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RESEARCH ARTICLE

Climate change-mediated heat stress vulnerability and adaptation strategies among outdoor workers

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ABSTRACT
The study examined the effect of heat stress on the well-being of outdoor workers and their coping strategies. A cross-sectional survey study was conducted between September 2019 and December 2019 to collect data from outdoor workers including hawkers and traffic wardens from 13 urban areas ($N = 322$) and analyzed using SPSS v.23. The results of the study show that most of the outdoor workers were in a good health state based on their self-health assessment. However, the respondents expressed concerns and symptoms of heat stress including heat cramps, heat exhaustion, heat stroke and sleep disorders. The findings also show that male outdoor workers were 1.3 times more likely than females to be affected by heat stress. Respondents in their 20s were more likely to be affected by heat stress, as a result of temperatures and humidity conditions, than those in their 30s (OR = 0.389, CI = 0.158–0962) and 40s (OR = 0.395, CI = 0.147–1.063). Coping strategies identified include the use of breathable cotton attires, drinking a lot of water, hiding under shades and reducing outdoor activity intermittently.

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Outdoor workers; heat Stress; health; disease; vulnerable; adaptability

Introduction

Climate change is one of the most pressing issues, having worldwide attention in recent times due to its persistent altercations to environmental conditions across the globe. The main cause of climate change is known to be the release of greenhouse gases, particularly carbon dioxide, which is trapped in the atmosphere leading to the warming of the earth (Kaddo, 2016). As a result of the constant release of heat waves into the atmosphere, climate change has caused elevated temperatures in most countries over the past few decades. In the last two decades, extreme weather and climate events are known to have severe effects and have become one of the main environmental challenges for public health in the developing world and particularly in sub-Sahara Africa (SSA) (Carter et al., 2020; Langkulsen & Rwodzi, 2020). The seriousness of climate change is also reflected in the assertion of Moda and Minhas (2019) that global climate change is among the most visible and major environmental concerns of the twenty-first century as these changes have dramatic effects on human livelihoods.

Urban centres in most developing countries are now witnessing rapid population growth and are becoming the epicenter of climatic effects. Though heat is a giver of life when it gets too hot or higher than the body can bear, then terrible things happen (Ragsdale & Stark, 2019). Zander and Mathew (2019), for example, have noted that of all extreme weather events, extreme temperatures and heat waves have some of the most severe impacts on people (Coates et al., 2014; Mora et al., 2017). Heat stress refers to heat in excess of what the body can tolerate without suffering physiological impairment. It generally occurs at temperatures above 35°C in high humidity (International Labor Organization, 2019).

The global atmospheric temperature in the past 30 years has become warmer than any preceding decade since 1850 (Edenhofer, 2015). According to the World Health Organization (2018), extreme temperatures contribute directly to mortality from respiratory and cardiovascular health complications. Other symptoms reported are confusion, irrational behaviour, crime and violence, increased migration, low coordination, fainting, vomiting, convulsions and loss of consciousness (Burke & Chen, 2015; Kjellstrom et al., 2017; Shapiro & Seidman, 1990). In addition, heat stress does not only influence the physiological body functions but could also have negative impacts on mental/emotional state (Anderson, 2016; Frimpong et al., 2020; Hansen et al., 2008; Sánchez & Hancock, 2017; Tawatsupa et al., 2012). A notable example of the disastrous effect of heat is the heat wave experienced across Europe in the summer of 2003, where more than 70,000 deaths were registered (Robine et al., 2008).

Many reports also suggest that high temperatures could have negative consequences on the economy. For example, Parsons (2014) reports that extreme heat temperatures decrease work efficiency and labour productivity. Zander et al. (2015) estimated the costs of heat-related productivity loss at USD 6.2 billion over one year for the Australian economy. In South-east Asia, 15–20% of annual work hours are lost in heat-exposed jobs, and the loss is projected to double by 2050 if nothing is done to control global warming (Kjellstrom, 2016). The International Labor Organization [ILO] (2019) reports that countries in West Africa are the most affected by heat stress and because of the labour productivity losses of about 5% and expected to

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worsen to 7% by 2030 if nothing is done to mitigate its effects. The report notes that the losses are even higher (10%) in Ghana, Cote d'voire, Togo and Benin and in about a decade, the losses are expected to translate into more than 8.9 million full-time jobs in the agricultural and construction sectors. Global projections suggest that over 2% of total working hours will be lost, which is equivalent to 80 million full-time jobs translating into losses of nearly $2.4 trillion.

Rother et al. (2020) report that climate change impacts occupational health in subtropical regions of Africa at a rate greater than the global average, and even more serious is the observation that the warming is expected to continue. However, outdoor workers are exposed to higher health risks during hot days and as such are more vulnerable to heat stress as compared to indoor workers (Lundgren et al., 2013; Xiang et al., 2014). A study undertaken in Hong Kong revealed that the internal temperature of a typical road constructor's helmet measured 57°C when the environmental temperature was only 33°C (Rowlinson et al., 2014). Though heat stress is a threat to outdoor workers worldwide, its impact on those based in Africa could be deemed more devastating because of resource constraints (Busby et al., 2014; Niang et al., 2014; Thomas & Nigam, 2018). In Ghana, most outdoor workers are largely from the informal sector which includes street vendors and hawkers. These people do not enjoy the health insurance covers and worker safety policies as employees in the formal sectors do and therefore are more prone to heat stress-related diseases (Becker & Stewart, 2011; Belshaw, 2009; Harduar Morano et al., 2016; Sheffield et al., 2013).

Due to the devastating nature of climate change including heat stress, there is a need for further studies such as this current study in order to properly understand the phenomena and provide appropriate interventions to mitigate its effect.

Such studies are relevant because, in all sectors of human endeavours and national economies, it is prudent to identify impacts and vulnerabilities of climate change since these phenomena can adversely affect social well-being and economic development. This gap motivates the study.

The purpose of the study, therefore, is to determine the effect of heat stress on the well-being of street vendors/hawkers and traffic wardens and their coping strategies in Accra, Ghana, with the aim of informing policy towards the mediation strategies of heat stress and associated ill-health among outdoor workers in Ghana. To achieve our objective, we sought to answer three main questions: (1) What are major concerns of the effect of heat on the outdoor worker?, (2) Effect of heat stress on work and well-being of respondents?, (3) Respondents' heat stress adoption strategies? Answers to these research questions can be used by the government and other stakeholders to understand the level of heat stress among Ghanaians outdoor workers and to craft policies and programmes aimed at promoting successful adaptation, mitigation and disaster risk management.

We contribute to the literature by examining the perception of the informal outdoor workers on the effects of heat stress and how they cope. This examination will help to understand the potential adaptation strategies and needs in the dynamic climate change environment (Rother et al., 2020) as it relates to outdoor workers in the urban city of Accra, Ghana. This is critical because the disastrous impacts of heat stress are expected to increase as the region is experiencing massive urbanization, high growth rate and environmental pollution. The SSA region, for example, has become the most urbanizing region in the world (Pinault, 2019), with Ghana having an urbanization rate of 56% compared with the SSA average of just over 40% (GSS, 2019; World Bank, 2016). The problem is bound to continue and deepen even as the population of the region is expected to double by 2050. It is worthy of mention that the dramatic urbanization presents the region with challenges including unemployment, high levels of informality, slums and environmental pollution. This is even more serious as most of the countries in the region have weak or poor social protection systems to provide safety nets for the poor.

The climate problem and the associated heat stress are expected to be more severe in the region because of the high level of informality, which tends to be characterized by high levels of poverty, inequality and decent work deficits. As noted earlier, workers in informal work arrangements generally lack access to social protection and accident and injury insurance, making them particularly vulnerable to the negative effects of heat stress on their livelihoods. The issues raised above give credence to the value of the study in examining the level of awareness, effects and coping strategies of urban outdoor workers to provide evidence-informed policy in mitigating the negative effects of heat stress. The study is situated in the extant literature that suggests that occupational climate change policies need to be considered at the micro-level, which is suggestive of the fact that one-size-fits-all adaptive strategies for different groups or communities of workers might not be appropriate or optimal (Moda & Minhas, 2019; Nunfam et al., 2020). Accordingly, this study examines the level of climate change awareness and adaptation of outdoor workers in the streets of Accra. The basic assumption is that the adaptive ability is dependent on factors such as the resilience or vulnerability level and availability of resources and therefore the focus on street vendors in the city of Accra will help shed some light on their peculiar situation and characteristics. The data band methodology employed to research objective is discussed next.

Methodology

Study location

The study was carried out in Greater Accra, in south-eastern Ghana. The region covers a total size of 3245 km^2 and is the national capital of the country. The population density is 1235.8 people/km^2. The region is known to be 90.5% urbanized with a population growth rate of 3.1% per year. The region attracts a lot of people from the hinterlands than residents leave to other regions. Accra was chosen because of its metropolitan nature, largely as a result of migration from inter-lands into Accra in search of greener pastures. Most of these migrants end up as outdoor workers on the streets.

Climate

As Accra is close to the equator, the daylight hours are practically uniform during the year. Relative humidity is generally high, varying from 65% in the midafternoon to 95% at night. The predominant wind direction in Accra is from the West-Southwest to North-Northeast sectors. Wind speeds normally range between 8 and 16 km/h (Steynor et al., 2015).

The mean monthly temperature in Accra ranges from 25.9°C (78.6°F) in August (the coolest) to 29.6°C (85.3°F) in March (the hottest), with an annual average of 27.6°C (81.7°F). During the 'cooler' months, their weather tends to be very humid than the warmer months in the year. The city experience dry heat that occurs during the warmer months and peaks during the Harmattan season (Steynor et al., 2015).

Study design and sample size

The study used a cross-sectional design to obtain quantitative data using a pre-tested questionnaire. We employed cross-sectional studies because it is the most relevant design when assessing the prevalence and measures the outcome and the exposures in study participants at the same time comparing (Kesmodel, 2018; Setia, 2016)

The study was conducted in 13 urban areas in Accra Metropolitan area of Ghana. The study population included hawkers and traffic wardens. Hawkers refer to people who sell and provide services along the major road. The traffic warden provides vehicular traffic directions at junctions and intersections on the road. The Miller and Brower's sample determination formula ($n = N/1 + N(\alpha)2$) was employed to ascertain the sample size. In the formulae: n is the sample size, N is the total population and α is the margin of error (Miller and Brower, 2003). The allowable margin of error and the standard deviation were set at 0.08 and 95% confidence level, respectively, in order to account for nonresponses, missing or inappropriately filled questionnaire. The minimum sample size was increased and rounded up to 10% (Odonkor & Mahami, 2020).

A stratified sampling technique was used in this study to determine the required number of participants from each of the two categories of outdoor workers (Odonkor et al., 2019). Thus, in selecting the respondents, sampling proportionate to size was used to determine the number of outdoor workers to be interviewed from each urban area. The sample size was obtained based on the proportion of population outdoor workers in the urban 13 areas. At the sampling site, all outdoor workers in the selected categories (i.e. hawkers and traffic wardens) who were present were considered for the study.

Data collection and analysis

Data were obtained for the study between September 2019 and December 2019. A total of 350 questionnaires were distributed across all the 15 districts in the region. The questionnaire elicited information on socio-demographic characteristics which included age, gender, residence, region of origin and worker category. The self-assessment of health status, effect of heat stress on work and well-being and heat stress adoption strategies were employed by the respondents to mitigate and adapt to the heat stress.

Three hundred and twenty-two questionnaires were filled and returned giving a response rate of 92%. The data from the survey were entered in a spreadsheet and later exported to SPSS for Windows Version 23.0.

The analysis included both descriptive and inferential statistics. Frequency (percentage) of variables and association between variables were established. Univariate analysis was used in obtaining the frequency of socio-demographic characteristics and other discrete variables of the study population. Chi-square test was used to determine the significance of the observed differences for categorical variables and p-value of 0.05 or less was considered as significant. Analyses of mean face validity and Cronbach's alpha test yielded 95% and 0.8 coefficient, respectively.

Ethical considerations

The study participants were informed about the purpose of the study and that participation in the study was entirely voluntary. They were free to refuse to answer any question and were at liberty to withdraw from the study at any time. They were also assured of utmost confidentiality before, during and at the end of the study with no identifiers, personal or name of their congregation. We obtained Ethical Clearance and Approval from the Ghana Institute of Management and Public Administration (GIMPA) Institutional Review Board.

Results

A total of 322 outdoor workers made up of 257 hawkers and 65 traffic wardens participated in the study. Most of the respondents (82.9%) in this cohort had secondary school education, 6.8% primary education and 10.2% had no formal education. In terms of age, the majority of the participants (60.6%) were between 20 and 30 years old, 37.6% were between 31 and 40 years and 1.9% representing the least were between 41 and 50 years old. In investigating the respondents' region of origination, most of them (73.0%) were from the coastal belt, 22.7% were from the middle belt and 4.3% for the northern belt. Table 1

The respondent's self-assessment of health status and selected demographics is presented in Table 2. Generally, majority of the respondents (50.0%) considered their health to be good, 40.7% deemed their health very good and 9.3% indicated that their health condition was poor. This information is important in helping to understand the effect of heat stress on work and well-being of respondents. For example, a persisting poor health status could influence respondent's perception on heat stress on their health.

Table 3 presents the respondents' major concern on the effect of heat on their health. It can be observed that majority (60.6%) of the respondents indicated stress as their major concern. This was followed by 19.9, 16.8 and 2.2% who indicated body water loss, sickness and retaining workspace, respectively, as their major concerns.

Respondents were asked multiple questions to assess the effect of heat stress on their work and well-being (Table 4). A key observation was that 29.8% of the participants admitted that they had fallen sick as a result of heat stress.

The effect of heat stress on the sleep of respondents is presented in Table 5. Majority (76.4%) indicated that heat stress

Table 1. Demographic characteristics of respondent.

Variable $N = 322$	Female N (%)	Male N (%)	Total N (%)
Education			
Primary	6 (1.9)	16 (5.0)	22 (6.8)
Secondary	111 (34.5)	156 (48.4)	267 (82.9)
No formal education	11 (3.4)	22 (6.8)	33 (10.2)
Total	128 (39.8)	194 (60.2)	322 (100)
Age			
20–30	85 (26.4)	110 (34.2)	195 (60.6)
31–40	43 (13.4)	78 (24.2)	121 (37.6)
41–50	0 (0.0)	6 (1.9)	6 (1.9)
Total	128 (39.8)	194 (60.2)	322 (100)
Residence			
Urban	128 (39.8)	194 (60.2)	322 (100)
Rural	0 (0)	0 (0)	0 (0)
Total	128 (39.8)	194 (60.2)	322 (100)
Region of origin			
Northern belt	5 (1.6)	9 (2.8)	14 (4.3)
Middle belt	5 (1.6)	68 (21.1)	73 (22.7)
Coastal belt	118 (36.6)	117 (36.3)	235 (73.0)
Total	128 (39.8)	194 (60.2)	322 (100)
Work category			
Traffic warden	20 (6.2)	45 (14.0)	65 (20.2)
Hawker	108 (33.5)	149 (46.3)	257 (79.8)
Total	128 (39.8)	194 (60.2)	322 (100)

Table 3. Respondents major concerns on the effect of heat.

Major concern	Female N (%)	Male N (%)	Total N (%)	Significance value
Sickness	31 (9.6)	23 (7.1)	54 (16.8)	$X = 15.719$
Stress	72 (22.4)	123 (38.2)	195 (60.6)	$P = 0.003$
Water loss in body	23 (7.1)	41 (12.7)	64 (19.9)	Cramer's V = 0.003
Retain work space	0 (0.0)	7 (2.2)	7 (2.2)	
Creating heat exhausting	2 (0.6)	0 (0.0)	2 (0.6)	
Total	128 (39.8)	194 (60.2)	322 (100)	

moderately affected their sleep, 26.7% said they were mildly affected and 6.9% seriously affected. Also, there were significant differences between the various levels of heat stress intensity (at $P < 0.005$). It is worth noting that 41.6% of the respondents reported they were unable to sleep as a result of the heat stress, 25.5% indicated that they were able to sleep for short periods, 15.5% said they sweat while sleeping and 17.4% of the respondents reported that they do not enjoy their sleep.

Data showing respondents' adaptation strategies are presented in Table 6. In the clothing category, breathable cotton attires were revealed by most respondents (82.9%) as the common clothing employed to adapt to the heat. With reactive measures towards heat exposure, 42.2% indicated that they usually look for places to hide from the sun or rest for short periods, 32.3% said they resort to putting on hats and 25.5% revealed regular water intake as their adaptive strategies.

Figure 1 presents the participants' perception of heat-related diseases. An interesting observation is the listing of malaria alongside heat cramps, heat exhaustion and heat-stroke. Majority of the respondents (51.1%) cited malaria as a prevailing disease due to heat stress. The others were 20.2% for both heat cramps and heat exhaustion, with the least being 6.2% for heatstroke.

Table 7 shows the results of logistic regression in the examination of the effects of heat stress on selected demographic characteristics. The results show that males were 1.3 times

Table 2. Respondents' self-assessment of health status and selected demographics.

Variable	Poor	Good	Very Good	Excellent	Significance value
Gender					
Female	17 (5.3)	52 (16.1)	59 (18.3)	128 (39.8)	$X = 8.847$
Male	13 (4.0)	109 (33.9)	72 (22.4)	194 (60.2)	$P = 0.012$
Total	30 (9.3)	161 (50.0)	131 (40.7)	322 (100)	Cramer's V = 0.012
Age					
20–30	24 (7.5)	88 (27.3)	83 (25.8)	195 (60.6)	$X = 25.772$
31–40	3 (0.9)	73 (22.7)	45 (14.0)	121 (37.6)	$P = 0.000$
41–50	3 (0.9)	0 (0.0)	3 (0.9)	6 (1.9)	Cramer's V = 0.000
Total	30 (9.3)	161 (50.0)	131 (40.7)	322 (100)	
Work category					
Traffic warden	1 (0.3)	38 (11.8)	26 (8.1)	65 (20.2)	$X = 6.464$
Hawker	29 (9.0)	123 (38.2)	105 (32.6)	257 (79.8)	$P = 0.039$
Total	30 (9.3)	161 (50.0)	131 (40.7)	322 (100)	Cramer's V = 0.039

Table 4. Effect of heat stress on work and well-being of respondents.

Variable	Number	Percentage
Do you sweat during work?		
Yes	278	86.3
No	44	13.7
Do you get fatigued easily?		
Yes	151	46.9
No	171	53.4
How much is the density of your thirst?		
I don't get thirsty	46	14.3
I get little thirsty	218	67.7
I get very thirsty	58	18
What is the effect of heat on your sleep?		
Inability to sleep	134	41.6
Reduce lent of sleep time	82	25.5
Induce sweating while sleeping	50	15.5
It makes sleeping boring and uncomfortable	56	17.4
How do you feel about the humidity level during work?		
Dry	68	21.1
Normal	179	55.6
Wet	75	23.3
Are you suffering from heat stress?		
Yes	258	80.1
No	64	19.9
Have you ever fallen sick as a result of heat stress?		
Yes	96	29.8
No	226	70.2

Table 5. Intensity and effect of heat stress on sleep.

Variable $N = 322$	Female N (%)	Male N (%)	Total N (%)	Significance value
Intensity of heat stress				
Mild	9 (3.1)	39 (13.5)	48 (26.7)	$X = 16.491$
Moderate	99 (34.4)	121 (42.0)	220 (76.4)	$P = 0.000$
Severe	3 (1.0)	17 (5.9)	20 (6.9)	Cramer's V = 0.000
Total	111 (38.5)	177 (61.5)	288 (100)	
Effect of heat stress on sleep				
Inability to sleep	51 (15.8)	83 (25.8)	134 (41.6)	$X = 11.174$
Reduce lent of sleep time	38 (11.8)	44 (13.7)	82 (25.5)	$P = 0.011$
Induce seating whiles sleeping	26 (8.1)	24 (7.5)	50 (15.5)	Cramer's V = 0.011
It makes sleeping boring and uncomfortable	13 (4.0)	43 (13.4)	56 (17.4)	
Total	128 (39.8)	194 (60.2)	322 (100)	

Table 6. Respondents Heat stress adoption strategies.

Variable $N = 322$	Female N (%)	Male N (%)	Total N (%)	Significance value
Use of clothing				
Breathable cotton	116 (36.0)	151 (46.9)	267 (82.9)	$X = 10.774$
Thick cotton overall	0 (0.0)	8 (2.5)	8 (2.5)	$P = 0.013$
Rayon/nylon	6 (1.9)	17 (5.3)	23 (7.1)	Cramer's $V = 0.013$
Other	6 (1.9)	18 (5.6)	24 (7.5)	
Total	128 (39.8)	194 (60.2)	322 (100)	
Method to limit heat exposure				
Get into a shade for a while	66 (20.5)	70 (21.7)	136 (42.2)	$X = 7.736$
Regular intake of watch	26 (8.1)	56 (17.4)	82 (25.5)	$P = 0.021$
Wearing of a heat	36 (11.2)	68 (21.1)	104 (32.3)	Cramer's $V = 0.021$
Total	128 (39.8)	194 (60.2)	322 (100)	

more likely than females to be affected by heat stress. Respondents in their 20s (OR = 0.389, CI = 0.158–0.962) were more likely to be affected by heat stress than those in their 30s (OR = 0.389, CI = 0.158–0.962) and 40s (OR = 0.395, CI = 0.1471.063). Also, a significant relationship was established between work category and effect of heat stress, $p = 0.050$.

Discussion

Demographic profile of respondents

The study revealed high literacy rate among the respondents as most of the outdoor workers (82.9%) had a secondary educational qualification. A similar finding was reported by Ngwenya et al. where most respondents out (79.67%) had a good educational background. The age profile of the respondents revealed a rather youthful outlook as majority were between 20 and 30 years old. This finding is consistent with a related study (Boadu, 2013; Sam et al., 2019; Spire & Choplin, 2018). It also confirms the assertion that it has become a normal phenomenon to see large numbers of young people engaged in street hawking in Ghana (Asare, 2010; Biney, 2019) due to the absence of regulatory structures or bodies. Additionally, considering the energy-consuming and strenuous nature of activities carried out by hawkers and traffic wardens, it is quite understandable to have identified many youthful respondents as they possess the required exuberance needed for such occupations. Nevertheless, the revelation of few respondents between the ages of 41 and 50 hinted, that street vending and traffic-related jobs may not be heavily restricted to young people.

Data about respondents' region of origination revealed that hawking and traffic control may not be highly restricted to natives of towns where such studies are carried out. This is because, though the present study revealed most of the outdoor workers (73%) originated from the coastal belt, an appreciable number was also from the middle and northern belts.

Self-assessment of health by respondents

In the study, we examined health self-assessment reports by respondents. This is very vital towards the health assessment particularly for low-income groups such as hawkers. This is partly because such low earners usually do not have access to professional or formal healthcare services and plans as compared to those in the formal sector. Most outdoor workers in the present study generally describe their health status as 'good' which consistently compares to a similar study by Ngwenya et al. Only 9.3% of the respondents in the current study indicated that their health status was poor.

Effect on heat stress on well-being and health of respondents

Negative impacts of heat stress on the health of outdoor workers have been reported in several literatures (Golbabaei et al., 2016; Pogačar et al., 2018; Tustin et al., 2018). We found in this study that heat stress causes profuse sweating among the respondents as a result of high temperatures. Sweating causes a reduction in body water levels and as a

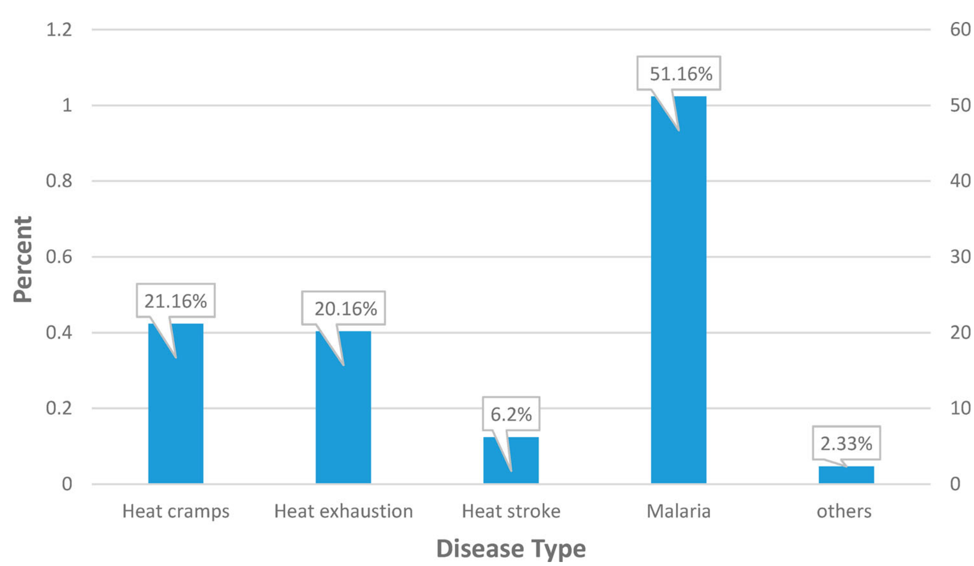

Figure 1. Disease as a result of heat stress.

Table 7. Multiple logistic regression model: effect of heat stress on socio-demographic characteristics.

Variable	OR	95% CI	*P*-value
Sex			
Male	Ref		
Female	1.273	0.557–2.908	0.567
Age			
20–30	Ref		
31–40	0.389	0.158–0.962	0.041*
41–50	0.395	0.147–1.063	0.066
Education			
Primary	Ref	27.6	
Secondary	1.088	0.456–2.597	0.850
No formal education	1.136	0.272–3.989	0.631
Degree	1.266	0.327–4.899	0.73
Work category			
Traffic warden	Ref	36.8	
Hawker	0.426	0.176–1.031	0.050*
Region of origin			
Northern belt	Ref	31.6	
Middle belt	4.789	1.043–21.990	0.044
Southern belt	1.386	0.457–4.209	0.56

OR, odds ratio; 95% CI, 95% confidence interval; Ref, reference category.
*Significant at 0.05.

result, there must be simultaneous water intake to compensate for that which was lost. When water intake insufficiently compares to water loss through sweating, dehydration could occur. Dehydration has serious health repercussions on outdoor workers because dehydration as a result of occupational heat stress could lead to myocardial infractions also referred to as heart attack (Fehling et al., 2015). In addition to sweating, fatigue/tiredness and heavy thirst are symptoms of dehydration (Shaheen et al., 2018). However, evidence from the data revealed that dehydration may not necessarily be a common health risk among the respondents. This is because, in contrast to sweating, majority of the respondents indicated they do not get fatigued easily. Probably, they take in enough water to compensate for water loss from sweating. Also, it could probably be as a result of physiological adaptations due to prolonged exposure to heat stress which increases endurance levels (Périard et al., 2015). Furthermore, additional evidence to suggest dehydration is uncommon among the respondents is the fact only 18% of them revealed they experience heavy thirst.

Other major well-being challenges associated with heat stress are sleeping disturbances and the inability to sleep in general (Kunz-Plapp et al., 2016; Williams, 2010). Hawkers and traffic wardens need uninterrupted sleep in order to be refreshed and prepared for the new day's work. In a related study of farmers in Ghana, Frimpong et al. (2020) reported some negative effects of heat stress, including the inability to sleep and reduced length of sleep time. With regard to gender, there were no significant differences among the male and female respondents in terms of the various effects of heat on sleep.

It is worth noting that even though physical well-being complications especially stress were common among the respondents, many did not associate heat stress with specific diseases, which provides some distinction between the well-being and health of the respondents (Stoewen, 2015). A few of the respondents, however, indicated that heat stress was related to the incidence of malaria. There is insufficient evidence in the literature to clearly specify the thermal predilections of the *Anopheles* organism (Blanford et al., 2009) but more recent studies have revealed that climate change plays a role in malaria distribution (Blanford et al., 2013; Gething et al., 2011; Le et al., 2019). Le et al. (2019) specifically found out that CO_2 elevations under climate change increase the risk of malaria but an increase in air temperature (associated with heat) negatively affects the malarial *plasmodium* parasite. Accordingly, more research needs to be carried out on atmospheric temperatures that favor the spread of malaria to better understand the effect of heat stress on this disease.

Respondents' heat stress adoption strategies

The present study revealed that respondents employ both proactive and reactive measures to cope with or adapt to heat stress. The wearing of breathable cotton clothing on sunny days was identified as the commonest proactive practice among the respondents with regard to the use of clothing. Breathable cotton clothing is loose and thin which makes it very efficient in heat management (Dehury & DeHuRy, 2017). In terms of reactive measures, seeking shelter under shades for a short while was indicated by most respondents. A significant number also revealed regular intake of water and wearing of hats as other reactive measures. These are consistent with the findings of Phuong et al. (2013), who report that most outdoor workers do not have the luxury of working under air conditioners and as a result, they adopt these low cost or readily available means of limiting their exposure to heat waves.

Influence of socio-demographic characteristics on knowledge of impact of heat stress

Multiple logistic regression analysis showed that differential effects with respect to gender-male outdoor workers are more likely to experience heat stress as compared to the females. This is in support of Pradyumna et al.'s (2018) study that showed that male outdoor workers are more vulnerable to heat stress than females. This could be due to the fact that the male respondents are more active and tend to stay in the heat or exposed to the heat for longer periods than the females. With regard to age, the younger respondents (those in their 20s) were more likely to be affected by heat stress. Possibly, the younger engage in more intense outdoor activities due to higher fitness and energy levels as compared to the older ones. It was also observed that the type of work outdoor performed by the respondents significantly had influence on whether the respondent experienced heat stress or otherwise.

Conclusions and policy implications

The study examined heat stress on outdoor workers and their coping strategies in Accra Ghana. The study revealed useful insights for heat stress vulnerability in Ghana, adaptation strategies and policy directions in Ghana.

The review of the literature and findings of the study show that most of the outdoor workers were in a good health state based on their self-health assessment. In terms of vulnerability, it was noted heat stress largely affected the physical well-being of the outdoor workers but in terms of health, however, only few admitted they felt sick due to the heat. Malaria was the commonest illness identified among the workers as a heat stress-related disease. This is interesting because research has shown that rising temperatures can fuel the spread of malaria in higher elevations and can even facilitate the transfer of malaria to areas where the disease had not been endemic historically (Endo & Eltahir, 2020; Pradyumna et al., 2018).

Data on adaptation showed that respondents had adapted well to heat stress considering the limited resources and health services at their disposal. Majority of the respondents indicated that they put on thin breathable cotton clothes which are very efficient in heat management. Furthermore, they seek shelter, take in water and wear hats to act as reactive mechanisms to limit heat exposure. Based on these and other results, several useful points for policy in this regard are outlined.

First of all, the Government of Ghana and other major stakeholders of health should increase publicity and education of Ghana's health effects of heat stress to the citizens. Thus, policy directions towards awareness efforts and education campaigns coupled with enhanced reporting of adverse occurrences of risks associated with working in hot settings are essential. Such a move could help give more information about the dangers of heat stress so that people can make more informed decisions.

Second, in light of the dangers posed by heat stress, it is therefore recommended that government should start paying attention to these outdoor workers. Strict heat management policies that will involve major stakeholders including the outdoor workers should be set up.

We conclude by noting that, shelter in the form of mini huts or structures should be sited in hotspot areas in the working environments of these workers to aid in limiting exposure to heat waves. This is because above a certain threshold of heat stress, the human body's internal regulation mechanisms can no longer maintain the body temperature at a level essential for normal functioning. Thus, there is an increased risk of distress, and also limitations in physical functions and abilities, and eventually also of injuries and heat-related illnesses. The latter illnesses range from mild forms, such as heat rash, heat cramps and heat exhaustion, to potentially fatal heatstroke. If the body temperature rises above 38°C ('heat exhaustion'), physical and cognitive functions are impaired; if it rises above 40.6°C ('heatstroke'), the risk of organ damage, loss of consciousness and, ultimately, death increase sharply (Field & Barros, 2014)

Disclosure statement

No potential conflict of interest was reported by the author(s).

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