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Research Article

The Effect of Heat on those Exposed to Hot and Humid Environment and their Awareness Regarding Heat Related Illness

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Abstract

Introduction: Qatar is a peninsula in the Arabian Gulf with hot dry climate and low annual rainfall. Increasing heat waves particularly in urban areas where construction is most prevalent highlights a need for heat exposure assessment of those exposed to hot environment.

Heat related illness (HRI) affects those individuals who work or excercise in a hot environment where their body is unable to dissipate excess internal heat. The workers at risk of HRI include outdoor workers and those people who work in hot environment such as firefighters, factory workers and those playing outside.

Objectives: The aim of the study is to assess the awareness regarding heat related illness among workers exposed to hot and humid environment and the clinical and biochemical effects of heat on their health.

Methods: All individuals coming to emergency department (ED) at Alkhor hospital, Hamad Medical Corporation (HMC) during summer 2016 with features of HRI is included in the study. All participants are asked to fill up a questionnaire regarding their age, socio demographic information, nature of work, history of illness, individual preventive measures, hours and duration of work and heat related symptoms experienced during work. They are evaluated in details including physical examination and blood investigations. Data is analyzed using SPSS 22 and ANOVA.

Results: A total of 174 participants were enrolled in the study. All patients were males. Eighty percent of participating individuals are from Bangladesh, India and Nepal as they constitute a major work force in Qatar. 127 patients (73%) are diagnosed as heat cramps (HC) and 47 (27%) as heat exhaustion (HE). The mean temperature of days when patients presented as heat cramps and heat exhaustion was 42.2°C and 42.47°C and mean humidity was 49.27% and 54.28% respectively. Nearly 86% of the individuals are working outdoor and 79.3% is taking break in between. 93% the participants were drinking fluids during their work. 37% of participants has some basic knowledge regarding HRI. 38% of the workers started developing their symptoms after working for more than 6 hours. The commonest complaint at the time of presentation to ED was muscle cramps (73%) followed by dizziness (68%) sweating (40%) and vomiting (29%). Creatinine was high in 57.6% of patients among which 63% was patients with heat cramps. Hyponatremia was found in 17.4% of participants. There was hypokalemia in 18.6%. Creatine phosphokinase and myoglobin were elevated more in heat cramps compared to heat exhaustion. There was no mortality.

Conclusion: This year the number of individuals visiting emergency department with features of HRI was less compared to previous years, probably due to strict implementation of summer working hours and increase in the awareness regarding HRI among target population. Companies should provide for its workers proper covered area at the time of rest. Workers should be encouraged to attend ED whenever they feel any discomfort while working in hot environment.

Keywords: *Heat; Hot; Humid; Heat Related Illness*

Abbreviations

ADH: Anti Diuretic Hormone; ALT: Alanine Transaminase; ANOVA: Analysis of Variance; AST: Aspartate Transaminase; BLS: Bureau of Labor Statistics; CDC: Centre for Disease Control; CPK: Creatinine Phosphokinase; ED: Emergency Department; EMS: Emergency Medical Service; g: Gram; HC: Heat Cramps; HE: Heat Exhaustion; HMC: Hamad Medical Corporation; HRI: Heat Related Illness; HS: Heat Stroke; L: Litre; meq: Milli Equivalents; MRC: Medical Research Centre; ORS: Oral Rehydration Solution; RFT: Renal Function Test; SD: Standared Deviation; SPSS: Statistical Package for Social Sciences; T(re): Rectal Temperature; WHO: World Health Organisation

Background

Heat related illness is an occupational hazard which affects those individuals who work in an environment where their body is unable to dissipate excess internal heat resulting in heat related illness like heat edema, heat cramps (HC), heat exhaustion (HE) and heat stroke (HS). The workers at risk of HRI include outdoor workers such as construction workers, farmers, postal workers, transportation workers, oil and gas workers and those people who work in hot environment such as firefighters and factory workers [1] and those playing outside and working in closed environment.

Heat stress causes discomfort, increases physiological strain [2,3] decreases efficiency and performance [4] and can increase accident rates [3] among workers. Thus, understanding the effects of heat and identifying the best way of reducing such impacts by implementing various measures has been the focus of various research.

The risks of excessive heat exposure have been well recognized in occupational settings such as in the military, mining and firefighting [5]. In hot low income countries, the threat of excessive heat exposure is greater on account of limited resources or access to cooling methods (especially air-conditioning) and economic drivers to maintain productivity [4,6]. However, the prevalence or extent of excessive heat exposure in such occupational settings is not well appreciated. This results in poor implementation of appropriate and meaningful guidelines and heat management systems [7]. Added to this, climate change and increasing global temperatures will exacerbate occupational heat exposure in many places around the world [4]. The human body maintains an internal body temperature of 37°C +/- 0.5°C. When the internal temperature increases above this range body compensates it with increased sweating and increasing the blood flow to emit the excess heat. In situations of extreme internal heat resulting from environmental and exertional factors such as heavy physical activity, the body's coping mechanisms are compromised, resulting in a cascade of health problems ranging from minimal adverse health effect (like heat edema and heat cramps) to severe adverse effects such as heat exhaustion and heat stroke which can lead to multi organ failure and possibly death.

Although HRI can occur at any temperature, individuals who work in hot and humid environments are at an increased risk because high humidity impairs body's sweating mechanism [8].

There are many studies regarding heat related morbidity and mortality among general population [9-11]. There is limited epidemiological data regarding HRI within the nonmilitary population. The limited occupational data indicate that workers are at an increased risk for HRI because unlike the general population who has a greater liberty to respond to the environmental changes, workers exposure and response to heat is controlled by the requirements of their jobs and employers [12]. Heat exposure, and resulting heat illness, is an important occupational health hazard for workers in manual occupations who are engaged in strenuous work outdoors [13,14].

Investigators have documented farmworker beliefs and knowledge about heat exposure and heat illness [15,16]. For example, Stoeckin-Marios., *et al.* [15] report that farmworkers have only little knowledge of HRI, including those about acclimatization and water consumption. Flocks., *et al.* [16] report that female farmworkers believe that heat exposure can affect their health badly and they lack training for working in hot environment. In a study conducted by H Morano., *et al*. [17] regarding occupational HRI emergency department visits and inpatient hospitalization among outdoor workers in the south east region of US between 2007 and 2011 indicates the need for enhanced heat stress prevention policies in that region.

Data from the BLS indicate that in 2013 there were 3160 HRI cases due to exposure to environmental heat, resulting in one or more days of lost work and 34 fatalities (BLS 2014). During 1992 - 2006, a total of 423 worker deaths from exposure to environmental heat were reported in the United States, resulting in an average annual fatality rate of 0.02 deaths per 100,000 workers. Of these 423 deaths, 102 (24%) occurred in workers employed in the agriculture, forestry, fishing, and hunting industries (CDC 2008 MMWR June 20, 2008/57 (24); 649-653).

Qatar has a dry, subtropical desert climate, with low annual rainfall and intensely hot and humid summers. July and August is around 42ºC (108ºF) with high humidity and it's not unusual for the temperature to reach as high as 50ºC (122ºF). In the winter months, temperatures are cooler but still warm, with the average around 23ºC from December to February. Almost all rainfall occurs during the winter months, mostly in heavy cloudbursts and thunderstorms. Because Qatar is a small country, there is little regional variation in the weather, although coastal areas may be slightly cooler than inland. Increasing heat waves particularly in urban areas where construction is most prevalent highlights a need for heat exposure assessment of construction workers.

Identifying the magnitude of occupational HRI is important because excessive heat exposure is likely to worsen in coming years because as predicted changes in weather pattern will result in longer and hotter summers (Intergovernmental panel on climate change 2014).

Definition of HRI include:

- **Heat Cramps (HC):** Painful muscle spasms in the abdomen, arms or legs following strenuous activity.
- **Heat Syncope:** Dizziness and fainting due to combination of dehydration, vasodilation, cardio vascular disease and certain medications.
- **Heat Exhaustion (HE):** Occurs as a result of water or sodium depletion, resulting in non-specific features of malaise, vomiting, hypotension with circulatory collapse. Core temperature is between 37 - 40°C.
- **Heat Stroke (HS):** Usually following on from a period of heat exhaustion with failure of body's thermoregulatory mechanisms. Symptoms include confusion, disorientation, leading to unconsciousness and seizures. Signs will include a core temperature of over 40°C with hot dry or moist skin.

Study Objectives

The objective of this study is to evaluate the awareness regarding heat related illness among individuals exposed to hot and humid environment and to identify the clinical and biochemical effect of heat on these individuals. Data obtained in this study can be utilized to give health education to the work force of Qatar and will help the medical fraternity to formulate proper guidelines for the management of HRI in the future.

Materials and Methods

Study subjects

Individuals presented to Alkhor hospital ED with features of HRI during summer between 1st of June to 30th of September 2016 is included in the study.

Study design

A descriptive analytical study conducted in the ED of Alkhor hospital, Hamad Medical Corporation (HMC), in the state of Qatar between June to September 2016. Individuals between 18 - 75 years coming to ED with features of HRI is included in the study. A complete clinical assessment including detailed history and physical examination is made by the treating physician.

The main exclusion criteria is those with cardiac, renal and hepatic diseases. Pregnant or lactating women were also excluded. The study is approved by local ethics committee at the Medical Research Centre (MRC), HMC (Research Protocol No 16253 and 17051) and is done in accordance with the principles of the Declaration of Helsinki and guidelines for Good Clinical Practice. All participants provided their verbal consent prior to the enrollment. The study is approved by Institutional Research Board and Quality improvement committee of Alkhor Hospital.

Procedures

Individuals with features of HRI is triaged to treatment area for initial evaluation and management. A clinical diagnosis of HRI is made by the attending physician based on the history and physical examination. They are evaluated in details including physical examination and blood investigations. All participants were asked to fill up a structured questionnaire regarding their age, socio demographic information, nature of work, history of illness, individual preventive measures, hours and duration of work and heat related symptoms experienced during work. Fifteen minutes are given to answer the questionnaire.

Blood is collected for complete blood count, complete metabolic panel, creatine phosphokinase (CPK) and myoglobin estimation. The environmental temperature and humidity are obtained on a day to day basis from Qatar meteorology department. Each patient is treated for their illness according to hospital policies and protocol which is based on international best practice guidelines.

Statistical analysis

Categorical and continuous values were expressed as frequency (percentage) and mean ± SD or median and range as appropriate. Descriptive statistics were used to summarize demographic, clinical, laboratory, biochemical, heat related and other characteristics of the participants. The Kolmogorov-Smirnov (K-S) test or Q-Q Plot as appropriate was used to test for normality of the data. The primary aim of the study is to assess the awareness regarding heat related illness among workers exposed to hot and humid environment and the clinical and biochemical effects of heat on their health. Associations between two or more qualitative or categorical variables were assessed using chi-square (χ^2) test and Fisher Exact or Yates corrected Chi-square as appropriate. Quantitative variables means between the two and more than two independent groups were analyzed using unpaired 't' test (or Mann Whitney U test) and one way analysis of variance (ANOVA) (or Kruskal-Wallis test test). Relationship between two quantitative variables was examined using Pearson's correlation coefficients. Pictorial presentations of the key results will be made using appropriate statistical graphs. All P values presented were two-tailed, and P values < 0.05 was considered as statistically significant. All Statistical analyses were done using statistical packages SPSS 22.0 (SPSS Inc. Chicago, IL).

Results

A total of 174 participants were enrolled in the study. All of them were males. This can be attributed to the location of the hospital, which caters mainly to the migrant labor community of the surrounding industrial area. Eighty percent of the participating individuals are from Bangladesh, India and Nepal as they constitute a major work force in Qatar. 95% of patients belong to the age group between 21 - 49 years. 70% of patients are manual laborers and 27% belongs to skilled work.

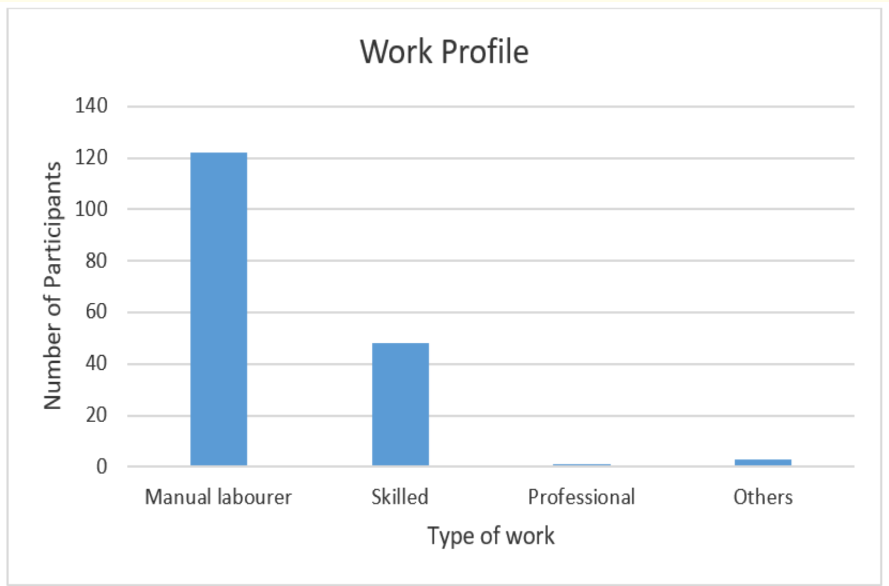

Figure 1: *Work profile of the participants.*

Heat cramps and heat exhaustion was more among manual workers (72 and 66 percent) compared to skilled workers (26 and 32 percent) even though it is not statistically significant (p = 0.221). 69.5% of the study population are working in Qatar for more than 1 year and almost 65.5% are in the same job for more than a year. Among those who developed HC, 37 (25.5%) were working in Qatar for less than a year. Similarly, 22 (26.9%) of those who developed HE was working in Qatar for less than a year. There is no significant ($p = 0.186$) correlation between heat cramps and heat exhaustion and duration of staying in the country. Nearly 150 (86%) participants were working outdoor. Among this 113 (89%) developed HC and 37 (79%) developed HE. The percentage of workers developing HRI is more among outdoor and majority developed HC ($p = 0.027$). The number of breaks ($p = 0.458$) or duration of breaks ($p = 0.992$) does not have any statistical significance in the type of HRI. Probably type of HRI is related to lot of other factors like acclimatization, temperature, humidity etc. 93% is drinking normal water but 3 patients (1.7%) drank Oral Rehydration Solution.

37% of participants had some basic information regarding HRI which is mainly obtained from company staff (81%). 68% of participants were nonsmokers and 10% consumed alcohol occasionally. There were 3 patients with diabetes, 4 with diabetes and coronary artery disease, 3 with hypertension and one with hypertension and coronary artery disease.

127 participants (73%) are diagnosed as heat cramps and 47 (27%) as heat exhaustion based on their clinical presentation. The mean temperature of days when patient presented as heat cramps and heat exhaustion was 42.2°C (SD ± 2.577) and 42.47°C (SD ± 2.561) and mean humidity was 49.27% (SD ± 17.90) and 54.28% (SD ± 8.897) respectively. The temperature does not show any statistical significance between HC or HE ($p = 0.55$) but during days with high humidity majority developed heat exhaustion ($p = 0.016$).

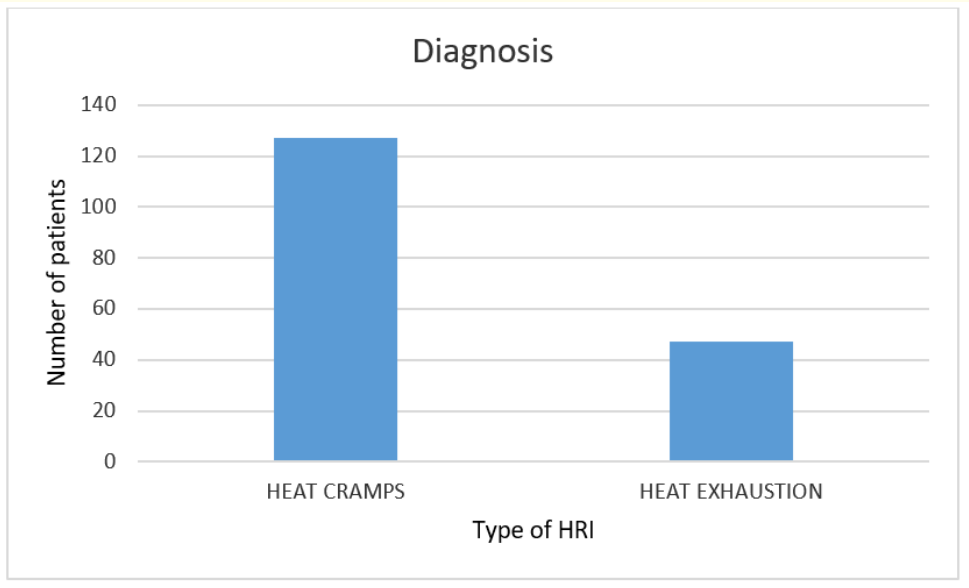

Figure 2: *Diagnosis of participants.*

72% of heat cramps and 66% of heat exhaustion were seen in manual laborers.

Among skilled workers 31% had heat exhaustion and 69% had heat cramps. There is no statistical significance between type of work and HRI ($p = 0.221$).

Nearly half of participants (47%) developed their symptoms while working between 8 am to 4 pm. There is no statistical correlation between developing HC and HE and time of exposure to heat ($p = 0.467$). 75% of those with heat cramps and 53% with heat exhaustion is working in Qatar for more than 1 year. HC was more among those who is in Qatar for more than a year ($p = 0.025$). 89% of patients with heat cramps and 79% with heat exhaustion are working out door. HC was more among those who work outdoor ($p = 0.027$). 15% of patient with HC developed their symptoms after working for 4 hours and percentage increased to 56 after six hours. Similarly, 25% of patients with HE developed their symptoms after working for 4 hours and increased to 55% after 6 hours. Within each category of duration of work (1 hour, 2 hour, 3 hour etc.) there is no statistical correlation between heat cramps and heat exhaustion ($p = 0.148$). 98% of patients with heat cramps and almost all patients with heat exhaustion took oral fluids during their work. Two patients were fasting and one did not take any fluids while working. Only three individuals took ORS and rest took plain water.

25% of patients with heat cramps had history of HRI before compared to 13% in patients with heat exhaustion (p = 0.554). Seventeen patients gave history of alcohol intake, of which sixteen developed heat cramps (p = 0.039). There is a significant statistical correlation between history of alcohol consumption and heat cramps.

The clinical features vary among patients with heat cramps and heat exhaustion. 70 patients (40.2%) presented with excessive sweating. 119 patients presented with dizziness. Dizziness was more among patients with heat exhaustion (85%, p = 0.004). 98.4% of heat cramps patients presented with generalized muscle cramps (p < 0.001). 18 patients with diagnosis of HC presented with tetany (p = 0.006). None of heat exhaustion patients had tetany. 13 (7.5%) patients presented with transient loss of consciousness which can be attributed to heat syncope. Nearly 30% of the individuals presented with vomiting and the number was almost equal among heat cramps and heat exhaustion (p = 0.505). 97% of the participants were not on any medications.

Hematocrit was high in 55% of heat cramps and 40% of heat exhaustion (p = 0.068). Small percentage of patients with heat cramps and heat exhaustion was showing a marginal increase in blood urea level (normal 2.76 - 8.07). The increase was more among patients with HC (6.197 ± 3.022, p 0.037). Blood urea was showing an increasing trend in relation with duration of exposure to hot environment.

Lab Parameters	Diagnosis	Mean	SD*	P value
WBC (4 - 10)	Heat Cramps	12.119	5.0083	0.068
	Heat Exhaustion	10.743	4.0980	
HB (12 - 15)	Heat Cramps	15.424	1.8693	0.199
	Heat Exhaustion	15.034	1.4650	
HCT (36 - 46)	Heat Cramps	46.788	5.7098	0.298
	Heat Exhaustion	45.834	4.2013	
UREA (2.76 - 8.07)	Heat Cramps	6.197	3.0225	0.037
	Heat Exhaustion	5.149	2.5950	
CREAT (53 - 97)	Heat Cramps	136.06	77.786	0.026
	Heat Exhaustion	108.17	57.207	
Na (135 - 145)	Heat Cramps	144.84	89.648	0.613
	Heat Exhaustion	138.19	2.954	
K (3.6 - 5.1)	Heat Cramps	3.997	.5916	0.315
	Heat Exhaustion	3.898	.5207	
Cl (96 - 110)	Heat Cramps	99.12	5.679	0.003
	Heat Exhaustion	101.49	4.185	
HCO_3 (24 - 30)	Heat Cramps	25.12	2.914	0.02
	Heat Exhaustion	26.06	2.079	
BIL (3.5 - 24)	Heat Cramps	12.97	7.317	0.47
	Heat Exhaustion	14.45	12.747	
ALP (45 - 129)	Heat Cramps	89.98	34.262	0.252
	Heat Exhaustion	83.50	24.484	
ALT (0 - 30)	Heat Cramps	41.54	70.117	0.277
	Heat Exhaustion	29.77	21.755	
AST (0 - 31)	Heat Cramps	36.74	46.404	0.098
	Heat Exhaustion	24.95	10.421	
CPK (39 - 308)	Heat Cramps	475.08	756.132	0.002
	Heat Exhaustion	241.13	228.679	
Myoglobin	Heat Cramps	391.62	677.937	0.042
	Heat Exhaustion	212.15	424.035	

Table 1: *Laboratory parameters.*

**Standard deviation.*

Serum creatinine (normal 53 - 97) was elevated in 63% of HC (136.06 ± 77.78) and 43% of HE (108.17 ± 57.20). The increase was more among individuals with HC and is statistically significant (p = 0.026). Serum creatinine also shows an elevation with duration of exposure to hot weather. Liver enzymes like ALT (normal 0 - 30) and AST (normal 0 - 31) was slightly elevated in 52 and 33 percentage of HC and 36 and 16 percentage of HE but has no statistical significance (p = 0.277, p = 0.098). Creatine phosphokinase (CPK) was elevated (normal 39 - 308) more in HC (mean 475.08) compared to HE (mean 241.13) and is statistically significant (p = 0.002). Myoglobin (normal 10 - 92) was elevated more in HC (mean 391.62) compared to HE (mean 212.15) and is statistically significant (p = 0.042).

Discussion

This study was conducted to analyse the awareness regarding HRI among individuals exposed to hot and humid environment and the clinical and biochemical effect of heat on their body.

All the participants are male and majority of them belong to Asian countries. The educational qualification of 90% of the participants are below high school level. This indicates the fact that majority of our participants belong to labor class working in construction field.

Heat related illness following periods of sustained heat wave have been reported previously [18-21]. Risk factors for HRI include old age, alcohol abuse, neurological disease, psychiatric illness and patients on long-term medications [22-26].

Exposure to high temperatures lead to elevation of body temperature, which causes activation of various physiological compensatory mechanisms which include increased cutaneous circulation and concomitant vasoconstriction of the renal and splanchnic circulation [22]. Heat stress causes cell damage by apoptosis, release of inflammatory mediators and endothelial damage leading to multi organ failure. The average temperature and humidity measured during the study period was 42.28°C (SD ± 2.56°C) and 50.63% (SD ± 16.09) respectively. The average body temperature of participants were 36.70°C (SD ± 0.55°C).

A World Health Organization (WHO) scientific group on health factors involved in working under conditions of heat stress concluded that "it is inadvisable for core body temperature to exceed 38°C (100.4°F) in prolonged daily exposure to heavy work". The value of 38°C (100.4°F) rectal temperaure (T (re)) incorporates a safety margin. In closely controlled conditions, the core body temperature may be allowed to rise to 39°C (102.2°F)" [WHO 1969]. In our study only five patients had oral temperature greater than 38°C. The oral temperature is 0.5°C less than rectal temperature. It is a limitation of our study that we could not measure T(re) of participants as there was a delay in getting permission from medical research department.

The T(re) of 38°C (100.4°F) or even more, does not mean that a person has developed heat illness. The physiological response to heat stress is quite variable among human population. In fact, it is well documented that many long distance runners complete their running with T(re) ≥ 41°C (105.8°F). In addition, T(re) of 41.9°C (107.4°F) have been measured in soccer players without any physical symptoms [27,28].

Various models are available to predict heat strain as a function of heat load and physical activity and are capable of being modified by a variety of confounding factors. The strain factors that can be predicted for the average worker are heart rate, body and skin temperature, sweat production and evaporation, skin wettedness, tolerance time, productivity and required rest allowance. Confounding factors include amount, fit, insulation, and moisture vapor permeability of the clothing worn, physical work capacity, body hydration, and heat acclimatization. From some of these models, it is possible to predict when and under what conditions the physiologic strain factors will reach or exceed values that are considered acceptable from the standpoint of health.

The average heart rate of patients presenting with HRI was 84.41/mt (SD ± 14.96). 86% were working in an outdoor environment and are exposed to direct sunlight. They were wearing head cover and company uniforms. Some of them were wearing protective sunglassess as well. (questions regarding this was not included in the questionnaire).

When workers are exposed to hot environments, they will show signs of distress and discomfort, such as increased core temperatures and heart rates, headache, dizziness, cramps, vomiting, nausea or other symptoms of HRI [29-35]. On repeated exposure to a hot environment, individuals will develop an increased sweating efficiency evidenced by earlier onset of sweating, greater sweat production, and lower electrolyte concentration. As a result, after daily heat exposure for 7 to 14 days, most individuals perform the work with a much lower core temperature, heart rate and a higher sweat rate with none of the symptoms that were experienced initially [35-40].

In our study population 38% of the workers started developing symptoms after working for more than 6 hours. There is no statistical correlation between duration of category of work (1 hr,2 hr, 3 hr etc.) and development of heat cramps or heat exhaustion ($p = 0.148$). Almost all the participants were drinking ample amount of water during their work. Three participants were drinking oral rehydration fluid.

Under conditions where sweat production may reach 6 to 8 liters in a hot working day, replacement of the water lost in the sweat by mouth is usually incomplete. The normal thirst mechanism is not sensitive enough to prompt us to drink enough water or to prevent dehydration. If water loss exceeds 1.5% to 2% of the body weight, then tolerance to heat stress begins to deteriorate and heart rate and body temperature will start to increase leading to a decline in work capacity [41]. When water loss exceeds 5%, it may lead to collapse and dehydration. Since thirst is not an adequate guide for water replacement, workers in hot jobs should be encouraged to drink water every 15 to 20 minutes. The fluids should be less than 15°C (59°F). For work that requires an increased level of exertion in a hot environment for a prolonged period (≥ 2 hours), drinks that contain carbohydrates and electrolytes should be used in place of water in order to replace the electrolytes lost from sweating and to avoid hyponatremia. The amount of dehydration can be estimated by measuring body weight at intervals during the day or at least at the beginning and end of the work shift. The worker should drink enough water to prevent loss of body weight.

The commonest complaint at the time of presentation to ED was muscle cramps (73%) followed by dizziness (68%) sweating (40%) and vomiting (29%). Dizziness was more among patients with heat exhaustion (85%, $p = 0.004$). 30% 0f patients with heat cramps and 25% with heat exhaustion are complaining of vomiting. This might be due to the compensatory splanchnic vasoconstriction that occurs secondary to dehydration [42,43]. Studies have shown that even though thermal stress results in an increased cardiac output, splanchnic flow is reduced because of increased splanchnic vascular resistance, resulting in intestinal ischaemia with focal necrosis, resulting in GI symptoms [44].

12.6% of patients with heat cramps are consuming alcohol compared to 2% in heat exhaustion ($p = 0.039$). Alcohol use (combined with heat stress) commonly has been associated with the occurrence of heat stroke [29]. It is a drug which interferes with central and peripheral nervous function and is associated with dehydration by suppressing ADH production. The ingestion of alcohol prior to or during work in the heat should not be permitted because it reduces heat tolerance and increases the risk of heat-related illnesses.

Haematocrit (normal 36 - 46%) was elevated in 51% of patients.There is no statistical significance between HC and HE regarding haematocrit elevation ($p = 0.234$). Creatinine (normal 53 - 97 umol/l) was high in 57.6% of patients among which 63% was patients with heat cramps ($p = 0.026$). All of our patients improved their renal function and electrolyte disturbances after judicious fluid resuscitation. None of them required hemodialysis. Suggested mechanisms of renal injury in patients with heat related illness include direct thermal injury, renal hypoperfusion secondary to compensatory renal artery vasoconstriction and rhabdomyolysis.

Serum sodium (normal 135 - 145 meq/l) was low in 21% of patients with heat cramps and 8.5% with heat exhaustion ($p = 0.613$). An important constituent of sweat is sodium chloride. In most circumstances a salt deficit does not readily occur because the normal diet provides 4 grams per day (174 mEq per day) of sodium [45]. However, the sodium content of sweat in unacclimatized individuals may range from 10 to 70 mEq per day sweat (0.23 - 1.62 g/L) [46], whereas for the acclimatized individual, sodium lost to sweat may be reduced to 23 mEq/L (0.530 g/L), less than 50% of that of the unacclimatized individual. It is possible for a heat-unacclimatized individual who consumes a restricted salt diet to develop a negative salt balance. In theory, a prolonged negative salt balance with a large fluid intake may result in a need for dietary supplementation of salt. Salt tablets can irritate the stomach and should not be used [35,47]. Heavier use of salt at meals has been suggested for heat-unacclimatized workers during the first 2 or 3 days of heat exposure if they are not on a restricted salt diet [35]. Sodium can also be replenished by drinking fluids containing approximately 20 mEq/L sodium, which is an amount found in many sports drinks [46]. In general, simply adding salt to the diet will adequately restore electrolyte balance. Moreover, carefully induced heat acclimatization reduces or eliminates the need for salt supplementation of the normal diet, during the first 2 or 3 days of heat exposure [35,48]. By the end of the third day of heat exposure, a significant amount of heat acclimatization might have occurred. Four patients (3.2%) with heat cramps had hyperkalemia (normal 3.6 - 5.1 mmol/l). 23.4% of heat exhaustion had hypokalemia ($p = 0.315$). Because potassium is lost in sweat, it can be substantially depleted when unacclimatized workers suddenly have to work in hot climates. Marked depletion of potassium can lead to serious physiologic consequences, including the development of heat stroke [29]. However, potassium loss is usually not a problem, except for individuals taking diuretics, because potassium is present in most foods, particularly meats and

	Variables	Heat Cramps N (%)	Heat exhaustion N (%)	P value
Occupation	Manual labourer	91 (71.7%)	31 (66%)	
	Others	3 (2.4%)	0 (0%)	0.221
	Professional	0 (0%)	1 (2.1%)	
	Skilled	33 (26%)	15 (31.9%)	
Time of event	00:00-08:00	44 (34.6%)	21 (44.7%)	
	08:00-16:00	62 (48.8%)	20 (42.6%)	0.467
	16:00-24:00	21 (16.5%)	6 (12.8%)	
Howlong in qatar	< 1month	1 (0.8%)	1 (2.1%)	
	1 - 6 months	14 (11%)	7 (14.9%)	0.025
	6 - 12 months	16 (12.6%)	14 (29.8%)	
	> 1 year	96 (75.6%)	25 (53.2%)	
Howlong In the same JOB		1 (0.8%)	0 (0%)	
	<1month	4 (3.1%)	2 (4.3%)	0.186
	1-6 months	16 (12.6%)	7 (14.9%)	
	6-12months	17 (13.4%)	13 (27.7%)	
	>1 year	89 (70.1%)	25 (53.2%)	
Work area	Indoor with A/C	3 (2.4%)	2 (4.3%)	
	Indoor without A/C	4 (3.1%)	7 (14.9%)	0.027
	Outdoor	113 (89%)	37 (78.7%)	
	Shaded	7 (5.5%)	1 (2.1%)	
Symptoms started after howmany hours of exposure	> 6hr	52 (40.9%)	14 (29.8%)	
	1hr	5 (3.9%)	2 (4.3%)	0.148
	2hr	6 (4.7%)	7 (14.9%)	
	3hr	10 (7.9%)	3 (6.4%)	
	4hr	19 (15%)	12 (25.55)	
	5hr	15 (11.8%)	5 (10.6%)	
	6hr	20 (15.7%)	4 (8.5%)	
	Yes	101 (79.5%)	37 (78.7%)	
Duration of work	< 30 mts	27 (21.3%)	9 (19.1%)	
	30 - 60 mts	42 (33.1%)	16 (34%)	0.992
	> 1 year	32 (25.2%)	12 (25.55%)	
	None	26 (20.5%)	10 (21.3%)	
Fluids	Fasting	2 (1.6%)	0 (0%)	
	No	1 (0.8%)	0 (0%)	0.568
	Yes	124 (97.6%)	47 (100%)	
Type of fluid	None	1 (0.8%)	0 (0%)	
	ORS	2 (1.6%)	1 (2.1%)	0.531
	Others	0 (0%)	1 (2.1%)	
	Water	119 (93.7%)	43 (91.5%)	0.531
	Water and ORS	5 (3.9%)	2 (4.3%)	
Health education	No	82 (64.6%)	28 (59.6%)	
	Yes	45 (35.4%)	19 (40.4%)	0.544
Health education from where	Company	39 (30.7%)	13 (27.7%)	
	Media	4 (3.1%)	3 (6.4%)	
	None	82 (64.6%)	30 (63.8%)	0.786
	Self	2 (1.6%)	1 (2.1%)	

Table 2: *Work related questions.*

fruits [41]. None of our patients were taking diuretics.Since some diuretics cause potassium loss, workers taking such medication while working in a hot environment should seek medical advice.

Salt and potassium supplements, if recommended by the responsible healthcare provider, may only be needed during the acclimatization period or under extraordinary circumstances.

A high prevalence of elevated liver aminotransferase levels has been reported in exertional heat stroke and has been attributed to ischaemia and direct thermal injury [49,50]. Among our study population ALT (normal 0 - 30 U/L) was elevated slightly in 48% of patients and AST (0 - 31 U/L) in 28%. ALT (41.54 ± 70.11) and AST (36.74 ± 46.40) was elevated in 52 and 33 percentage of HC and 36 (29.77 ± 21.75) and 16 (24.95 ± 10.42) percentage of HE but has no statistical significance (p = 0.277, p = 0.098).

CPK and myoglobin were elevated more in heat cramps compared to heat exhaustion, 25.6% and 58.8% respectively (p = 0.002 and p = 0.042). The amount of CPK and myoglobin were elevating steadily in relation to duration of exposure to hot weather.

Conclusion

There is no significant correlation between the duration of staying in the country and developing of heat cramps and heat exhaustion. The percentage of workers developing HRI is more among outdoor workers and majority developed heat cramps. The number of breaks or duration of breaks does not have any statistical significance in the type of HRI. When humidity was high majority developed heat exhaustion. Majority of patients presented to our hospital with features of HRI is diagnosed to have heat cramps. No single case of heat stroke was identified during this period. Usual mode of presentation was excessive sweatig, dizziness, vomiting and muscle cramps. Out of 174 cases only one case was admitted to hospital because of very high level of myoglobin and CPK with altered RFT. All other patients are discharged from ED after parenteral fluids and other supportive measures.

Recommendations

We suggest that people working in hot environment should be given proper knowledge regarding heat related illness and how it can be prevented. All workers should be advised to drink plain water or ORS frequently during work. Workers should be encouraged to attend emergency department whenever they feel any discomfort while working in hot environment.

Study Limitations

We were unable to check the rectal temperature of patients coming to ED with features of HRI. As the workers are transferred from site to hospital in air conditioned vehicles and after first aid treatment from EMS or medical personnel from the company, their clinical features and laboratory findings might have been altered.

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