.2%	100.0%
iron and metals	No	6	30	36
	%	16.7%	83.3%	100.0%
plastic	No	18	40	58
	%	31.0%	69.0%	100.0%
Cement and derivatives	No	1	1	2
	%	50.0%	50.0%	100.0%
Total	No	45	196	241
	%	18.7%	81.3%	100.0%
Chi-square		11.059		
P		0.026		

Table (4-5): Distribution of study population by work-related stress status and activity

Where, H= High

M/L= moderate/low

High = Total score > third quartile of sample

*P<0.05 (Significant)

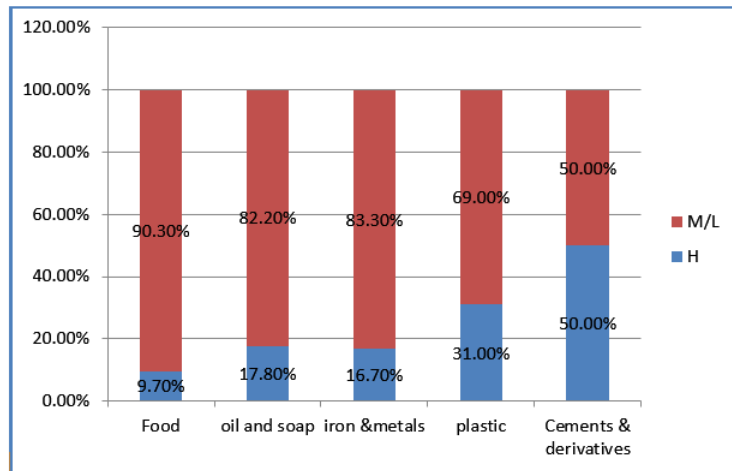


Figure (4-9): Distribution of study population by work-related stress status and activity

Table (4-8), Figure (4-9): shows the distribution of the population study by work-related stress status and activity. I found a significant difference between industrial sectors and stress, with a maximum percentage of high stress in cement and derivatives, plastic, oil and soap, and iron and metal (50, 31, 17.8, 16.7% respectively), while there was no high stress in food industries (9.7%).

stress			Heat stress measurements (WBGT (0C))					Total
			17.4	23.7583	25.54	25.6828	25.913	
stress	H	Count	1	13	6	7	18	45
		% within stress	2.2%	28.9%	13.3%	15.6%	40.0%	100.0%
	M/L	Count	1	60	30	65	40	196
		% within stress	.5%	30.6%	15.3%	33.2%	20.4%	100.0%
Total		Count	2	73	36	72	58	241
		% within stress	.8%	30.3%	14.9%	29.9%	24.1%	100.0%

Table (4-6): Cross tabulation of the study population by stress status and heat stress measurement (WBGT (0C)):

Table (4-6): Cross tabulation of the study population by stress status and heat stress measurement (WBGT (0C)): I found a significant association between a high score of WBGT measure and increased exposure to work-related stress.

DISCUSSION

This study is an attempt to assess Work stress using a work-related stress questionnaire (Karasek) among 241 workers and measured thermal stress using Wet Bulb Globe Temperature (WBGT) in °C taking into consideration the specialty of Sudan, hot climates, in different industrial sectors in Omdurman to improve the working place.

This study covers food industries, oils and soap, iron and metals, plastic and cement, and derivatives. Ninety-two factories in various industrial sectors were visited to collect data on the workplace and individuals (241 workers were surveyed for possible heat stress exposure {name, age, sex, occupation, work duration, shift, working hours, habits related to smoking, etc.}).

This study indicates that decision latitude had a high score among causes of stress (median=24), followed by psychological demands and social support (each with a median of 21to17). This finding agrees with earlier studies conducted by Bhagat. (Bhagat et al, 2010), Australian nurses study conducted by Win Wood (2006) and earlier study conducted by Coffman. (Coffman, Gilligan, 2002).

This study illustrated that about 12.40% of workers are subjected to high stress. However, the psychological burden and decision latitude represented the maximum percentage of high stress (24.1% and 19.9%, respectively) compared to the support for workers representing the minimum percentage (12.40%).

The earlier study established by Lavoie also pointed to the contribution of the psychosocial work environment to psychological stress among healthcare professionals before and during a significant organizational change. (Lavoie, et al, 2010)

Regarding gender in the study, it was also shown that female workers are more exposed to high stress than male workers. These findings agree with the previous research conducted by Ritvanen. This study illustrated that workers in the age group of fewer than 20 years old and between 20-30 years old were more exposed to high stress than other age group members (26.5% to 21.7%). These findings also agree with previous findings of the study by Ruthanne, which pointed out that workers under 30 years old were more exposed to high stress. (Ritvanen, et al, 2006). This might be justified by factors such as the youngest workers being weaker at acclimatization and lacking experience.

The study findings agree with the earlier study in some respects: Sheen, where over-stress factor levels were perceived to be more affecting over youngsters, widows, divorcees, people of separated marriages, and high psychological demand (51). This finding may refer to socioeconomic factors in which widowed and divorced women suffered more than others. (Shen, et al,2005)

This study indicated that the maximum percentage of high stress was mainly found among low-income groups (33.30%), followed by the middle-income group (28.00 %). However, the higher-income individuals were less exposed to high stress (15.50%). This finding agrees with the previous study by Rothwell, which linked stress and low-income families. (Rothwell, Han, 2010)

On the other hand, the present study's findings showed that the maximum percentage of high stress was mainly found among smokers (36.00%). This finding agrees with the previous case study of Silveira, which clarified the association between smoking among industrial workers in Brazil and stress levels. (Silveira, et al,2020).

Another study conducted by Kouvonen also found high Work stress among smokers., (Kouvonen, et al, 2005). Consistent with the present study's findings, workers with no hobbies were more exposed to high stress than those with hobbies (66.70% and 52.30%, respectively). This agrees with two previous studies, Pavelková, and Kalliath,). Both indicated that the workers, hobbies reduced the work-related stress. (Pavelková, Bužgová, 2015 and Kalliath, 2014).

In our study, the findings indicate that the unskilled worker group (less than 5 years of experience) was more exposed to statistically high stress than other groups, followed by Semiskilled (5-10 years 19.40% and 18.20%% respectively, while the least stressed groups are skilled (more than ten years of experience,) (15.80%).

This finding agrees with the earlier study conducted by Chakraborty that most construction workers were semi-skilled or unskilled, which puts a great deal of pressure on them and predisposes them to experience stress at work. (Chakraborty, et al, 2018). This study proves that if work-day hours exceeded 8 hours, workers were prone to experience higher stress than those with 8 hours of workday (27.30% and 21.30%). It agrees with the previous study in some respects: Virtanen, which indicated that work stress may result from long working hours. (Virtanen, et al,2009).

On the other hand, the present study's findings indicate a significant difference in stress levels for those who worked two shifts and others who worked only one shift. In contrast, those working two shifts were more exposed to high stress (44.40% and 16.60 %, respectively). The earlier study conducted by Kim also agreed with this finding. (Kim, et al,2002). This study documented significant differences between industrial sectors in percentage levels of stress, as in cement and derivatives, plastic, oils and soap, and iron and metal (50, 31, 17.80,16.70% respectively), while these were lower stress levels in the food industry (9.70%)

The Previous study conducted by Tabatabaei also indicated the stress levels associated with cement Factory employees in Iran. (Tabatabaei, et al, 2011)

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

This study is an attempt to assess Work stress using a work–related stress questionnaire (Karasek) among 241 workers and measured thermal stress using Wet Bulb Globe Temperature (WBGT) in °C taking into consideration the specially of Sudan, hot climates, in different industrial sectors in Omdurman to improve the working place.

This study covers food industries, oils and soap, iron and metals, plastic, cement, and derivatives. Ninety-two factories in various industrial sectors were visited to collect data on the workplace and individuals (241 workers were surveyed for possible heat stress exposure {name, age, sex, occupation, work duration, shift, working hours, habits related to smoking, etc.}).

Factors contributing to heat stress in 92 industrial sectors were also examined, looking into the factories suffering from higher heat levels than TLV and others with heat stress boundaries.

It also examined factors predisposing to stress among the 241 workers, such as the Socio-demographic data of workers, to determine whether there was a significant relationship between these factors and the development of stress among the workers. It also considered the association of gender differences, age, marital status, socio-economic status, and other stress-related issues among factories.

Conclusions Related to Findings

- This study states that 12.40% of workers were subjected to high work-related stress and clarifies that the psychological burden and decision latitude were behind the high-stress percentage.
- The study showed a relationship between socio-demographic and work-related factors, which are the most significant in high stress.
- The study also maintained that female workers are more subjected to high work-related stress than male workers.
- This study illustrates that those less than 30 years of age were more exposed to high stress than other age groups.
- On the other hand, this study showed an association between different factors, such as working hours, work shifts, marital status, hobbies, and high stress.
- This study also shows that two-shift workers are more highly stressed than single shifts.
- Widows, divorcees, and dependents contrast with those who are married and independent, and those with low personal income contrast with the workers with higher incomes.
- This study illustrates that the maximum percentage of high stress was found mainly among smokers.
- The study showed that workers with hobbies were protected from high-stress hobbies such as sports, reading, etc.)
- The study also documents significant differences between industrial sectors regarding stress, with a maximum percentage of high stress in cement and derivatives, plastic, oil and soap, and iron and metal.

Recommendations

Prevention of work-related stress:

1. Run training courses by master trainers on hazard and risk assessment to develop occupational hygiene teams.
2. Enforce first aid safety in factories.
3. Establish control and engineering measures in factories in the indoor environment.

4. Create awareness of decision latitude, psychological demand, and social support in the workplace to reduce communal stress.
5. Involve employees in factory diction making.
6. Establish an 8-hour per day shift system in the factory.
7. Engage women in not-so-hard jobs to improve their performance.
8. Observe needs of vulnerable groups in the workforce (divorcee women, widows, older workers etc).
9. Supplement wages to improve the economic status of the workers.

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