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ORIGINAL ARTICLE

IMPACT OF ENVIRONMENTAL HEAT EXPOSURE ON THE HEALTH STATUS IN FARMWORKERS, NAKHON RATCHASIMA, THAILAND

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ABSTRACT

Background. Thailand is a tropical developing country which has a serious increase in health risk due to hot weather exposure among outdoor workers.

Objectives. The aims of this study were to compare the factors related to environmental heat exposure in three different seasons, and to assess the relationship between environmental heat and dehydration status in each season among farmworkers in Nakhon Ratchasima, Thailand.

Methods. A semi-longitudinal study was carried out in 22 male farmworkers throughout a year of farming. The primary data were collected in farmworkers for socio-demographic information, clinical assessments, and heat-related illnesses.

Results. Average of environmental heat index (Median, SD) were severe in summer (WBGT=38.1, 2.8°C), rainy season (WBGT=36.1, 2.1°C), and winter (WBGT=31.5, 2.7°C). Average urine Sp. Gr. in summer, rainy season, and winter were 1.022, 1.020, and 1.018 respectively. The third sentence should be corrected as follows: The Friedman analysis revealed a statistically significant difference between the three different seasons in WBGT (wet bulb globe temperature), body temperature, heart rate ($P<0.01$), and respiratory rate ($P<0.05$). There was a statistically significant difference between the three different seasons for skin rash/itching, dizziness, muscle cramp dyspnea ($P<0.05$), and weakness ($P<0.01$). *Wilcoxon* signed-ranks analysis found a significant difference in the medians of the paired sets of urine Sp. Gr. values between baseline and summer ($P<0.05$). *Spearman's* rank correlation coefficient did not find a relationship between WBGT and urine Sp. Gr. in the three different seasons.

Conclusions. This study demonstrated that farmworkers had exposure to environmental heat stress which was expressed through physical changes. Therefore, there is a need for either interventions or guidelines to prevent dehydration for outdoor workers in this region.

Key words: *heat exposure, dehydration, heat-related illnesses, farmworkers, Thailand*

INTRODUCTION

Currently, climate change has been linked to the rise in environmental temperature which is a huge global issue. Extreme heat exposure is increasingly recognized as a threat to the survival of human beings because it can cause a serious increase in the occurrence of diseases and heat-related illnesses [1]. In developing countries, outdoor workers normally working up to 12-hour shifts in a thermally stressful environment for as long as 21 days without a break [2]. About 94% of farmworkers expressed that high heat exposure affected their health [3]. *Gubernot* et al. [4] demonstrated that outdoor workers in the United States are 13 times more likely to die of heat-related illness than workers in other industries. The mortality rate owing to the heat stress has been increasing around the world such as 56,000 deaths in Russia, 10,000 deaths in the United States, 3,418 deaths in Europe, and 2,541 deaths in India [5]. A heat index higher than 35°C, increases mortality in relation to the elevation of temperature and duration of the heatwave [6]. Thailand is a tropical developing country located in Southeast Asia with a population of around 66 million citizens [7]. The majority occupation of Thais is farming. Farmworkers in low to middle income are more

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vulnerable because many of them engage in heavy physical work under direct sunlight exposure [8]. The Bureau of Occupational and Environmental Diseases (BOED) of Thailand reported that the morbidity rate of heat and light effect was 0.17 per 100,000 populations in 2017 [9]. Heat stress can be defined as a buildup of body heat generated either internally by environmental temperature exposure or metabolic load. Previous studies have provided pieces of evidence that extreme heat environments increase the occurrence of adverse physiological parameter changes [10], which might be affecting fatigue, comfort, concentration, accident, and health symptoms. However, Thai farmworkers have been affected by heat-related illnesses from high temperature exposure with limited resting in the shade, adequate fluid intake, and appropriate clothing. Most of them are commonly under-reported hazards in medical records. The International Organization for Standardization (ISO 7243) has adopted the wet bulb globe temperature (WBGT) method to assess environmental heat stress [11, 12], which is the most well-known. The skin and/or aural and/or oral temperatures were used to measure the effect of the WBGT index on physiological parameters [13]. Low fluid intake of farmworkers results in a high risk of dehydration while working among high temperatures and humidity [14]. There is a possibility for impairment of the body's thermoregulatory system, potentially allowing for uncontrollable body temperature balance [15]. Therefore, the researchers were interested to compare the factors related environmental heat exposure in three different seasons, and to examine the association between occupational heat exposure and health effects among farmworkers in Nakhon Ratchasima, Thailand.

MATERIAL AND METHODS

Study site and population

A semi-longitudinal study was conducted among twenty-two male farmworkers by using eligibility criteria to recruit the participants, which consisted of age over 18 years old, growing rice by themselves in every activity more than 1 year, and without kidney disease, liver failure, and other disorder related to sweating. In total, the study comprised three data collections carried out in the rice cultivation period as follows: paddy preparation in summer (April), rice planting in rainy season (August), and harvesting in winter (December) in 2018. The experimental protocol was approved by the Ethics Review Committee for Research Involving Human Research Subjects, Health Sciences Group, Chulalongkorn University under ethical clearance COA number 045/2017.

Questionnaire

Face to face questionnaires were conducted by a researcher asking questions of a respondent in person at the workplace immediately after farm activities finished. The questionnaire was divided into three parts as follows: socio-demographic information, clinical assessment, and heat-related illness (while working) (yes/no). The questionnaire was inspected for the content validity. The calculated IOC score given was 0.93. Then, the reliability was improved by trying out the questionnaire on 30 male rice farmers in another group of participants. The *Cronbach's* alpha coefficient value was 0.76.

Clinical assessment

Physiological assessment was measured while working to assess the worker's physical change in the workplace and was used to measure the severity of an environment after they continue working. The main physiological assessment parameters were comprised of forehead skin temperature, blood pressure, heart rate, and respiratory rate. During farm activities, every single worker was monitored for body temperature on the forehead by an infrared thermometer after 30 minutes of working. Heart rate and respiratory rate were monitored by a digital blood pressure machine at the workplace immediately after farm activities finished. Metabolic workload (Kcal/h) was observed and recorded to individual clothing type, body movement, working speed, work activity, and machinery application. The estimated metabolic workload was calculated per ACGIH guidelines [16].

Dehydration assessment

Dehydration status was evaluated by urine specific gravity (Sp. Gr.), which is an important biomarker to indicate hydration in the body. Urine specimens were collected in a first-morning void (first urine void after waking up) of approximately 20 ml and analyzed by a clinical-refractometer (Clinical Refractometer, RHCN-200ATC, JEDTO) in the range of 1.000-1.050. Then, the specimens were stored cold (4-8°C) and subsequently submitted to the health center laboratory for analysis. The urine Sp. Gr. were measured 4 times, including baseline at one month before farm began (farming break period), summer in the hottest month (April), rainy season in the rainiest month (August), and winter in the coldest month (December). The urine Sp. Gr. less than 1.026 was classified as adequate hydration (normal range) and more than or equal to 1.026 was classified as dehydration (abnormal range) [17]. The urine Sp. Gr. was measured 3 times and the average value was recorded.

Environmental heat assessment

The WBGT (3M model Quest Temp 36) index was used to monitor environmental heat conditions, which indicates in value of air temperature, air velocity (m/s), radiant heat, and relative humidity (%). The WBGT index value was displayed on the monitor after calculation by considering the above four environmental parameters to represent heat stress in humans. The WBGT was mounted in the real field and left for at least 30 minutes before recording the first measurements. The WBGT value was recorded every 15 minutes during working hours. The WBGT was calibrated before use by putting the calibration verification module near the wet bulb globe's keypad. It was placed at a height approximately 1.1 meters from the ground for standing individuals and away from any objects that might block radiant heat or airflow. The metabolic workload (Kcal/h) assessment was calculated (by observing working posture, movement, frequency, machine usage, activity characteristics, and clothing) and interpreted as per the guideline of the Labor Protection Act, Ministry of Labor [18], Thailand (Ministerial Regulation on the Prescribing of Standard for Administration and Management of Occupational Safety, Health, and Environment in relation to Heat, Light and Noise, A.D. 2006).

Statistical analysis

This study used a licensed IBM SPSS program version 28 to analyze the general characteristics. Study variables in the study population were described by frequency, percentage, median, standard deviation (SD), and range (minimum and maximum). *Friedman's* analysis was used to identify the differences in clinical assessments and health-related illnesses between different seasons. Pairwise comparison was used to compare median differences in clinical assessments and health-related illnesses between different seasons. *Wilcoxon* signed-ranks analysis was used to compare urine Sp. Gr. between baseline and different seasons. *Spearman's* rank correlation coefficient was used to examine the relationship between WBGT and urine Sp. Gr. in different seasons. Statistical significance was set to be *P*-value less than 0.05.

RESULTS

Table 1 demonstrated the distribution of the respondents by their socio-demographic information. A total of 22 participants were male with an average age (SD) of 49.8 (9.7) years. Most of them were married (90.9%) and had an elementary school education (81.8%). The average household income (SD) was 555,909.1 (584,479.1) Baht per year. The participant's body mass index (BMI) was within the range of 20.3-50.1 kg/m^2, with a median (SD) of 25.5 (7.2) kg/m^2.

Table 1. Socio-demographic information

Socio-demographic information	Median (SD)	n (%)
Age (years)	49.8 (9.7)	
Marital status		
Married		20 (90.9)
Single		2 (9.1)
Level of education		
Elementary school		18 (81.8)
High school		4 (18.2)
Average household income (Baht/year) (1 USD~33 THB)	555,909.1 (584,479.1)	
Weight (kg)	68.0 (15.3)	
Height (cm)	165.7 (7.4)	
Body mass index (kg/m^2)	25.5 (7.2)	
Normal (18.5-22.9)		14 (63.6)
Overweight (23.0-24.9)		2 (9.1)
Obese (>24.9)		6 (27.3)
Rang=20.3-50.1		

The results presented comparisons of clinical assessment in different seasons (Table 2). Participants had the highest concentration (median, SD) of urine Sp. Gr. (1.022, 0.006), body temperature (36.8, 0.6°C), heart rate (87.0, 14.5 times/minute), respiratory rate (27.0, 5.5 times/minute), weather temperature (32.8, 1.4°C), WBGT (38.1, 2.8°C), and metabolic workload (308.6, 73.7 Kcal/h) in summer. *Friedman* analysis revealed that the differences in body temperatures were found to be statistically significant between summer and winter ($P<0.01$) and rainy season and winter ($P<0.01$). The respiratory rate showed that there was a statistically significant difference between summer and winter ($P<0.05$). Weather temperature was statistically significantly different between summer and winter ($P<0.01$) and rainy season and winter ($P<0.01$). The WBGT was statistically significantly different between summer and rainy season ($P<0.01$), summer and winter ($P<0.01$), and rainy season and winter ($P<0.01$).

The workload classification of farmworkers exposed to high heat stress for heavy workload in summer, and medium workload in rainy season and winter when compared to heat exposure and average metabolic rates of the Ministerial Regulation on the Prescribing of Standard for administration and management of the Occupational Safety, Health and Environment in Relation to Heat, Light, and Noise A.D. 2006 [18], is presented in Table 3.

The urine Sp. Gr. value was measured on 22 farmworkers to determine dehydration status. The results implied that participants had abnormal urine Sp. Gr. (≥1.026) in baseline, summer, rainy season,

Table 2. Comparisons of clinical assessment in different seasons

Clinical assessment	Seasons			χ^2	P
	Summer	Rainy	Winter		
	Median (SD) Range	Median (SD) Range	Median (SD) Range		
Urine Sp. Gr.	1.022 (0.006) 1.008-1.030	1.020 (0.008) 1.008-1.038	1.018 (0.005) 1.009-1.028	1.63	NS
Body temperature (°C)	36.8 (0.6) 35.3-37.7	36.0 (0.9) 33.9-37.4	35.9 (1.1) 33.7-37.9	15.36	<0.01** [b, c]
Heart rate (time/minute)	87.0 (14.5) 66.0-117.0	84.0 (15.2) 57.0-118.0	81.0 (11.9) 60.0-112.0	1.97	NS
Respiratory rate (time/minute)	27.0 (5.5) 21.0-47.0	25.0 (3.9) 20.0-36.0	24.1 (2.7) 20.0-30.0	4.69	<0.05* [b]
Weather temperature (°C)	32.8 (1.4) 31.0-35.5	32.3 (1.5) 28.6-34.0	29.6 (2.0) 26.4-34.4	31.64	<0.01** [b, c]
WBGT (°C)	38.1 (2.8) 32.7-46.4	36.1 (2.1) 31.2-39.2	31.5 (2.7) 24.2-37.5	26.45	<0.01** [a, b, c]
Metabolic workload (Kcal/h)	308.6 (73.7) 280-490	258.1 (34.3) 240-320	288.1 (30.9) 160-300	1.08	NS

Note: *Friedman* and pairwise comparison analysis, *=significant value at P<0.05, **=significant value at P<0.01; a=there was a significant difference between summer and rainy season, b=there was a significant difference between summer and winter, c=there was a significant difference between rainy season and winter, and NS=not significant

Table 3. Workload classification assessment in different seasons

Seasons	Task description	Workload classification (Metabolic rate of average)	WBGT (°C)
Summer	Paddy preparing: plowing by walking tractor and tractor	Heavy (308.6 Kcal/h)	38.1
Rainy	Transplanting: rice seeding by manual and sprayer, direct seeding, water management by water pump, manual seeds elimination, and applying pesticides and fertilizers, etc.	Medium (258.1 Kcal/h)	36.1
Winter	Harvesting: harvest by harvester and manual harvesting	Medium (288.1 Kcal/h)	31.5

and winter at 22.7%, 45.5%, 31.8%, and 18.2%, respectively. *Wilcoxon* signed-ranks analysis found a significant difference in the medians of the paired sets of urine Sp. Gr. values between baseline and summer ($P<0.05$); meanwhile, there was no significant difference in the medians of the paired sets of urine Sp. Gr. values, either between baseline and rainy season, or between baseline and winter (Figure 1). Notably, the relationship between WBGT and urine Sp. Gr. in three different seasons were not linear (*Spearman's* rank correlation coefficient analysis) (Figure 2).

As shown in Table 4, the heat-related illnesses while working in the different seasons show that farmworkers had skin rash/itching (31.8%), weakness (63.6%), dizziness (40.9%), headache (9.1%), vomiting (13.6%), muscle cramp (45.5%), and dyspnea (63.6%) in the rainy season. Most of them had heat syncope (4.5%) in summer. There was a statistically significant difference between the three seasons of skin rash/itching, dizziness, muscle cramp dyspnea ($P<0.05$), and weakness ($P<0.01$). Pairwise comparison analysis indicated that skin rash/itching, muscle cramp, and

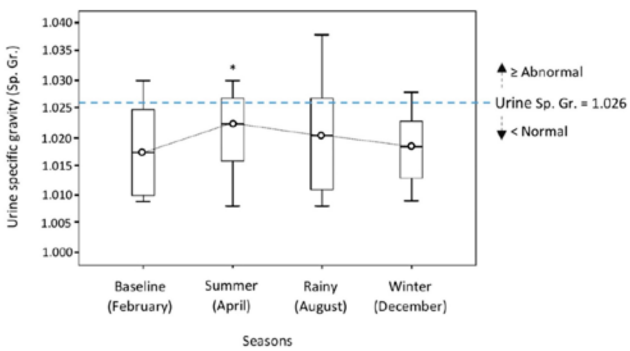

Figure 1. Comparison of urine specific gravity between baseline and other different seasons

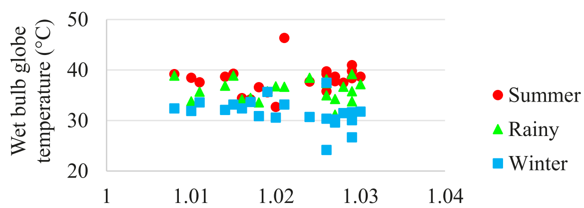

Figure 2. The relationship between wet bulb globe temperature and urine specific gravity in different seasons

Table 4. Comparisons of heat-related illness in different seasons

Heat-related illness	Seasons						χ^2	P
	Summer		Rainy		Winter			
	Yes n (%)	No n (%)	Yes n (%)	No n (%)	Yes n (%)	No n (%)		
Skin rash/itching	4 (18.2)	18 (81.8)	7 (31.8)	15 (68.2)	1 (4.5)	21 (95.5)	6.00	<0.05* b, c
Weakness	8 (36.4)	14 (63.6)	14 (63.6)	8 (36.4)	3 (13.6)	19 (86.4)	10.85	<0.01** c
Dizziness	3 (13.6)	19 (86.4)	9 (40.9)	13 (59.1)	2 (9.1)	20 (90.9)	8.60	<0.05* a, c
Headache	2 (9.1)	20 (90.9)	2 (9.1)	20 (90.9)	1 (4.5)	21 (95.5)	0.50	NS
Vomiting	2 (9.1)	20 (90.9)	3 (13.6)	19 (86.4)	1 (4.5)	21 (95.5)	1.20	NS
Muscle cramp	9 (40.9)	13 (59.1)	10 (45.5)	12 (54.5)	3 (13.6)	19 (86.4)	5.73	<0.05* b, c
Dyspnea	14 (63.6)	8 (36.4)	14 (63.6)	8 (36.4)	5 (22.7)	17 (77.3)	8.52	<0.05* b, c
Heat syncope	1 (4.5)	21 (95.5)	0 (0.0)	22 (100.0)	0 (0.0)	22 (100.0)	2.00	NS

Note: *Friedman* and pairwise comparison analysis, *=significant value at P<0.05, **=significant value at P<0.01; a=there was a significant difference between summer and rainy season, b=there was a significant difference between summer and winter, c=there was a significant difference between rainy season and winter, and NS=not significant

dyspnea were statistically significant differences between summer and winter (P<0.05) and rainy season and winter (P<0.05). Weakness was a statistically significant difference between rainy season and winter (P<0.01). Dizziness was a statistically significant difference between summer and rainy season (P<0.05) and rainy season and winter (P<0.05).

DISCUSSION

All participants were male farmworkers, the same as previous studies have mentioned that farmers who mostly work in every activity in farming were male [19]. The findings of this study demonstrated clinical assessment including urine Sp. Gr., body temperature, heart rate, respiratory rate, weather temperature, and wet bulb globe temperature (WBGT) in three different seasons. Farmworkers worked among severe heat environmental conditions throughout the farming season. Similarly, seasonal variation in heat exposure was noted, with March to October having higher WBGT than other months [20]. The WBGT can more closely reflect thermal conditions conducive to heat stress on humans. The WBGT value was significantly different in the three seasons (summer, rainy, and winter), similar to previous studies [21]. As expected, there is a report of WBGT measurements showing the highest temperature in summer [22]. Most farmworkers were spending 4-10 hours paddy preparation processes in 38.1 °C WBGT in summer with a heavy metabolic workload (308.6 Kcal/h) and in the rice planting processes in 36.1 °C WBGT in the rainy season with a medium metabolic workload (258.1 Kcal/h). Noteworthy is the weather in the rainy season had as high temperature as the summer temperature. *Frimpong* et al. [20] have explained that generally the maximum WBGT in rainy months is still exceeding 27 °C during the middle of the day. At that time, most of the strenuous labor was done for a lot of the farm activities with a high metabolic workload (308.6-258.1 Kcal/h) during WBGT rising above the threshold limit value (TLV) (38.1-36.1°C WBGT) between May to August.

The Thai regulation on administration and management of occupational safety, health and environment in relation to heat specified the following criteria: i) light workload means the labor's work among environmental temperature lower than 34°C WBGT with metabolization lower than 200 Kcal/h, ii) medium workload means the labor's work among environmental temperature lower than 32°C WBGT with metabolization between 200-350 Kcal/h, and iii) heavy workload means the labor's work among environmental temperature lower than 30°C WBGT with metabolization higher than 350 Kcal/h [18]. When comparing metabolization to environmental temperature (°C WBGT) it was found that all of them work in extreme heat conditions over the regulation defined for summer and rainy seasons. Thus, the workload characteristics of farmworkers were defined as heavy in summer, and medium in rainy season and winter. In addition, the WBGT was found to be the most accurate methods to be associated with physiological parameters under heat stress conditions [13]. The finding showed that body temperature, respiratory rate, and weather temperature were statistically significant between three seasons. Heat stress occurs when the human body is not able to dissipate sufficient excess metabolic heat, leading to an increase in body temperature and heart rate [23, 24] with WBGT increment up to 28-30°C [25]. The farmworkers had more abnormal results of clinical assessment occurring in summer than the rainy season and winter. It might be because most of them worked in the hottest temperature condition season with inappropriate behavior. Thus, farmworkers need to be aware of self-practice to prevent clinical health effects owing to extreme heat exposure in every single season.

The highest occurrence of heat-related illness experienced in farmworkers working among high heat conditions were skin rash/itching, weakness, dizziness, headache, vomiting, muscle cramp, and dyspnea in the rainy season. The results contrasts with previous studies in Thailand that found heat-related patients were the highest in summer [5]. This probably explains that the temperature in the rainy season (32.3°C or 36.1°C WBGT) and summer (32.8°C or 38.1°C WBGT) are not much different. Nevertheless, the rainy season has the highest relative humidity which is a significant factor that can affect the incidence of respiratory system allergies, and comfort [26, 27]. Health effects may be attributed to other related factors such as workload, working hours, fluid consumption, clothing, rest time, etc. Extreme heat-exposure is still the main factor for vulnerability to illness at 2.3 times higher odds compared to unexposed farmworkers (P<0.0001) [25]. This study found one case with heat syncope, same as the result that the lowest cases reported were heat syncope and heat stroke [28, 29]. Noteworthy, Sawka studies indicate that a healthy military male had the symptom of heat syncope during heavy training among extreme environmental conditions with an average of only 29.4°C WBGT [30]. Furthermore, these finding showed a statistically significant difference between the three seasons. Previous studies explained that with a threshold of environmental temperature greater than 32°C, the ambient temperature was positively associated with a high risk of heat-related injury for outdoor workers [31]. However, heat-related symptoms are not unique to heat exposure and it is likely that part of the reported symptoms can be caused due to other factors [32]. Thus, farmworkers who work among various risk factors should be aware and avoid and protect themselves from these hazards.

Urine Sp. Gr. as biomarkers can be useful in human medicine for early identification and localization of dehydration from extreme heat exposure, which can be detected within 24 hours [33]. Even urine Sp. Gr. was not significantly different between the three seasons; urine Sp. Gr. concentration was high in summer and the rainy season. A recent study in Thailand showed urine Sp. Gr. among sea salt workers were over 1.020 in summer [34]. Similar to previous studies that reported that agricultural workers had urine Sp. Gr. values up over 1.020 (dehydration) from March to August [21]. These were probably because farmworkers were exposed high heat temperatures during work times in summer and the rainy season, which affects to evaporation and leads to loss of body water, sodium, chloride, and potassium. Those electrolytes are responsible for the maintenance of overall fluid balance in the body. Surprisingly, there were statistically significant differences in urine Sp. Gr. values between baseline and summer. It might be that the farmworkers were exposed to the extreme heat temperatures in the hottest month, most of their activities were performed outdoors, and they did not use proper personal protective equipment for heat protection with insufficient liquid intake during farm work. Working in hot and humid environment can leads to dehydration status, which increases the concentration of urine Sp. Gr. values. Similar to a prior study which indicated that Australian workers who are miners working in an ambient temperature of 36.2°C result in 60% of workers working in a dehydrated condition [35]. Urinary Sp. Gr. is a measure of the concentration of solutes in the urine loss (dehydration) [37]. As the *Scott* et al. [37] study recommended, when temperatures reach 35°C or above, the workers shall take a preventative cool-down rest under shade and take more fluid intake to replace the body fluid loss to avoid dehydration.

WBGT index was used to evaluate environmental temperature which recorded air temperature, natural wet temperature, globe temperature, relative humidity, and air velocity. The present study demonstrates that the WBGT level was highest in summer as expected. The rainy season, apart from having a high temperature, still has high humidity which contributes to the likelihood of heat stress by reducing the ability to dissipate excess metabolic heat through the evaporation of sweat [38,39]. The findings revealed that there is no significant relationship between WBGT and urine Sp. Gr. in the three seasons. In contrast with prior studies which indicated that the *Pearson* correlation measure showed a significantly high correlation between the WBGT and urine Sp. Gr. (r_2=0.89, P=0.001) [40]. Additionally, outdoor workers with moderate and heavy workloads had significantly increased dehydration (urine Sp. Gr. ≥ 1.030) [41]. The results found the farmworkers were exposed to high WBGT and had high urine Sp. Gr. concentrations. This might suggest that farmworkers who work outdoors should apply the use of proper personal protective equipment for heat exposure (cover whole body and ventilate). Another suggestion for the farmworkers who working in weather temperatures over 32°C or 34°C WBGT, is that must take a minimum break for approximately 10-15 minutes under the shade ever 1.5-2.0 hours and drink water or a fluid replacement of 1 liter per hour. However, this study had several limitations. First, heat exposure was measured in a single point in each season for all farmworkers; individual heat measurement is recommended for further study. Second, urine Sp. Gr. might be in error when the subject is experiencing diuresis because of alcohol or caffeine intake or is taking vitamin supplements or some meditations.

CONCLUSIONS

Our findings showed that adequate sociodemographic information and clinical evaluation of heat-related diseases are desirable in vulnerable populations of farm workers. The urine Sp. Gr. values represented dehydration status in farmworkers while working daily in different seasons. The clinical assessments were in the highest concentration in the summer; moreover, heat-related illnesses were highly occurring in the summer and rainy season. The environmental temperature was measured in WBGT for the summer and rainy season which was over the standard of the American Conference of Governmental Industrial Hygienists (ACGIH) TLV for heat exposure. Farmworkers should be trained to increase awareness of significant preventive practices to avoid the health effects of extreme heat exposure. In particular, the administrative controls are needed to decrease extreme heat exposure in occupational settings such as workload consideration, heat acclimatization, time breaks under shaded areas, providing cool water and heat protection clothing. A future project is urgently needed to develop scientific interventions to prevent heat stress and improve dehydration status in farm and outdoor workers in this region.

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Conflict of interest

The authors declare no conflict of interest.

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