FINAL REPORT

How do workers perceive heat, heavy workload, dehydration and lack of access to sanitation as risk factors for chronic kidney disease? – Surveying from different occupational groups in South India

Submitted by

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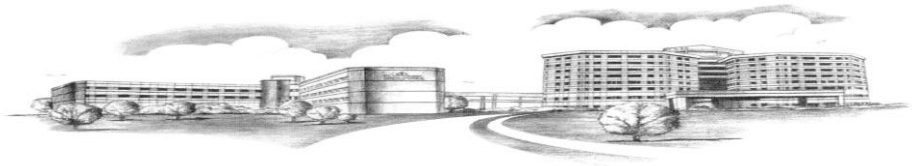

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I - ABBREVIATIONS

CKD	:	Chronic kidney disease
WBGT	:	Wet Bulb Globe Temperature
HRI	:	Heat Related Illness
MGRW	:	Mahatma Gandhi Rural Works
IPCC	:	Intergovernmental Panel on Climate Change
UTI	:	Urinary Tract Infection
HOTHAPS	:	High Occupational Temperature Health and Productivity Suppression
ACGIH	:	American Conference of Governmental Industrial Hygienists
TLV	:	Threshold Limit Value
HSI	:	Heat Strain Indicators
OR	:	Odds Ratio
CI	:	Confidence Interval
ILO	:	International Labour Organisation
MGNREGA	:	Mahatma Gandhi National Rural Employment Guarantee
AWC	:	Anganwdi centres
WCD	:	Women & Child Development
NGOs	:	Non-Governmental Organization
IEC	:	Institutional Ethics Committee
SPSS	:	Service Product for Statistical Solution

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PROJECT TITLE

How do workers perceive heat, heavy workload, dehydration and lack of access to sanitation as risk factors for chronic kidney disease? – Surveying from different occupational groups in South India

Project Duration **:** 6 months (May 2022 to October 2022)

ABSTRACT

Background: Extreme heat events are growing more frequent as a result of global warming and unaddressed is the lack of working population understanding of non-traditional risk factors for the onset and progression of chronic kidney disease (CKD) of uncertain origin, such as heat, dehydration, inadequate sanitation, and heavy workload. This study aims to bridge the gap by gathering outdoor workers' perspective on these non-traditional risk factors and their coping strategies.

Methods: A cross-sectional study was conducted between May and September 2022 with 418 outdoor workers from five outdoor workplaces in southern India. Using a modified and validated High Occupational Temperature Health and Productivity Suppression (HOTHAPS) questionnaire, employees' perceptions of non-traditional risk factors for CKDu were assessed. The data was analysed u sing the SPSS tool using the Mann-Whitney U and Kruskal-Wallis.

Results: 44% of workers reported that during summer (May, June and July) occupational heat exposures had made their daily work more challenging. The risk of heat related illness (Odds Ratio=1.03, CI= 0.59-1.8) and urinogenital symptoms (Odds Ratio=1.14, CI=0.75-1.73) were high among the female workers. The workers awareness on heat (52%), dehydration (57%) as a risk factor for renal illness were also high among the female workers, however excessive physical workload among male workers (69%). All four risk factors were primarily recognised by workers aged 40 and above, which was significantly associated (p=0.05). Less than 50% of workers were aware that traditional coping methods and significant association was observed between the gender (p=0.001), years of exposure (p=0.001), work category (p=0.001) and the awareness of taking a *shower to cool their bodies* as a coping method, with female workers having the highest level of awareness.

Conclusions: The study underlines the necessity to increase worker awareness in order to reduce the incidence of kidney illness caused by heat stress. Protecting outdoor workers in un-organised sectors may be achievable through the use of simple and practicable cooling measures and protective labour legislation.

Keywords: non-traditional, heat, inadequate sanitation, workload, renal diseases, outdoor workers

EXECUTIVE SUMMARY

Climate change has led to a significant rise of 0.8 C–0.9 ºC in global mean temperature over the last century and has been linked with significant increases in the frequency and severity of heat waves (extreme heat events). Climate change has also been increasingly connected to detrimental human health. One of the consequences of climate-related extreme heat exposure is dehydration and volume loss, leading to acute mortality from exacerbations of pre-existing chronic disease as well as from outright heat exhaustion and heat stroke. Recent studies have also shown that recurrent heat exposure with physical exertion, inadequate hydration, and sanitation can lead to chronic kidney disease (CKD), also stated as a non-traditional risk factor that is distinct from that caused by diabetes, hypertension. Epidemics of CKD consistent with heat stress nephropathy are now occurring across the world. The new national public health concern for many countries in Central America, the Northern Territory of Sri Lanka and some parts of India (Andhra Pradesh and Odisha) is the new emerging epidemic of kidney disease of unknown aetiology (CKDu) that is affecting thousands of people, many of whom happen to be people of working age. The occupational health of a working population exposed to hot environments is under-studied in India, where many workers are exposed to arduous physical labour in intense heat, which puts them at an increased risk for negative health outcomes, including compromised renal health. With this background, the present study aimed to evaluate the workers' perception and awareness of heat, heavy workload, dehydration, and lack of access to sanitation as a non-traditional risk factor for the incidence of chronic kidney disease or renal illnesses in a select outdoor working population across different sectors and locations in Southern India. *The primary objective is to examine the workers' heat exposures and awareness of renal illness caused by non-traditional risk factors, as well as their everyday coping techniques for protecting themselves against heat exposure.*

In the present study, a total of 418 workers were recruited for the study from 4 occupational sectors (viz., brick manufacturing, agriculture workers, Mahatma Gandhi rural workers, and construction workers), and perception questionnaires were administered. The average dry bulb temperature between May to October 2022 was found to be 31° and the heat Index (WBGT) was also higher the safe index and all the workers are working above the American Conference of Governmental Industrial Hygienists (ACGIH) safe limit as most of them were engaged in heavy and moderate workload.

The questionnaire survey showed that out of 418 outdoor workers, the maximum percentage (58%) of workers were female workers and the maximum number of workers aged between 30 and 40 years old, with a higher percentage (80%) having more than 3 years of experience in the same work place. 44% (n=184) perceived their day-to-day work to be more strenuous due to high heat exposures that prevailed about 3 months (May, June, and July) in a year. Among the workers, 72% reported excessive sweating/thirst, 30% reported muscle cramps, 28% headache, and 10% prickly heat, and about 86% (n = 359) of workers had any one of the Heat Related Illnesses (HRIs), where these HRIs were significantly reported among the female workers and the risk was higher compared to male workers (OR=1.03, CI= 0.59-1.8) "*Also, a high prevalence of HRIs was reported by the workers who were ≥30 years (91%) and had ≥ 3 years of work experience in the same field (92%), and engaged in heavy physical work (57%). This was the key finding from the study which gave us the clear picture on which population to target for increasing awareness of this issue so as to protect their health"*.

The results of the urino-genital symptom showed a higher prevalence of dehydration (57%) prevalence among the females compared to males, and 20% of the females reported pain in the bottom of their back due to awkward ergonomic positions and long working hours compared to males. The perception (70%) and the risk of experiencing "any one urino-genital symptom" was also high among the female workers (Odds Ratio=1.14, CI=0.75-1.73). A significant association between gender and the numbness/swollen legs or hands (p=0.006) which is also a key indicator of kidney related illnesses was observed. The presence of kidney stones was reported by 3.3% workers and was reported high among the female workers (n = 8). "*This showed that female workers could be the most vulnerable population to the kidney stones or kidney-related illnesses due to heat exposure and lack of welfare facilities at workplaces".*

The workers' awareness of the incidence of renal illness due to heat was 18% (n = 76), poor-hydration 25% (n = 104), poor-sanitation 17% (n = 69), heavy physical workload 9% (n = 39), as the perceived risk factor due to heat was very minimal among the out-door workers. Female workers had the highest awareness of heat (52%) and dehydration (57%) as risk factors for kidney disease, while male workers had the highest awareness of intense physical workload (69%) as a risk factor. All four risk factors were primarily recognised by workers aged 40 and above (23%), which was significantly associated (p=0.05). A significant correlation was seen between workers with a greater number of years of heat exposures at work (>9 years) and awareness of inadequate sanitation as a risk factor for kidney illness (p=0.005).

As far as the workers' awareness of the coping mechanisms was concerned, 41%, 39%, 33%, and 30% of the workers strongly agreed that wearing less/thinner/cotton clothing, drinking more drinks, moving to a shady area, and taking a shower may lessen the impact of heat exposure on their bodies which are the traditional coping methods against heat. 93% and 79% of the working population were unaware of the sitali breathing system (Yoga method) and local body cooling by ice gel packs, respectively, and a significant association was observed between the gender (p=0.001), years of exposure (p=0.001), and work category (p=0.001) and the awareness of taking a shower to cool their bodies. Higher percentages of workers strongly agreed with the intake of tender coconut (66%), fruits such as melon and lemon (55%), cucumber (48%), buttermilk (45%), and Indian traditional cooling drinks (42%). However, their awareness of sabja seeds (11%), aloe-vera (18%), and fenugreek (13%), which are also proven to be effective coolants, was minimal.

Key findings from the study

- This study conclusively demonstrates that outdoor workers who are exposed to high ambient temperatures with minimal cooling measures pose a major occupational health risk, particularly in countries with high ambient temperatures.

- The risk of heat stress is increasing as a result of climate change, and a significant proportion of heat-related illnesses, particularly kidney-related illnesses will impact workers engaged in heavy manual labour, particularly *female workers*, who make up a significant portion of the working population in developing nations (India – 437 million).

- A high *prevalence of heat-related diseases (HRIs)* was reported by *female worker s*, workers under the age of 30 (91%), those with less than three years of heat exposures at work (92%), and those engaged in intense physical labour (57%). The study also revealed that *female workers* are the most susceptible to kidney stones and kidney-related disorders and workers under the age of 30 have a low awareness of heat as a risk factor for kidney-related diseases and kidney stones.

- Women in outdoor workplace sectors (~15 million in rural occupations) have a higher risk of suffering from *urino-genital and kidney issues due to a lack of sanitation facilities* at their workplaces as reported high among the female workers (70%) in the present study. This shows that *Gender sensitivity must be strongly considered in future planning for interventions to tackle heat stress.*

- *Female workers'* awareness and knowledge of heat (52%), inadequate hydration (57%) as a risk factor for renal illness was higher however excessive physical workload as a risk factor was higher among male workers (69%). *Age (>40 years vs <40 years)* had significantly favourable statistically significant relationship with their awareness of heat, inadequate hydration, poor sanitation, and intense physical labour load as non-traditional risk factors for kidney-related illness.

- *Less than 50% of workers were aware* that traditional coping methods could minimise their risk of heat-related illness, with female workers having the highest level of awareness.

- The results of this study can serve as a starting point for additional in-depth research aimed at increasing the working population's awareness of HRIs and kidney-related diseases in the context of a changing climate to avoid future adverse Occupational Health repercussions of working in heat.

1. INTRODUCTION

Global climate change is increasing, posing a threat, either directly or indirectly, to a wide range of sustainable development issues, including health, food security, and employment (1). Particularly, climate change affects the living and working environments that create health threats for millions of working people (2-3). One of the most direct health effects occurring from climate change is an increased rate of mortality and morbidity associated with exposure to high-ambient temperatures that is already a leading cause of fatalities and a health burden for developing countries (4-8). According to the IPCC special report on Global Warming, global average temperatures may reach 1.5°C as soon as 2030. If present trends continue, global warming will reach 1.5°C between 2030 and 2052. The community including working population will be vulnerable to heat stress when the temperature increases (9-10).

Heat stress is described as exposure to high-heat circumstances mixed with physical activity, while heat strain is defined as the physiological changes that occur as a consequence of heat stress. When the inside body temperature is between 36° C to 38°C, which varies significantly between people, the human body operates effectively. Heat loss mechanisms (such as increased epidermal blood flow and sweat) are engaged when the internal body temperature increases. These systems depend on a temperature difference between the skin and the environment, which is impeded by excessive humidity, a lack of ventilation, and clothing, among other reasons. Internal body temperature rises are greater and occur more rapidly when heat removal systems are inhibited. Additionally, when blood is transported from critical organs to the skin, activation of heat loss mechanisms raises cardiovascular strain.

Working in hot, humid tropical climates like in India becomes more challenging (11). In May 2013, a heat wave killed 600 people in Andhra Pradesh and Odisha in southern India, when temperatures reached 47°C(12). Dehydration, heat stroke, and a lack of water are to blamed. Workplace heat is a potential hazard for workers in many indoor and outdoor settings, leading to a spectrum of Heat-Related Illnesses (HRIs) that may occur when the human body absorbs and generates more heat than that can be dissipated (13).Workers can have greater vulnerability to heat-health risks depending on their exposures, outdoor or indoor, and other social determinants (14) and disproportionately disadvantaged due to working circumstances and access to cooling provisions and, other protective resources. The workplace conditions as well as workers awareness on the HRIs play a significant role in increasing heat-exposure, sensitivity to heat, sustained workability, and acclimation capacity. In some cases, it may amplify the risks during temperature extremes, thereby increasing their vulnerability to climate-related health effects (15).

2. LITERATURE REVIEW

Heat& strenuous workload

In tropical occupational settings with already warm/hot climates, workers have an added risk of climate-induced rising temperatures that are supported by recent reports of increased incidences of HRIs such as heat stroke, kidney stones, cardiovascular issues, muscular cramps, etc., and/or even death (16). Studies show that warm climate due to global warming is positively associated with the formation of kidney stones (17-18)and other kidney anomalies(19) a consequence of hypothermia induced volume depletion that could progress to Chronic Kidney Disease (CKD) (20-

23). One such research finding has been reported in an Indian study by Venugopal with a 9 % prevalence of kidney stones among indoor workers (24). Diabetes mellitus, hypertension, and many other nephrotoxic factors cause progressive damage to kidney function and the effect of heat stress speeds up the progression to overt (25). The combined effect of heat and heavy workload subjects the workers to a higher risk of heat-related health illnesses (2, 12, 26-28) and are alsoa key driers of kidney damage has been reported in few research findings (24, 29).

Poor sanitation and poor hydration (dehydration)

Poor sanitation is also identified as a one of the risk factors especially among the women workers(30). Lack of access to toilets in some work places, in turn causes some women to eat and drink less, in order to avoid having to defecate or urinate for several hours, thus putting them at a higher risk for malnutrition also dehydration which is the key indicator of renal illnesses. Many jobs involving high heat exposure, especially in informal sectors, have a large proportion of women workers who are engaged in physical work. Women due to their size, physical capacity and other physiological factors are more vulnerable to health risks (31). Lack of adequate sanitation facility at the work places subjects women to suffer periodically from urinogenital problems like Urinary Tract Infection (UTI), burning sensation and edema/swollen legs (32), which may on prolonged duration may lead to renal illnesses.

Dehydration has also been identified as a risk factor for renal-illnesses. Exposures to hot, humid conditions combined with strenuous work produce excessive amounts of sweat leading to dehydration (33-34)commonly associated with 'pre-renal' dysfunction, that may potentially cause Acute Kidney Injury (AKI) that may lead to low-grade renal injury that progresses to CKD over (35). Excessive sweating and consequent dehydration increase heat strain (15) and increases the risk of developing heat-related illness (24, 36). Without sufficient fluid intake to compensate for the water lost through sweating, the blood osmolarity is further affected that may lead to nephrolithiasis (37).

Poor knowledge and attitude of the working population

Several studies have documented heat-related illnesses, but the question is whether the people aware of these illnesses are due to heat exposure coupled with heavy physical work load and poor hydration at work. Participants were aware of the illness by name and symptoms but were not aware of the risk factors that could cause this illness. There is a greatly increased need for new types of knowledge in this area of research in order to address the expanded range, diversity, and complexity of factors that will determine the occupational health of protecting working people. The possible consequence of rising temperatures on the health of a working population exposed to hot environments is under-studied in India, where many workers are exposed to arduous physical labour in intense heat, which puts them at an increased risk for negative health outcomes, including decreased kidney function. So far, no research has been conducted to investigate people's assumptions about heat-related illness at work.

Hence, to bridge this gap, this study focused on characterizing the socio-demographic attributes, work category (heavy/moderate), and years of exposure of the outdoor working population and obtaining baseline participant knowledge and awareness of heat related illness as well as their knowledge of the heat coping mechanisms so as to rightly identify the best adaptation technology that could be acceptable by the workers and hence reduce the

prevalence of heat illness starting from the grass root level.

3. PURPOSE OF THE STUDY

To evaluate the workers perception and awareness on heat, heavy workload, dehydration and lack of access to sanitation as a non-traditional risk factor for incidence of chronic kidney disease/renal illnesses.

PROJECT OBJECTIVES

1. To identify from our previous research, four at-risk occupational sectors to extreme heat in south Indian workplaces.
2. Modify and validate a questionnaire (HOTHAPS questionnaire) to assess workers' perceptions of non-traditional risk factors for CKDu, using a sample size of 100 workers from each industry.
3. Conduct targeted interviews with workers during the summer to assess their understanding of heat, hydration, and workload as CKDu risk factors.
4. To analyse and categorise workers according to their perceptions and knowledge in preparation for a future interventional study.

4. METHODOLOGY

Study design: We conducted a cross-sectional observational design based on a questionnaire survey among 4 outdoor workplaces, viz., brick manufacturing, agriculture, Mahatma Gandhi Rural Work, and construction workplaces in southern India during summer (May to October 2022). The districts of Tiruvallur, Kanchipuram, Chengalpattu, and Chennai in Tamil Nadu were among the studied areas. We selected the locations based on the results of an earlier study that identified the most vulnerable workers to HRIs due to high temperatures and heavy workload (38).

The study was started after we got the necessary Institutional Ethical Clearance (IEC) from SRIHER (Annexure I) and permission from the management, where we screened 418 workers for the study based on the sample size calculation shown below.

Sample size calculation: The sample size for the study for adequate participants to obtain meaningful results was calculated by using GBD Chronic Kidney Disease Study 2020 (3) which showed a prevalence of 29.1%.

Sample size (N) = (Z) 2 (p x q) / d^2

Where,

- Z = alpha value for 95% confidence (1.96)
- p= Prevalence (29.1%), q= (1-P) & d= Precision (4.5)

Sample size (N) = (1.96)2* (29.1*70.9)/ (4.5*4.5)

= 3.8*2063.19/20.25,

N = ~386.84

For the present study sample size of ~ 418 was selected excluding few unwilling participants.

Screening of participants was based on their willingness to take part as well as inclusion and exclusion criteria listed below and both male and female participants were included and there was no exception.

Inclusion criteria:

- Workers who work in hot outdoor working environment.
- Apparently healthy individuals within the working age or 18-60 yrs.
- Exposed to similar job profile at least for the past 3 years

Exclusion criteria:

- Workers with a pre-existing health condition such as Blood pressure, Diabetics, Asthma, endocrine problems, and if they have used any medication such as NSAIDs (Non-Steroidal Anti-Inflammatory Drugs), long term medications, etc., were excluded from the study.

Through videos, pamphlets, and stories, we explained to the workers who were chosen what the study was about and why it was important. We also told them what we were planning to do and what we expected from them. The questions were administered to workers in person, in their native language. Workers were told about the risks and benefits of taking part in the study, and they gave their informed consent before the questionnaires were given out. If the participants spoke a different language, it was translated into their native language by a trained translator. The present study is a qualitative one, and the data was collected in the ways described below.

Method: A modified and validated High Occupational Temperature Health and Productivity Suppression (HOTHAPS) questionnaire (Annexure II) was used to capture workers' perception of non-traditional risk factors for CKDu. The questionnaire has ***10 parts*** each with a focus on the following information: ***Part 1*** covers the general information like age, gender, and education status, their duration of work, type of work, education status, existing illness, smoking and other food habits. **Part *2*** covers questions concerning the type of work. Part ***3*** deals with questions in relation to heat exposure at work. **Part *4*** covers questions concerning sanitation and dehydration, which is the most important indicator of kidney illness. ***Part 6*** focuses on gathering the workers' attitude towards perceived heat strain using a 5-level Likert Scale; Part 7 deals with the questions concerning kidney problems that they already have or have had; how long they have it; what are the symptoms they are experiencing; **Part *8 & 9*** gather the workers' knowledge on coping mechanisms that they follow to cope with the heat and their knowledge of heat as a non-traditional risk factor for kidney related illnesses; and Part ***10*** gathers the workers' attitude towards the coping mechanisms to reduce heat impact using a 5-level Likert Scale.

The weather of the study location during the monitoring period was obtained from the "Weather Underground" online source, which provides local and long-range weather forecasts, weather reports, maps, and tropical weather conditions for locations worldwide (39). The data on *heat index, Wet Bulb Globe Temperature (WBGT*), was obtained from the validated online Climate CHIP tool (40).

Data analysis: All data was entered into Microsoft Excel and statistically analysed using SPSS-licensed statistical software version 16 and "R" software. Descriptive analysis was carried out to calculate the frequency and

percentages of the variables to assess the socio demographic and heat related illnesses. The Mann-Whitney U test and Kruskal-Wallis tests were carried out to investigate the association of socio demographic and non-traditional risk factors. Chi-square tests were used to examine the association between gender and heat-related illnesses. The level of significance was taken at a 5% level.

5. DESCRIPTION OF THE STUDY AND FINDINGS

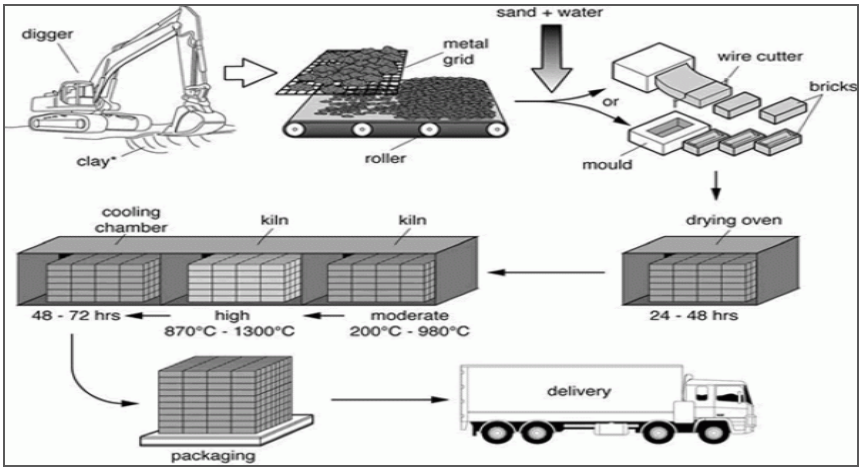
5.1. Basis for workplace selection

The workplaces were chosen in accordance with our earlier research findings regarding those that were most susceptible to hot weather, unfavourable working circumstances, people living in poverty, and those that required target-based labour each day.

5.2. Workplace process and worker's exposure

Brick workers: The brick production process is based on manual labour, and brick kilns are estimated to employ around 10 million workers in India. Brick production is a seasonal vocation, as the brick kilns do not operate during the rainy season. Most of the workers migrate with their families from backward and poor regions of the country. Families, including young children, work in harsh, low paying conditions. Here, the workers are exposed to high ambient heat in out-door through the day engaging themselves in material procuring, tempering, moulding of bricks, stacking for baking, then unstacking after baking, then arranging the baked bricks and loading and unloading on the vehicles. During the baking process also, they are exposed to process heat in addition to the ambient heat. The brick making process is shown in *figure 1*, where at each stage they are exposure to heat as well as engaged in heavy physical workload.

Agriculture workers: These group included both farm workers and gardening workers where the garden workers were engaged in monitoring the health of all plants and green scapes, watering, feeding plants, trimming trees and shrubs, fertilizing and mowing lawns, weeding gardens, keeping green spaces, walkways clear of debris and litter. They also carry out regular maintenance on equipment to determine the time on maintenance and the type of repairs required. The farm workers were engaged in sowing seed, watering and removing weeds at the time of assessment. Both the workers were exposed to high ambient heat thought the day and were engaged in heavy physical workload and lack sufficient basic facilities, such as access to clean drinking water and sanitation at the work area.



Process of Brick Manufacturing Industry

The Mahatma Gandhi National Rural (MGRW) workers: The Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA) was developed by the Indian government to reduce rural poverty through 100 days of guaranteed employment to adult members of a rural household who demand employment and are willing to do unskilled manual work per financial year. Majority of workers are related to agricultural and allied activities, besides the works that will facilitate rural sanitation projects in a major way. Other works include watershed, irrigation and flood management works, fisheries and works in coastal areas and the rural drinking water and sanitation related works. These workers also had the same work scenarios as in case of agriculture and brick workers.

Construction workers: There were different work tasks involved in construction; such as intense shovelling, carrying and disposal of debris, cutting of iron bars etc. There were different categories of workers namely: manual labourers, masons, stone cutters, bar bending workers, painters, electricians etc. The amount of time spent exposed to the hot sun varied depending upon the nature of work performed. Most of the workers were migrant workers from states like Bihar, Andhra Pradesh and Orissa. Besides working in the construction site, the workers were also constantly exposed to heat due to their temporary housing inside the campus. Their temporary housing was made of metal sheets, providing small relief from heat exposure. These workers had good sanitation and water facility at their workplace.

5.3. Sampling method and observations

<u>Sampling methods</u>

Brick workers: The brick fields were located in Malayambakkam, Thiruvallur district of Tamilnadu. The bricks workers were engaged in work from 4am–10am and 4pm–7pm. A qualitative data was collected on days when work was in progress. Both male and female workers were involved in the work place and the workers were falling under heavy and moderate work category. Most locations were selected based upon the heat exposures that were commonly encountered by the workers during their shifts.

Agriculture workers: The agricultural fields were located in Porur town, Thiruvallur district of Tamilnadu. The workers were engaged in work from morning 8:00 am to afternoon 3:00 pm. A qualitative data was collected on days

when work was in progress. Both male and female workers were involved in the work place and the workers were falling under heavy, moderate and light work category. Most locations were selected based upon the heat exposures that were commonly encountered by the workers during their shifts.

MGRW workers: Sampling was done in Tirukazhukundram, Chengalpattu district. A qualitative data was collected on days when work was in progress. They were engaged in work from 8 am–4 pm with one hr 12am to 1:00 pm lunch break. Most locations were selected based upon the heat exposures that were commonly encountered by the workers during their shifts which was between 10:00 am to 1:00 pm.

Construction workers: Sampling was done in Mandaveli, Chennai district. A qualitative data was collected on days when work was in progress. They were engaged in work from 8 am–5 pm with one hr 12 am to 1:00 pm lunch break but for few they stayed there itself and hence did not have any specific working time. Both male and female workers were involved in the work place and all the workers were falling under moderate and heavy work category. Most locations were selected based upon the heat exposures that were commonly encountered by the workers during their shifts.

Monitoring dates and locations

No	Workplace	Location in Tamilnadu	Assessment dates
1.	Brick Manufacturing Industry	Malayambakkam, Thiruvallur district	08.06.2022,09.06.2022 &15.06.2022
2.	Agriculture Field	Porur town, Thiruvallur district	13.06.2022 & 14.06.2022
3.	Mahatma Gandhi Rural Works	Tirukazhukundram, Chengalpattu district	30.06.2022,05.07.2022 & 06.07.2022
4.	Construction sector	Mandaveli, Chennai district	28.07.2022 & 29.07.2022

Observations made during the study

Bricks workplace: The workplace was a piece of land in open area with the brick kiln. A shed consisting a metal sheet covering and some brick and concrete (up to quarter length of the wall) was the office cum storage area cum all-purpose area for book-keeping etc. The workplace had ample air movement being closer to agricultural lands. Some shade in the form of the shed and some trees around the work area were available. No engineering controls are provided to the workers for heat exposure reduction during work. Water was available for consumption and self-pacing option was given with production targets for a day but there was poor sanitation facility at the workplace also the workers did not show much interest in using the toilets if it was constructed too.

Agriculture workplace: This work place was also a open farm land with no rest facility available for the workers. The employees worked in different posture, even standing and bending for long period of time. The workers had break for about 2 hours and there was no restriction for the workers to drink water. Drinking water was provided to them in the field itself. The drinking water pot was placed next to their work area. The workers were wearing saree and some cloth covering their head to prevent the heat from direct sun. Few women wore a shirt on top of the saree

for ease of work which further increased their heat stress due to inhibition of evaporative cooling. This workplace also did not have toileting facility for both men and women. And the knowledge level on heat etc... was very minimal.

MGRW workplace: The workplace area was a large barren area with the weeds. It had ample air movement being closer to agricultural open lands as in case of the above two workplaces. Here also no welfare facilities including toilets were provided for the workforce in the workplaces. No special provisions were made for supplying drinking water to the workers; instead have to bring themselves from their home to drink. The drinking water was not sufficient for them as they could not carry huge water bottles as said by the workers.

Construction workplace: Construction workers at the site were mostly immigrant workers who work at a site for a few days before moving to another site according to the management of a contractor who finds them employment. Many of them are workers from neighbouring states and subsequently they spoke a different language and could respond to the survey only after translation. The translator unsuccessfully attempted to explain the concept of productivity targets to the workers, but could elicit few responses. The workers shared their workload with other workers for delivering their planned work. They lived in temporary shacks close to their work site, which usually were very confined and poorly ventilated. This meant that workers could start early and work longer hours. The workers' children also helped their parents with their work. The women workers sometimes finished a bit earlier than the men to cook the evening meals. Women workers were exposed to heat again at home due to cooking with bio fuels.

5.4. Findings from the study

5.4.1Study Population

In the regions of Malayambakkam, Porur, Tirukazhukundram & Mandaveli located in and around Chennai, four workplaces were evaluated. A total of 418 workers were interviewed, of whom 42 % (n = 174) were males and 58% (n = 244) were females. The mean age of the study population was 48.60±13.79 years and (n = 231) 55.2% had some basic level of education. Among them 11 % (n=46) of them were smokers and 20% (n=85) consume alcohol and about 18 % (n=76) had some pre-existing medical condition such as hypertension. Of the 418 workers, 64.4% (n=269) of them were involved in heavy labour, such as loading& unloading of bricks, lifting of bricks for drying process, arranging of bricks in case of brick workplace; ploughing, weeds removal, plantation in case of agriculture workers; hammering, demolishing of buildings, mason work etc. in case of construction workplace and similar activities among the MGRW. And about 30% (n=125) of them were engaged in moderate work like electrical, painting, tying the picked weed, arranging the drying bricks etc. and few were engaged in light works like supervising the workers. The demographic details of the study participants are shown in *Table 1*.

Table 1. Demographic characteristic of participants located in Tamilnadu state, Southern India (n=418)

S. No	Variables		Total sample	Number of workers (n)	Percentage of total workforce (%)	Percentage for subcategory (Gender wise)
1.	Age	≥41 years	418	207	50	Nil
		<41 years	418	211	50	Nil
2.	Gender	Male	418	174	42	42
		Female	418	244	58	58
3.	Smoking status	Male	174	46	26	26
		Female	244	0	0	0
4.	Alcohol consumption	Male	174	85	49	49
		Female	244	0	0	0
5.	Literacy	Male	174	124	71	71
		Female	244	107	44	44
6.	≥3 years of exposure to same workplace	Male	174	116	67	67
		Female	244	217	89	89
7.	Work Category[#] (Heavy)	Male	174	125	72	72
		Female	244	144	59	59
8.	Work Category[#] (Moderate)	Male	174	36	21	21
		Female	244	89	36	36
9.	Work Category[#] (Light)	Male	174	13	7	7
		Female	244	11	5	5
10.	Pre-existing illness related to kidney	Male	174	26	15	15
		Female	244	50	20	20

[#]*Work category was based on the observations made by the certified industrial hygienist as per ACGIH guidelines, 2021*

5.4.2 Heat profile in the study area:

The average dry bulb temperature between May to October 2022 in and around workplace in Chennai city was found to be 31˚C and the maximum average was found during the month of May and June (32˚C) (*Table 2*). The heat Index (WBGT) was higher during the same period and it was observed that all the workers are working above the ACGIH safe limit as all of them were engaged in heavy and moderate workload, except for few workers.

Table 2: Heat profile in the study location

SI. No.	Month (2022)	Work Category: Heavy, Moderate, Light Recommended TLV limit (˚C) *: 27.5, 28.0, 31			
		Average			
		Dry Bulb Temp (˚C)	Relative Humidity (%)	Wind velocity (m/s)	WBGT* (˚C)
1.	May	31.88	74.0	0.002	29.2
2.	June	31.80	73.0	0.001	29.1
3.	July	30.30	78.0	0.002	28.2
4.	August	30.30	78.2	0.002	28.2
5.	September	30.50	75.0	0.002	28.2
6.	October	29.60	75.7	0.001	27.2

*Note:*American Conference of Governmental Industrial Hygienists, 2021 (41)*

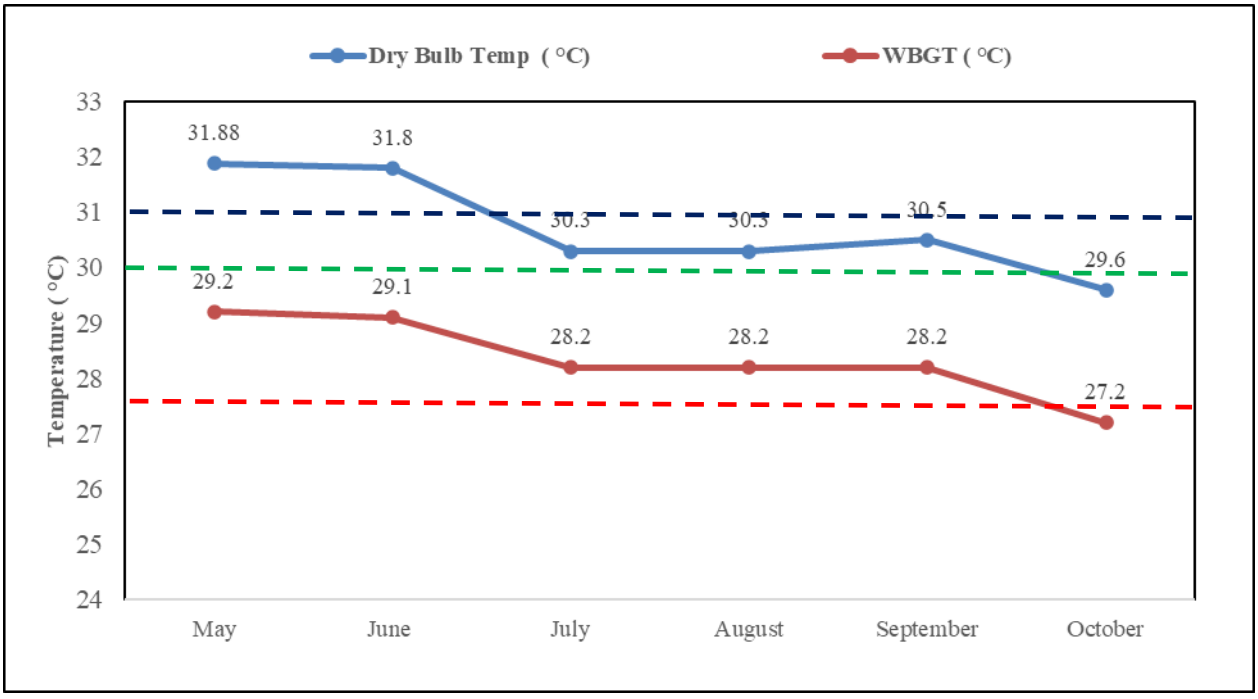


Figure 1: Heat profile in outdoor occupational sectors in southern India during May to October, 2022 (red, green & blue lines are the ACGIH 2021 safe limit for WBGT for heavy, moderate& light workers respectively)

5.4.3 Workers perception on heat related health impacts Heat strain Indicators (HSI)

The study population perceived that 44% (n=184) of their work to be more strenuous and occupational heat exposures as a problem for at least 3 months in a year. Among the workers, 72% of the workers reported excessive sweating/thirst, 30% (n=125) reported muscle/heat cramps, 28% (n=115) reported prickly heat and these observations were statistically significant among the male workers (p=0.054, p=0.001, p=0.008 and p=0.046) respectively compared to the female workers (*Table 3*). Nearly 54% workers reported tiredness/weakness and least percent of them reported nausea/vomiting (2%) due to workplace ambient heat exposure. 86 % (n=210) of female workers perceived any one above said heat strain indicators compared to male workers however the risk was 1.03 times high among the male workers (OR: 1.03; 95% CI: 0.59 to 1.80) (*Table 3*). When we asked for the urino-genital symptoms, 53% of the workers reported dehydration, 30% changes in urine volume, numbness/swollen legs by about 14% of the workers & 11% reported skin itching which are the key indicators of heat strain (*Figure 2*); also when we focused on kidney related illness 3% reported of having kidney stone and 19% had pain in the bottom of their back which is one of the indicators of kidney abnormalities and had significant association with the gender which was not statistically significant. (OR: 0.8; 95%CI: 0.57-1.33) (*Table 3*).

Table 3: Worker's perceptions on heat strain symptoms (n=418)

Variable	Characteristics	Male			Female			p-Value*, OR (CI)
		Total number of workers	n	Percent (%)	Total number of workers	n	Percent (%)	
Heat related health symptoms	Excessive sweating/Thirst	174	117	67	244	185	76	0.054, **0.655 (0.425-1.01)**
	Muscle cramps	174	36	21	244	89	36	0.001, **0.454 (0.290-0.713)**
	Tiredness/weakness/	174	98	56	244	129	53	0.485, **1.150 (0.777-1.70)**
	dizziness	174	20	11	244	29	12	0.903, **0.963 (0.525-1.765)**
	Headache	174	36	21	244	79	32	0.008, **0.545 (0.346-0.858)**
	Nausea/Vomiting	174	5	3	244	5	2	0.587, **1.414 (0.403-4.962)**

Variable	Characteristics	Male			Female			p-Value*, OR (CI)
		Total number of workers	n	Percent (%)	Total number of workers	n	Percent (%)	
	Prickly heat	174	24	14	244	19	8	0.046, **1.895 (1.003-3.580)**
	Heat stroke	174	1	1	244	5	2	0.212, **0.276 (0.032-2.386)**
	Any one above listed symptom with female as the vulnerable group	174	149	86	244	210	86	0.900 **1.036, (0.593-1.809)**
Urino genital symptoms	Dehydration	174	86	49	244	137	56	0.174, **0.763 (0.517-1.128)**
	Changes in Urine volume	174	53	30	244	73	30	0.905, **1.026 (0.672-1.567)**
	skin itching	174	21	12	244	25	10	0.557, **1.202 (0.650-2.226)**
	Numbness/swollen legs or hands	174	15	9	244	44	18	0.006, **0.429 (0.230-0.799)**
	Kidney stones	174	6	3	244	8	3	0.924, **1.054 (0.359-3.093)**
	pain in bottom of your back	174	30	17	244	48	20	0.529, **0.851 (0.514-1.409)**
	Any one above listed symptom with female as the vulnerable group	174	117	67	244	171	70	0.536 **1.141, (0.75-1.734)**

*Note: *chi-square test was conducted and p-value>0.05 indicates significant, OR is the crudes odds ratio.*

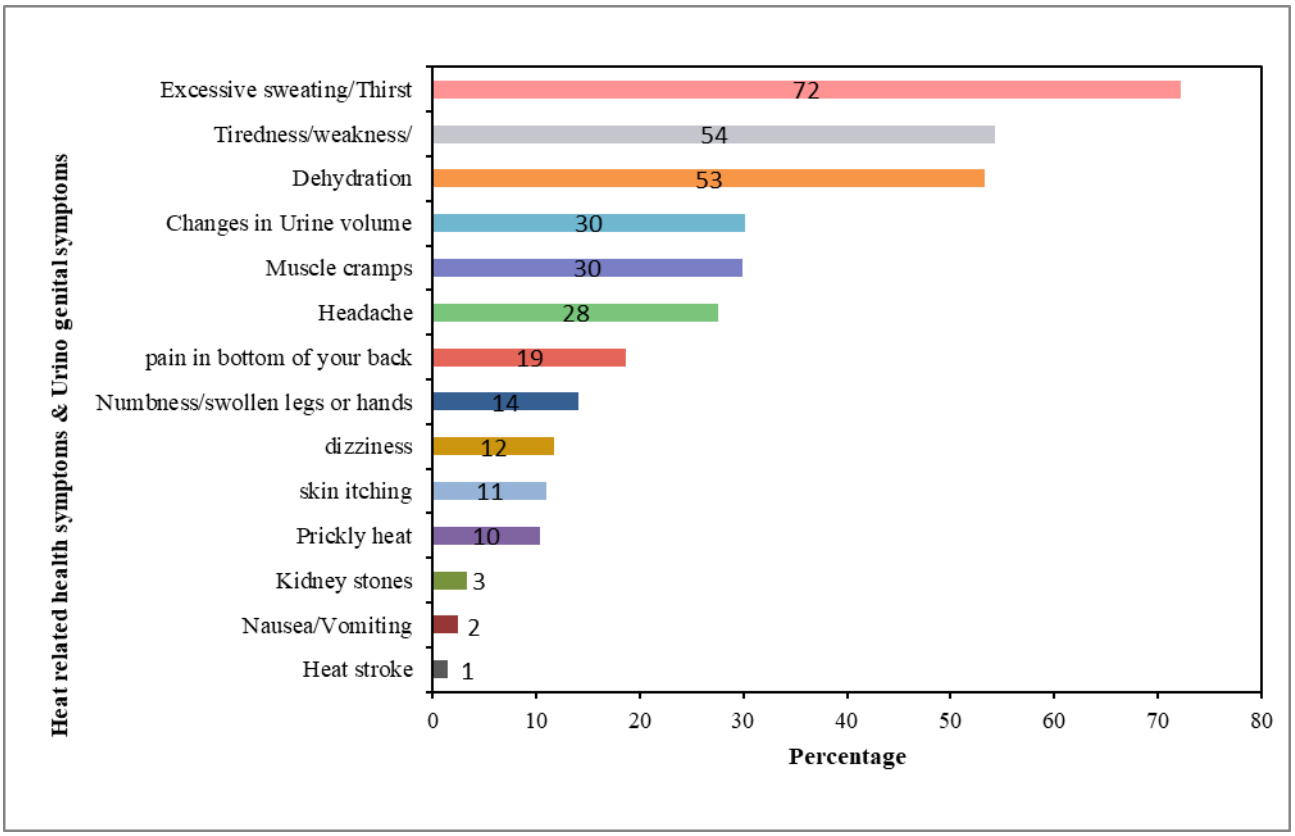


Figure 2: Perceived heat strain symptoms by study participants

5.4.4 Workers knowledge about the impact of heat on kidney related illnesses

The distribution of knowledge of participation listed in *Table 4* indicates the only 18% of the participants had fair knowledge/aware about heat exposure, as a risk factor for kidney related illness. About 25 % of them were aware and had good knowledge on poor hydration may cause kidney problem and about 17% of the participants were aware of poor sanitation and19% were aware that intake of beverages could lead to kidney diseases. But only 9% were aware that heavy physical workload and exposure to heat for prolonged duration might cause kidney illness which was an interesting finding from the study. Among the participants, maximum percentage of 12% got their knowledge from Friends/colleague/supervisors etc but not from the Medias.

We also tried to stratify the workers belief on heat exposure, poor hydration, poor sanitation, heavy physical work load and intake of beverages and we observed from the *Figure 3* that 7%, 5%, 4%, 3%, 2% of the participants strongly agree that poor hydration, intake of beverages, poor sanitation, heavy physical work load and heat exposure could cause kidney related illness. More than 50 % strongly disagree that heat exposure, poor sanitation, poor hydration, heavy physical work and beverage consumption could cause kidney related illness. However, less than 15% of the participants reported neutral (neither agree nor disagree) for any one of the questions.

Table 4: Distribution of workers knowledge about the impact of heat on kidney related illnesses

Sl. No	Factors influencing kidney related disorders	Response as "yes"		Response as "no/not aware"	
		n	%	n	(%)
1.	Are you aware that exposure to prolonged heat may cause kidney related problems?	76	18.2	342	81.8
2.	Do you know that not hydrating yourself and heat exposure frequently may cause kidney related problems?	104	24.9	314	75.1
3.	Do you know that poor sanitation access at your work place stop you from hydrating yourself and may cause kidney related problems?	69	16.5	349	83.5
4.	Do you know that doing heavy physical work and prolonged exposure to heat may cause kidney related problems?	39	9.3	379	90.7
5.	Do you know that consumption of beverages containing high levels of fructose while working in hot area cause kidney related problems?	80	19.1	338	80.9

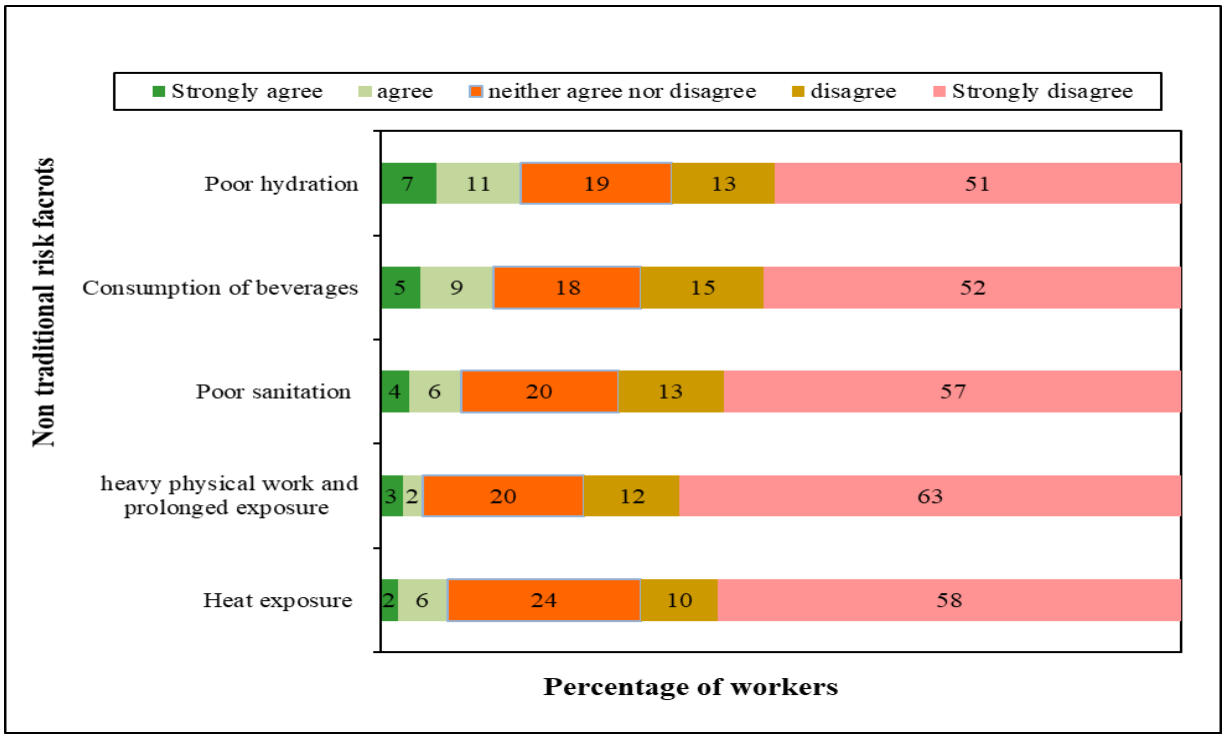


Figure 3: Distribution of workers belief about the impact of heat on kidney related illnesses

The stratified findings for gender, age, work-category and duration of their work in the same field on the non-traditional risk factors for kidney related illness as in *table 5a* and *5b* (Annexure IV) showed that

- **Gender:** Gender had a significant association with the participant's awareness on heavy physical work and prolonged exposure and Consumption of beverages as a risk for kidney related illnesses as well as Consumption of beverages as a risk factor for those who believed more than 50%.
- **Age group:**
  - ***≥30 and <30 years old:*** This age had a significant association with the participant's awareness on poor sanitation, heavy physical work and prolonged exposure and Consumption of beverages as a risk for kidney related illnesses; It had a significant association with Consumption of beverages alone as a risk for kidney related illnesses for those who believed more than 50%.
  - ***≥40 and <40 years old:*** This age group had a significant association with aware and not aware on all the factors i.e. heat exposure, poor hydration, poor sanitation, heavy physical work and prolonged exposure and Consumption of beverages s a risk for kidney related illnesses; their percentage of belief for more than 50% was observed to be significant for Consumption of beverages alone.
- **Work category** This group had a significant association with the participant's awareness on heat exposure, poor hydration s a risk for kidney related illnesses; It also had a significant association with poor sanitation and heavy physical work and prolonged exposure & consumption of beverages as a risk for kidney related illnesses among the workers who believed more than 50%.
- **Years of exposure:**
  - ***≥3 and <3 years of exposure***: This group had no association with aware and not aware for other factors; however, it had a significant association with aware and not aware on heat exposure, heavy physical work and prolonged exposure for those who believed more than 50%.
  - ***≥9 and <9 years of exposure:*** This group had a significant association with the participant's awareness on poor sanitation, heavy physical work and prolonged exposure s a risk for kidney related illnesses however, it had no significant association for those who believed more than 50%.

Table 5a: Association between the non-traditional risk factors for kidney related illness and majore study varibles

Sl. no	Variable	Category	Non-traditional risk factors for kidney related illness (Aware and Not aware)														
			Heat exposure			Poor hydration			Poor sanitation			heavy physical work and prolonged exposure			Consumption of beverages		
			n	%	p-value	n	%	p-value	n	%	p-value	n	%	p-value	n	%	p-value
1	Gender	Male (174)	36	21	0.262	44	25	0.871	34	20	0.159	27	16	0.001	43	25	0.015
		Female (244)	40	16		60	25		35	14		12	5		37	15	
3	Age	≥40 years (207)	28	14	0.015	39	19	0.005	17	8	0.001	10	5	0.002	25	12	0.001
		<40 years (211)	48	23		65	31		52	25		29	14		55	26	
4	Work category	Heavy (269)	41	15	0.036	56	21	0.01	38	14	0.078	20	7	0.074	51	19	0.9
		Moderate & Light (149)	35	23		48	32		31	21		19	13		29	19	
6	Years of exposure	≥9 years (185)	27	15	0.091	44	24	0.644	20	11	0.005	11	6	0.034	29	16	0.109
		<9 years (233)	49	21		60	26		49	21		28	12		51	22	

5.4.5 Participants knowledge and attitude towards the coping mechanisms to reduce heat impact

Personal cooling startegies

The participants perception on the personal cooling startegies showed that maximum percentge of participnats strongly agree that wearing less/thinner/cotton clothes (41%), drinking more fluids (39%), cooling arms with water (18%), using wet towels (17%), moving to shady place (33%), taking showers more frequently (30%), cooling feet with water (15%) and only (3%) of the participnats perceived sitali breathing system (Yoga method) and local body cooling by ice gel packs could decrease the body heat and these two mode of personal cooling were unaware by about 92% and 78% of the participants respectively. However, 15 to 20% of the partcipants neither agreed nor disagrred that wearing less/thinner/cotton clothes, drinking more fluids,taking showers more frequently, cooling arms with water, moving to shade place, using wet towels, cooling feet with water can decrease the body tempertaure and less than 5% forsitali breathing system (Yoga method) and local body cooling by ice gel packs could decrease the body temperature (*Table 6* and *figure 4*).

Table 6: Knowledge and attitude towards the coping mechanisms to reduce heat impact

No.	Cooling strategy	Not aware about it at all		Strongly disagree		Disagree		Neither agree nor disagree		Agree		Strongly agree	
A	**Personnel cooling strategies**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
1.	Wearing less/thinner/cotton clothes	33	8	18	4	73	17	85	20	70	17	172	41
2.	Drinking more fluids	33	8	29	7	50	12	87	21	87	21	165	39
3.	Taking showers more frequently	77	18	74	18	55	13	86	21	77	18	126	30
4.	Cooling arms with water	179	43	115	28	111	27	66	16	49	12	77	18
5.	Using wet towels	173	41	124	30	124	30	67	16	32	8	71	17
6.	Cooling feet with water	193	46	150	36	96	23	64	15	45	11	63	15
7.	Moving to shady place	53	13	51	12	75	18	77	18	79	19	136	33
8.	Sitali breathing system (Yoga method)	387	93	294	70	88	21	18	4	5	1	13	3
9.	Local body cooling by ice gel packs	330	79	255	61	123	29	21	5	8	2	11	3
B	**Nutritional intake**												
1.	Cucumber	61	15	26	6	31	7	49	12	110	26	202	48
2.	Buttermilk	25	6	16	4	32	8	74	18	107	26	189	45
3.	Ragi drinks	67	16	46	11	67	16	58	14	70	17	177	42
4.	Tender coconut	25	6	15	4	29	7	38	9	60	14	276	66
5.	Mint	192	46	147	35	106	25	55	13	38	9	72	17
6.	Yogurt	212	51	168	40	96	23	37	9	35	8	82	20
7.	Sabja seeds	311	74	240	57	84	20	26	6	20	5	48	11
8.	Fruits like melon, Lemon	20	5	16	4	23	6	49	12	106	25	224	54
9.	Aloe vera	158	38	147	35	73	17	79	19	45	11	74	18
10.	Chilli	324	78	260	62	107	26	20	5	8	2	23	6
11.	Fenugreek	160	38	147	35	74	18	81	8	62	26	54	13

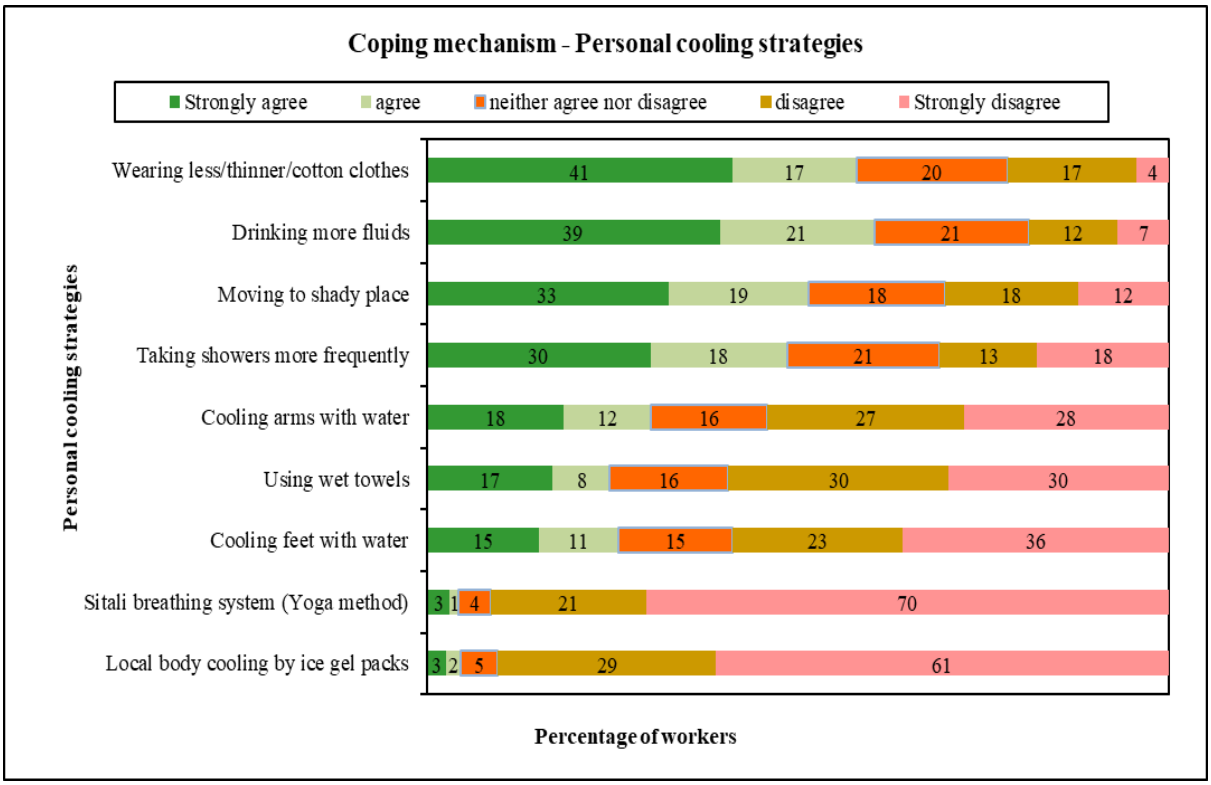


Figure 4: Distribution of workers belief about personal cooling startegies in bringing down the body temperature

The stratified findings for gender, age, work-category and duration of their work in the same field on personal cooling strategy in bringing down the body temperature as in *table 7a1, a2 and extension tables of 7a1, a2, 7b1 & 7b2 (Annexure IV)* showed that

- **Gender:** This group had a significant association with the participant's awareness on Wearing thin clothes, taking showers more frequently, moving to shady place, Sitali breathing system (Yoga method), local body cooling by ice gel packs as personal cooling strategies; It also had a significant association with wearing thin clothes, drinking more fluids, taking showers more frequently, moving to shady place, Sitali breathing system (Yoga method), local body cooling by ice gel packs as personal cooling strategies for those who believed more than 50%.
- **Age group:**
  - ***≥30 and <30 years old:*** This age group had a significant association with participants awareness on taking showers more frequently, Sitali breathing system (Yoga method), as personal cooling strategies; It had a significant association with taking showers more frequently alone for those who believed more than 50%
  - ***≥40 and <40 years old:*** This age group had a significant association with participant's awareness on taking showers more frequently, local body cooling by ice gel packs as personal cooling strategies; It also had a significant association with taking showers more frequently, using wet towels, Sitali breathing system (Yoga method), Local body cooling by ice gel packs for those who believed more than 50%.

- **Work category:** This group had a significant association with participant's awareness on local body cooling, drinking more fluids, taking showers more frequently, cooling arms with water, cooling feet with water, ice gel packs as personal cooling strategies; it also had a significant association with taking showers more frequently, using wet towels, moving to shady place, local body cooling by ice gel as personal cooling strategies for those who believed more than 50%.
- **Years of exposure:**
    - ***≥3 and <3 years of exposure***: This group had a significant association with participant's awareness on taking showers more frequently, cooling arms with water, moving to shady place as personal cooling strategies; it also had a significant association with taking showers more frequently, moving to shady place as personal cooling strategies for those who believed more than 50%.
    - ***≥9 and <9 years of exposure:*** This group had a significant association with participant's awareness on taking showers more frequently and moving to shady place as personal cooling strategies; it also had a significant association with Wearing thin clothes, drinking more fluids, taking showers more frequently, using wet towels, Sitali breathing system (Yoga method), as personal cooling strategies for those who believed more than 50%.

Table 7a1: Association between the study variables and the personal cooling startegy (awarness and not aware)

Sl.no	Variable	Category	Attitude towards about the coping mechanisms to reduce heat impact Personal cooling mechanism (Aware and Not aware)														
			Wearing less/thinner/cotton clothes			drinking more fluids			taking showers more frequently			cooling feet with water			Moving to shady place		
			n	(%)	p-value	n	(%)	p-value	n	(%)	p-value	n	(%)	p-value	n	(%)	p-value
1	Gender	Male (174)	154	89	0.021	165	95	0.082	159	91	0.001	91	52	0.597	165	95	0.001
		Female (244)	231	95		220	90		182	75		134	55		200	82	
3	Age	≥40 years (207)	192	93	0.627	191	92	0.901	152	73	0.001	114	55	0.614	179	86	0.607
		<40 years (211)	193	91		194	92		189	90		111	53		186	88	
4	Work category	Heavy (269)	246	91	0.505	240	89	0.003	201	75	0.001	133	49	0.016	229	85	0.071
		Moderate & Light (149)	139	93		145	97		140	94		92	62		136	91	
6	Years of exposure	≥9 years (185)	168	91	0.382	166	90	0.109	125	68	0.001	97	52	0.611	152	82	0.005
		<9 years (233)	217	93		219	94		216	93		128	55		213	91	

Nutrition as a cooling strategy

The results showed that maximim percentage of the participants strongly agree tender coconut (66%),buttermilk (45%), Ragi drinks (42%), Fruits like melon, Lemon (54%), Cucumber (48%), Yogurt (20%),Mint (17%),Aloe vera (18%), Sabja seeds (11%), Fenugreek (13%), Chili (6%).Also maximum percentage of participants strongly disagreed chilli (62%) followed by sabja seeds (57%), (*figure 5*) and less than 28% disagreed cucumber, yougurt, mint, alovera and others etc could paly a vaital role in cooling the body temperature.And only less than 20 % has a neutral reply for these nutritional food in cooling the body temperature.

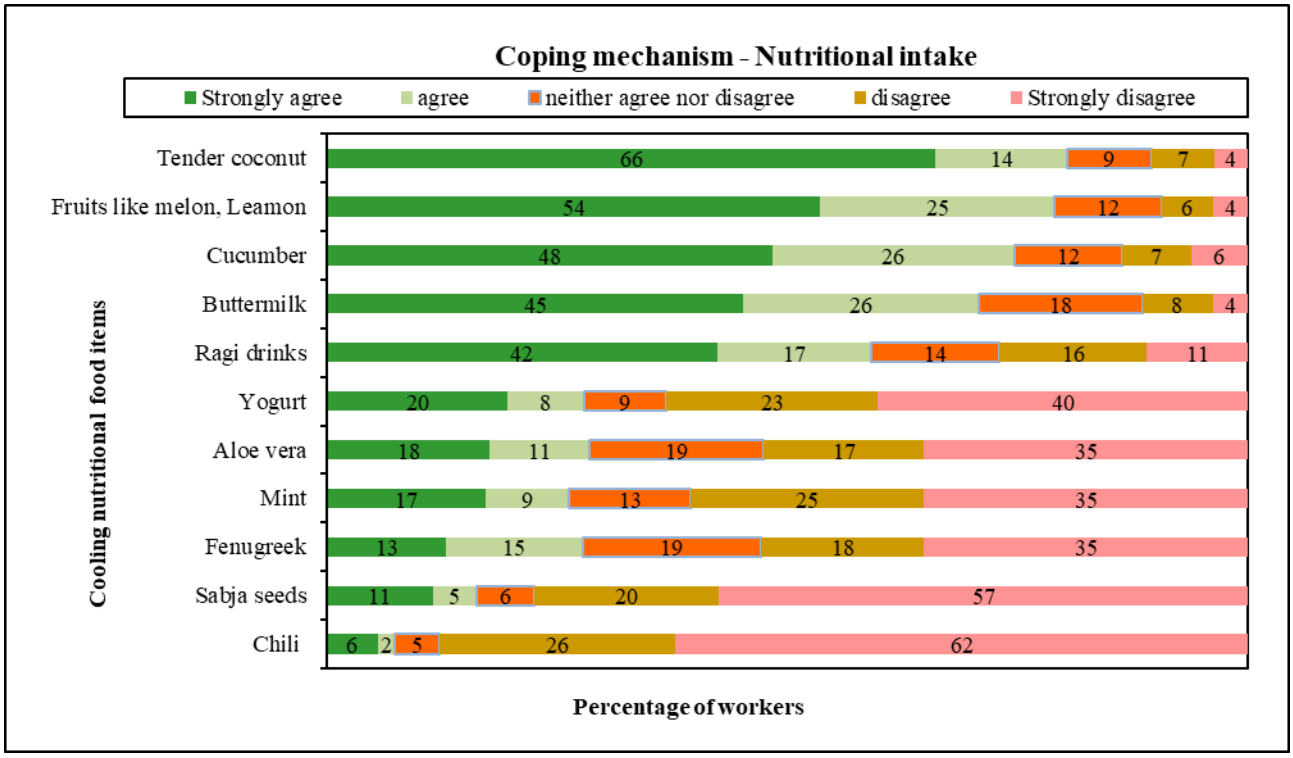


Figure 5: Distribution of workers belief about the role of nutrition in bringing down the body temperature

The stratified findings for gender, age, work-category and duration of their work in the same field on personal cooling strategy in bringing down the body temperature as in *table 7a* and *7b (Annexure IV)* showed that

- **Gender:** This group had a significant association with participant's awareness on cucumber, ragi drinks, chilli, aloe vera, fenugreek as nutritional intake cooling strategies. Significant association was noted between the gender and intake of ragi drinks, aloe vera, chilli, fenugreek for those who believed more than 50%as nutritional intake cooling strategies.
- **Age group:**
  - ***≥30 and <30 years old:*** This age group had a significant association with participant's awareness only on buttermilk& ragi drinks as nutritional intake cooling strategies; It also had a significant association with buttermilk alone as nutritional intake cooling strategies for those who believed more than 50%as nutritional intake cooling strategies.
  - ***≥40 and <40 years old:*** This age group had a significant association with participant's awareness on ragi drinks, aloe vera, fenugreek as nutritional intake cooling strategies;

based on their belief, there was a significant association with ragi drinks and fenugreek as nutritional intake cooling strategies for those who believed more than 50%as nutritional intake cooling strategies.

- **Work category:** This group had higher number of significant associations with participant's awareness on cucumber, buttermilk, ragi drinks, tender coconuts, mint, yogurt, sabja seed, chilli as nutritional intake cooling strategies; It also had a significant association with ragi drinks, mint, yogurt, sabja seeds, chilli, fenugreek as nutritional intake cooling strategies for those who believed more than 50%as nutritional intake cooling strategies.
- **Years of exposure:**
    - ***≥3 and <3 years of exposure***: This group had a significant association with participant's awareness only on millet-based ragi drinks & chilli as nutritional intake cooling strategies; It also had a significant association with buttermilk alone as nutritional intake cooling strategies for those who believed more than 50%as nutritional intake cooling strategies.
    - ***≥9 and <9 years of exposure:*** This group had a significant association with participant's awareness on cucumber, ragi drinks, aloe vera &fenugreek as nutritional intake cooling strategies; It also had a significant association with aloe vera, fenugreek as nutritional intake cooling strategies for those who believed more than 50% as nutritional intake cooling strategies.

Table 7a2: Association between the study variables and the nutition cooling startegy (awarness and not aware)

Sl. no	Variable	Category	Attitude towards about the coping mechanisms to reduce heat impact Nutritional Intake (Aware and Not aware)																		
			Cucumber			Buttermilk			Ragi drinks			Tender coconuts			Fruits like melon, Lemon			Aloe vera			Fenugreek		
			n	(%)	p-value	n	(%)	p-value	n	(%)	p-value	n	(%)	p-value	n	(%)	p-value	n	(%)	p-value	n	(%)	p-value
1	Gender	Male (174)	157	90	0.018	159	91	0.055	131	75	0.001	167	96	0.155	168	97	0.28	120	69	0.016	123	71	0.001
		Female (244)	200	82		234	96		220	90		226	93		230	94		140	57		135	55	
3	Age	≥40 years (207)	175	85	0.62	197	95	0.327	191	92	0.001	193	93	0.505	194	94	0.156	118	57	0.03	107	52	0.001
		<40 years (211)	182	86		196	93		160	76		200	95		204	97		142	67		151	72	
4	Work category	Heavy (269)	215	80	0.001	248	92	0.035	215	80	0.002	247	92	0.011	254	94	0.309	163	61	0.363	171	64	0.297
		Moderate & Light (149)	142	95		145	97		136	91		146	98		144	97		97	65		87	58	
6	Years of exposure	≥9 years (185)	150	81	0.026	178	96	0.092	165	89	0.01	170	92	0.103	174	94	0.322	97	52	0.001	99	54	0.002
		<9 years (233)	207	89		215	92		186	80		223	96		224	96		163	70		159	68	

5.5. Discussion

Heat exposure and workers' perception

In India, the daily high temperatures are often between 37.8°C (100°F) and 46.1°C (115°F) in the summer season (42) and in Chennai, located in Tamilnadu, the average ambient temperature ranged between 34.8°C (94.6°F) and 29.6°C (85.3°F) (42), where during this year in 2022, the average daily high temperatures in Chennai decreased from 98°F to 92°F due to climate change. In the present study, outdoor workers in Chennai area were exposed to higher heat levels in hotter periods (May to August) and the average temperature ranged between 30 °C – 32°C.Notably, heavy manual work was predominantly performed by more than 60% of the outdoor workers. This could reveal that outdoor workers in Chennai could be vulnerable to the HRIs as they are less likely to receive appropriate heat mitigation, protection, or compensation for loss of production. This finding which is evident from (*Table 3*), also corroborated with the self-reported perceptions of the workers, many of whom perceived occupational heat stress as having negative implications for their health (*Table 3*). Such high-risk hot working environments have been reported not only in India (15, 43-45) but also around the globe (4, 19, 46). Physical exertion, combined with a lack cooling intervention, exacerbates this heat(44, 47), which is supported by the workers' perceptions in this study (*Table 3*). Any increase in workers' current heat levels and exposures is likely to have a negative impact on their health and productivity (11). Hence, from this study and previous Indian-based research (45, 48-51), it appears that modest increases in global temperature, as predicted by climate change, will have significant impacts on outdoor workers in tropical countries India and other similar tropical countries where workers already have excessively high heat levels.

Workers knowledge about the impact of non-traditional risk factors on kidney related illnesses

The present epidemiological surveys has demonstrated an increase in the prevalence of kidney diseases in populations living in hot, humid climates (52)and prolonged exposures can produce different types of effects such as heat-induced exhaustion, cramps, rash and/or kidney anomalies (35, 53-55). While exposed to humid hot conditions and strenuous work, the human body produces excessive amounts of sweat in an attempt to lose heat through sweat evaporation (33). Though dehydration is commonly associated with "pre-renal" dysfunction, repeated severe dehydration might potentially cause acute kidney injury from heatstroke, rhabdomyolysis, and hypotension. Recurrent dehydration may lead to low-grade renal injury that progresses to CKD over time (35). Working in a warm environment intensifies the kidney function in maintaining a stable blood osmolarity and insufficient fluid intake to compensate for water lost through sweating. This further affects the osmolarity of the blood, leading to nephrolithiasis (37). In the present study, 3.3 % of the workforce had renal calculi, and they received treatment for it and interestingly these workers were mostly female workers which might be as they restrict themselves to urinate at work time due to poor sanitation facility. However, less than 20% the employees were aware that a severe workload and exposure to heat could have caused kidney issues. As a result of the findings, there is an urgent need to raise awareness among underprivileged employees using convincing evidence in order to protect them from the occurrence of kidney disease caused by heat and a demanding physical workload.

Participants knowledge and attitude towards the coping mechanisms to reduce heat

According to the IPCC summary report on climate change, 2014, combating the heat is an urgent need right now. It states that these extreme events clearly indicate the need for adaptation to changes in climatic conditions and readiness, particularly for heat stress, is a crucial context for the future (56). The severity of the heat stress issue at work and the significance of implementing preventive measures to shield the working population from potential health hazards and productivity declines are both made abundantly obvious in a number of literatures (57-62). As a result of climate change, the average global temperature will rise by 1.5 degrees Celsius, which would cause "heat waves" in areas with typically mild climates and sustained enhanced hot seasons in nations with already hot climates (Collins et al. 2013). As a result, "adaptations" to climate change will be required everywhere, and such preventative adaptation measures are already being implemented in places with extremely hot days (10, 63-65).The preventive and adaptation strategies for workplaces must be practical, long-lasting, and well tested before being implemented.

However, the biggest issue is how much workers are aware of this intervention and how much they are willing to use it to protect themselves from heat exhaustion. The current study unequivocally demonstrated that, less than 5% of the participants were aware of personal cooling interventions like the sitali breathing system (a yoga technique), local body cooling with ice gel packs. Additionally, less than 20 % of participants were aware that using wet towels and cooling their arms with water, cooling their feet with water would also lower their body heat loads, which were the most common interventions people used in the olden days. We found that more than80%of people were aware of nutritional interventions and agreed that eating traditional foods like cucumber, buttermilk, ragi drinks, tender coconut, and fruits like melon and lemon could lower their body temperatures. Additionally, a higher percentage of heavy labourers believed that certain nutrients, such as cucumber, buttermilk, Ragi drinks, tender coconut, fruits like melon and lemon have a positive effect on lowering body temperature when compared to other foods. It was also found that employees with more than 9 years of experience were surer that cucumber, buttermilk, tender coconut, fruits like melon and lemon were good for their bodies when they ate them. We also found that female was more likely to be aware of these interventions than male workers. No such similar studies have been conducted so far in gathering the workers awareness on the non-traditional risk factors for kidney-related illness and also the coping knowledge, making this study novel especially for the outdoor unaddressed workers.

5.6. Conclusion

The study concludes that (1) outdoor workers in Chennai, India is exposed to high HRIs due to high ambient heat conditions in their workplaces; (2) Outdoor workers have poor knowledge and awareness of heat as a major risk factor for kidney-related illness. Female workers had much more awareness compared to their male counter parts; and (3) their acceptance of heat, heavy workload, poor sanitation, and hydration as risk factors for HRIs and kidney-related illness is minimal. The current study provides evidence to highlight the importance of teaching the impoverished working population about heat as a pressing concern in tropical settings such as India, where rising temperatures pose particular occupational health and productivity threats. To prevent occupational health risks for outdoor workers, it is imperative to adopt a simple, cost-effective, realistic, practically acceptable, and long-lasting intervention option that can be deployed on-site. Further research is required to determine the extent to which the

fact that heat, dehydration, poor sanitation, and physically exhausting workload can cause renal disease reaches the public, particularly the working community, which is more susceptible to this scenario due to the negative effects of heat stress on workers' health and productivity as climate change continues. To advance this research, the author is currently engaged in a post-doctoral project that will involve undertaking an intervention study with a subgroup of workers from certain outdoor occupations, such as agriculture workers and bricklayers. As part of a future study, the author also intends to analyse the workers' knowledge after educating them about heat-related illnesses and renal diseases, which could demonstrate the extent to which our educational awareness reaches workers and its effect on HRIs and renal diseases.

5.7. Study limitations

The present study has the following limitations:

- The study is based on the subjective questionnaire, and hence the results may be biased, and workers with true HRIs and kidney illness may be missed.
- Specific recommendations could not be suggested based on the workers perception as it may vary between a person
- The study could not conclude that the kidney illness was due to heat as no physiological measurements were done, which was beyond the scope of the study

5.8. Recommendations

Here are few recommendations that could be suggested for the outdoor workers

1. The management of the workplace can try to implementation work-rest cycle and skewed working hours to avoid heat exposure
2. For resting during their break time, temporary cool resting area with ample ventilation and fans are recommended. One such cost effective solution could be coconut palm thatched roofs that have been used for generations in India and have been proven to be much cooler than the metal and asbestos sheet roofs for the rest area. In about 80 countries that grow coconuts and palms where air conditioning is not feasible or economically viable. The structure has to be redone every few months which will incur some cost to the employer.

Coconut palm thatched roof huts

3. The management can provide or encourage the workers to intake fluid supplements during their working hour like tender coconut, electrolytes and buttermilk at regular intervals.

4. Arrangements can be made at regular basis by inviting NGOs or any other expertise in the field to create awareness among the workers and the supervisors on recognizing signs and symptoms of heat related illnesses and its importance which can be done by distributing pamphlets, stories, street plays, movies etc.
5. Encouragement should be done to the management by the government to conduct regular free medical surveillance camp for the workers to identify the renal illness at the initial stage
6. Workers can be asked to avoid working with tight clothes and suggesting workers wear breathable light cotton clothes

5.9. Benefits to the society

Long Term

- The lessons learnt from the current study from the local level can be directly used to study and collect knowledge and attitude of the outworkers in a regional and country level study.
- The knowledge generated in this project could further be distilled and fed into the regional industrial networks to formulate new requirements for occupational health.
- The study results form the foundation for joining hands with more and more recipient labour unions and workers to understand & emphasize the need for safe working environment and attach high value to health and safety at work with an aim to improve health promotion for the working people and consequent poverty reduction.

Immediate

- These study results could alert and create awareness among the outdoor workers and the management on the risk related to heat exposure, incidence of kidney illness due to heat exposure, and the feasible heat prevention techniques so as to safe guard form heat stress.
- Implementing Climate Change adaptation strategies from the study will be a key in combating the predicted increase / exacerbation of renal health issues due to heat stress at workplaces.
- Several intervention and adaption strategies with a holistic approach, while at the same time also encouraging and ensuring awareness mitigation actions at a regional and national level can be implemented.
- The results could help to drive comprehensive protective labor policies to prevent the occupational health and productivity risk consequences for few million workers in developing countries in the looming climate crisis.

5.10. Practical application for humanitarian work

Heat is regarded as natural in the world of outdoor workplace. There is a notion that there is nothing that can be done about heat, therefore workers in the informal sectors are left to deal with the heat and its health effects. Few billion poor informal labourers around the world are disproportionately affected by the climate change caused by the wealthy and affluent. Workers' lack of understanding that heat might have negative effects on their health and productivity can be one of the primary causes for their inability to protect themselves. If a worker is unaware of the signs and symptoms of heat strain caused by heat-stress, he or she may fail to take protective measures when they manifest. The study demonstrates the poor level of information that workers have regarding heat stress, their

perceptions of heat stress symptoms, and any knowledge protective measures they take against the deleterious effects of heat before they develop into irreversible heat-related illnesses such as renal disease. According to the findings of our study, it is concerning that workers under the age of 30 have a low awareness of heat as a risk factor for kidney-related diseases and kidney stones. The importance of raising awareness and educating workers about the dangers of working in heat, the various influencing factors, recognising the signs and symptoms of heat strain, and methods for mitigating heat strain by modifying the working environment, working style, and other external interventions that can help to reduce the adverse effects of heat on their health is most needed. Given the predicted rise in global temperatures, this is an urgent issue. Unless modifications are made now, it is likely that the future workforce will be plagued by heat-induced poor health and productivity losses. This will further impoverish the workforce and undermine the 2030 sustainable development goal of reducing poverty. There is a need for amendments to recompense the poor for their contribution to the climate crisis caused by the wealthy and powerful. There is a need for stronger and more protective laws to provide better welfare amenities to the informal labourers who are the cornerstone of the Indian economy.

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ANNEXURE I

Institutional Ethical Clearance

SRI RAMACHANDRA
INSTITUTE OF HIGHER EDUCATION AND RESEARCH
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INSTITUTIONAL ETHICS COMMITTEE
(Other than Clinical Evaluation of Drugs / Procedures/ Devices/ Diagnostics/Vaccine/ Herbal Remedies)

Chairperson:
Dr.A.Nalini
Member Secretary:
Dr.Pankaj B.Shah
Members:
Dr.R.Suresh
Dr.Solomon F.D.Paul
Ms.Anitha Jayaraj
Mrs.Sudha Ganapathy
Mrs. Charumathi Thiagarajan
Dr.K.Punnagai
Dr.Swapnatai A. Meshram
Dr.Nalini Kumaravelu
Dr.B.Rajesh

11.07.2022

To
Dr. Vidhya Venugopal
Professor,
Dept. of Environmental Health Engineering
Sri Ramachandra Institute of Higher Education & Research (DU)

REF: IEC-NI/22/APR/82/46
SUB: How do workers perceive heat, heavy workload, dehydration, and lack of access to sanitation as risk factors for Chronic Kidney Disease? – Surveying from different occupational groups in South India.

.....

Thank you for submitting the clarifications. The Institutional Ethics Committee approves the project for SRIHER, Chennai site. Project should be conducted as per ICMR guidelines, ICMR COVID 19 research ethics guidelines and maintaining social distancing and physical distancing as per Govt. guidelines and ICMR COVID 19 research ethics guidelines.

You are advised to be familiar with ICMR guidelines on Biomedical Research & Health Research (2017) in human beings, ICMR National guidelines for Ethics Committees reviewing Biomedical and Health Research During COVID 19 Pandemic released on 06.05.2020, also to adhere to the Principles of good clinical practice and COVID-19 guidelines as and when they are updated. You are required to submit the final report after the completion of study to the Institutional Ethics Committee.

Yours Sincerely,

(DR.PANKAJ B.SHAH)
Note: Please quote IEC Reference number in all future communications

ANNEXURE II

Main study questionnaire

Part 1 General information about person interviewed and the organization she/he represents

1. Name:
2. ID No:
3. Date of interview:
4. Name of the interviewer:
5. Name of the industry:
6. Location of the industry:
7. Age group: ☐1 10-20 /☐2 21-30/ ☐3 31-40/ ☐4 41-50/ ☐5 51-60/ ☐6 61-70
8. Sex: ☐1 Male / ☐2 Female
9. Food habits: ☐1Vegetarian / ☐2Non vegetarian
10. Education: ☐1 Illiterate / ☐2 Primary / ☐3 Secondary / ☐4 Higher Secondary / ☐5 University/ ☐6 Polytechnic/Diploma
11. Designation: ☐1 Worker ☐2 Supervisory ☐3Manager
12. Worker category:
13. Smoking: ☐1 Smoker /☐2 Non Smoker /☐3 Ex smoker
14. Consuming alcohol: ☐1 Yes ☐2 No ☐3 Ex
15. Any existing illness: Diabetes☐1 Yes ☐2 No

    Hypertension☐1 Yes ☐2 No
    Respiratory illness☐1 Yes ☐2 No
    Specify Others_____ specify
    None ☐1 Yes ☐2 No
16. Taking NSAID Medication: ☐1 Yes ☐2 No
17. Taking any herbal medication: ☐1 Yes ☐2 No

    If yes, which one –describe: _____

Part 2 Questions concerning the type of work

1. Type of work: ☐1Light ☐2Moderate ☐3Heavy ☐4 Very Heavy
2. How many ***hours*** per day do you usually work excluding regular break timings? _____
3. Do you have additional breaks during summer? ☐1 Yes / ☐2 No

a. If yes, mention no. of ***hours/minutes***_____

4. How long you are employed here? _____***years/months*** (more than 6months means acclimatized)
5. What was your previous job and where (relating to heat)? _____

6. Are you a seasonal worker in the work place?
    a. If yes mention, the type of jobs you do during your away from the current work.

Part 3 Questions in relation to heat exposure at work

1. Do you work near a direct heat source (outdoors) ☐1 Yes / ☐2 No
2. Are you comfortable with the ambient temperature? ☐1 Yes / ☐2 No
3. Is heat exposure a problem during the hot season? ☐1 Yes / ☐2 No
4. How many months do you feel hot /uncomfortably hot in this workplace?

☐1 1-3 months/ ☐2 4-6 months/ ☐3 7-9 months / ☐4 9-12 months/ ☐5 Never

5. Describe how bad the heat stress can be in the hot season.

☐1 Extremely bad/ ☐2 Very bad/ ☐3 Bad/ ☐4 Manageable/ ☐5 No stress at all

Part 4 Questions concerning impacts of heat on health

1. Have you ever had these symptoms at work?
    a. Excessive sweating ☐1 Yes / ☐2 No
    b. Muscle/Heat cramps ☐1 Yes / ☐2 No
    c. Thirst ☐1 Yes / ☐2 No
    d. Tiredness/weakness/☐1 Yes / ☐2 No
    e. dizziness☐1 Yes / ☐2 No
    f. headache ☐1 Yes / ☐2 No
    g. nausea or vomiting☐1 Yes / ☐2 No
    h. fainting☐1 Yes / ☐2 No
    i. Prickly heat ☐1 Yes / ☐2 No
    j. Heat stroke ☐1 Yes / ☐2 No
    k. Kidney related problems ☐1 Yes / ☐2 No
       if yes like what_____
    l. Others_____
    m. None ☐1 Yes / ☐2 No

Part 5 Questions concerning dehydration

1. Do you feel dehydrated? ☐1 Yes / ☐2 No
2. Do you have any pressure ulcers? ☐1 Yes / ☐2 No
3. Do you have any other skin conditions? ☐1 Yes / ☐2 No
4. Do you have nausea or fainting spells? ☐1 Yes / ☐2 No
5. Have you ever been admitted to hospital/medical centre due to dehydration?
   ☐1 Yes / ☐2 No
    a. If yes: Approximately for how many days?.....
6. Do you think this problem would have been better if you had better access to drinking water facilities☐1 Yes / ☐2 No
7. Do you think this problem would have been better if you had better access to toilets? ☐1 Yes / ☐2 No

Part 6 Attitude towards perceived heat strain usinga 5-level Likert Scale

1. How would you rate your personal heat strain?

No (0%)	Little (30%)	Moderate (50%)	Clearly (80%)	Very much (100%)

2. How would you rate your risk for personal health issues during summer?

No (0%)	Little (30%)	Moderate (50%)	Clearly (80%)	Very much (100%)

Part 7 Questions concerning kidney problems

1. Have you noticed changes in your urine volume? ☐1 Yes / ☐2 No
2. Do you have excessive tiredness or skin itching? ☐1 Yes / ☐2 No
3. Do you have numbness or swollen legs or hands due to water retention?
   ☐1 Yes / ☐2 No
   a. If Yes to 1, 2 and 3, what is the color of your urine?
      a) Reddish
      b) Dark Yellow
      c) Yellow
      d) Colorless
      e) Have not noticed
      f) Don't know
4. Have you been treated for kidney stones? ☐1 Yes / ☐2 No
   a. If yes: When? ----------
5. Do you feel pain in the bottom of your back? ☐1 Yes / ☐2 No
   a. If yes: For how long?
      a) The last week
      b) The last month
      c) The last 2-6 month
      d) Longer than the last 6 months
6. Do you think this problem would have been better if you had better access to toilets? ☐1 Yes / ☐2 No
7. Have you ever been admitted to hospital/medical centre because of kidney problems? ☐1 Yes / ☐2 No

Part 8 Questions concerning coping mechanisms

1. How do you limit heat exposure/cope with heat exhaustion, when needed?

   ☐1 take rest/ ☐2 Change/remove clothing/ ☐3 drink water/ ☐4 cool shower, bath, or sponge bath/☐5 move to an air-conditioned/cooler environment/ ☐6 any other method, do specify_____ ☐7 None

2. Is sufficient water available at all times when you need it? ☐1 Yes / ☐2 No
3. Do you drink water at work? ☐1 Yes / ☐2 No
   a. If yes, how? _____(litres)
4. How much did you drink before you came to work today? What type of fluids did drink?
   _____

5. Do you take any traditional special diet to cope with heat? ☐1 Yes / ☐2 No
6. What traditional or other methods do you adopt for coping with heat?
   _____
7. Do you spend more money during hot much seasons to cope with heat? ☐1 Yes / ☐2 No

a. If yes, specify _____ (Currency units) per week/month

8. Do you spend more time to cope with heat? ☐1 Yes / ☐2 No
   b. If yes how much_____(min/hrs) – convert to % of productivity time or personal time
9. Does the time spent on coping heat impact your social life? ☐1 Yes / ☐2 No
10. How does it affect your social life? ☐1 Moderately/ ☐2 Highly/ ☐3 Extremely/ ☐4 No impact

Part 9 Knowledge about the heat as non-traditional risk factors

1. Are you aware that exposure to prolonged heat may cause kidney related problems ☐1 Yes / ☐2 No
   a. If yes: How did to come to know
      a. Friends/colleague/supervisors /any others
      b. Magazines, medias (TV/radio etc.)
      c. From forefathers
      d. Researchers like us

Strongly disagree				Strongly agree
1 (0%)	2 (30%)	3 (50%)	4 (80%)	5 (100%)

2. Do you know that not hydrating yourself and heat exposure frequently may cause kidney related problems ☐1 Yes / ☐2 No
   a. If yes: How did to come to know
      a. Friends/colleague/supervisors /any others
      b. Magazines, medias (TV/radio etc.)
      c. From forefathers
      d. Researchers like us

Strongly disagree				Strongly agree
1 (0%)	2 (30%)	3 (50%)	4 (80%)	5 (100%)

3. Do you know that poor sanitation access at your work place stop you from hydrating yourself and may cause kidney related problems ☐1 Yes / ☐2 No
   a. If yes: How did to come to know
      a. Friends/colleague/supervisors /any others
      b. Magazines, medias (TV/radio etc.)
      c. From forefathers
      d. Researchers like us

Strongly disagree				Strongly agree
1 (0%)	2 (30%)	3 (50%)	4 (80%)	5 (100%)

4. Do you know that doing heavy physical work and prolonged exposure to heat may cause kidney related problems ☐1 Yes / ☐2 No
    a. If yes: How did to come to know
        a. Friends/colleague/supervisors /any others
        b. Magazines, medias (TV/radio etc.)
        c. From forefathers
        d. Researchers like us

Strongly disagree				Strongly agree
1 (0%)	2 (30%)	3 (50%)	4 (80%)	5 (100%)

5. Do you know that consumption of beverages containing high levels of fructose while working in hot area cause kidney related problems ☐1 Yes / ☐2 No
    a. If yes: How did to come to know
        a. Friends/colleague/supervisors /any others
        b. Magazines, medias (TV/radio etc.)
        c. From forefathers
        d. Researchers like us

Strongly disagree				Strongly agree
1 (0%)	2 (30%)	3 (50%)	4 (80%)	5 (100%)

Part 10 Attitude towards about the coping mechanisms to reduce heat impact

Do you feel that the following coping strategies could reduce the impact of heat on your body?

No.	Cooling strategy	Not aware about it at all	Strongly disagree				Strongly agree
		0	1 (0%)	2 (30%)	3 (50%)	4 (80%)	5 (100%)
A.	**Personnel cooling strategies**						
1.	wearing less/thinner/cotton clothes						
2.	drinking more fluids						
3.	taking showers more frequently						
4.	cooling arms with water						
5.	using wet towels						

6.	cooling feet with water						
7.	Moving to shady place						
8.	Sitali breathing system (Yoga method)						
9.	Local body cooling by ice gel packs						
B.	**Eating cooling foods**						
1.	Cucumber						
2.	buttermilk						
3.	ragi drinks						
4.	tender coconut						
5.	mint						
6.	yogurt						
7.	Sabja seeds						
8.	fruits like melon, Lemon						
9.	Aloe vera						
10.	Chili						
11.	Fenugreek						

INFORMED CONSENT

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Description of the Study:

The present study aims to explore the hidden risk factor and to protect the worker's health by investigating workers' perceptions of exposure to heat, hydration practices, workload and poor sanitation as a risk for CKD at select South Indian workplaces. We propose to conduct a cross-sectional observational design based on questionnaire survey among 4 outdoor and 4 indoor sectors in southern India during summer. Focused interviews with validated questionnaires will be used to collect the required information on the objective 1 to 4 listed in section 2.The proposed

objectives will be able to identifying the CKD vulnerable outdoor workers due to occupational heat exposures nationally and will help suggest protective interventions to control further growth of the disease into epidemic proportions also the research evidence on the association between heat exposure, hydration, workload and poor sanitation is expected to bring about a substantial interest in outdoor workers health at policy level as well as identify preventative actions to reduce health impacts. We would identify from our own previous studies the most vulnerable occupational groups to extreme heat and workload. After getting necessary institutional clearance for the research and the workplaces to conduct the study, we would recruit workers from the selected workplaces by explaining the need for the study through videos, pamphlets and stories.

Possible Risks to the participant:

There are few risks involved in withdrawing blood like giddiness; minimal pain and infection. Specific precautionary measures will be followed to prevent the risks. The trained phlebotomist collects the sample using sterile techniques.

Possible Benefits to the participant:

1. You will have a better understanding of your current health status and your susceptibility to heat stress.
2. We will educate you about the effects of heat stress & ways to minimize them and give you counseling to seek medical advice in case of the findings are adverse

Cost and Payments to the participant:

There is NO cost for participation in this study. Participation is completely on voluntary basis and hence no payment will be provided.

Confidentiality:

Information obtained in this study is strictly confidential. Your name will not be used in reporting of information in publications or conference presentations**.**

Participant's right to withdraw from the study:

You have the right to refuse to participate in this study, the right to withdraw from the study and the right to have your data destroyed at any point during or after the study, without penalty.

Voluntary consent by the participant:

Participation in this study is completely voluntary, and your consent is required before you participate in this study. I have read this consent form (or it has been read to me) and I fully understood the contents of this document and voluntarily consent to participate in the study. All of my questions concerning this study have been answered. If I have any questions in the future about this study they will be answered by the investigator listed above. I understand that this consent ends at the conclusion of this study. By signing this form, I agree to participate in this study. A copy of this form has been given to me.

Date:

Participant's Signature/Thumb impression Witness signature/Thumb impression

Name: Name:

Certification of Informed Consent

I certify that I have explained the nature and purpose of this study to the above named individual, and I have discussed the potential benefits of this study participation. The questions the individual had about this study have been answered, and we will always be available to address future questions as they arise.

Date: Signature of person obtaining consent

Name: Affiliation

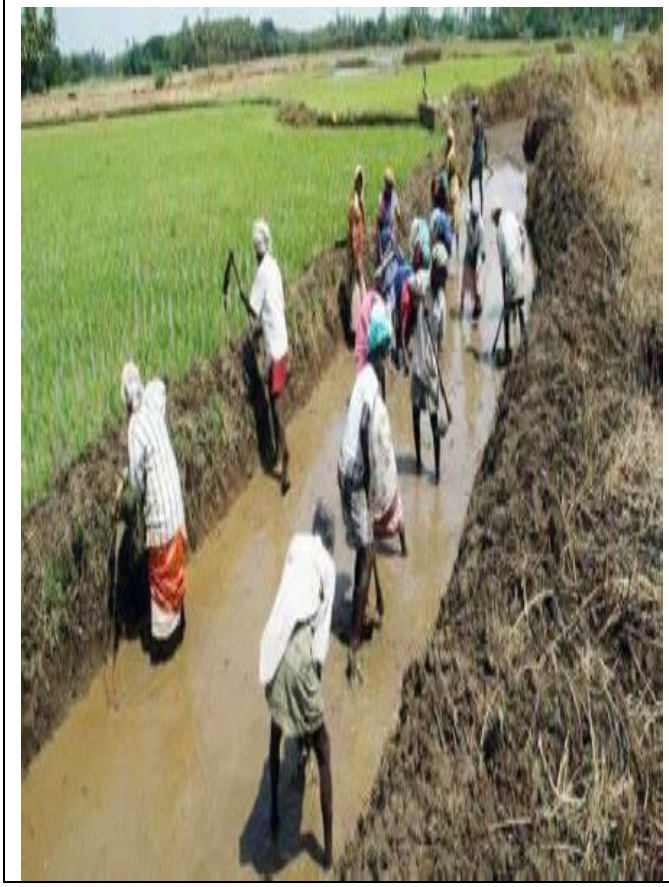
ANNEXURE III

PHOTOGRAPHS TAKEN IN THE OCCUPATIONAL SECTORS

BRICK MANUFACTURING SECTOR

AGRICULTURE SECTOR

MAHATMA GANDHI RURAL WORKER



CONSTRUCTION SECTOR

OUTREACH ACTIVITIES

ANNEXURE IV

Table 5b: Association between the non-traditional risk factors for kidney related illness and belief of the participants

Sl. no	Variable	Category	Non-traditional risk factors for kidney related illness (Believe >=50% and less than 50%)														
			Heat exposure			Poor hydration			Poor sanitation			heavy physical work and prolonged exposure			Consumption of beverages		
			n	%	p-value	n	%	p-value	n	%	p-value	n	%	p-value	n	%	p-value
1	Gender	Male(174)	60	34	0.474	66	38	0.574	57	33	0.243	52	30	0.073	74	43	0.001
		Female(244)	76	31		86	35		67	27		54	22		62	25	
2	Age	≥30 years(307)	101	33	0.792	108	35	0.403	89	29	0.616	76	25	0.638	91	30	0.036
		<30 years(111)	35	32		44	40		35	32		30	27		45	41	
3		≥40 years(207)	64	31	0.485	70	34	0.284	60	29	0.763	51	25	0.737	52	25	0.001
		<40 years(211)	72	34		82	39		64	30		55	26		84	40	
4	Work category	Heavy(269)	94	35	0.158	104	39	0.19	89	33	0.04	82	30	0.001	106	39	0.001
		Moderate & Light(149)	42	28		48	32		35	23		24	16		30	20	
5	Years of exposure	≥3 years(333)	117	35	0.025	121	36	0.982	106	32	0.055	92	28	0.035	107	32	0.728
		<3 years(85)	19	22		31	36		18	21		14	16		29	34	
6		≥9 years(185)	63	34	0.555	68	37	0.882	60	32	0.27	53	29	0.169	56	30	0.379
		<9 years(233)	73	31		84	36		64	27		53	23		80	34	

Table 7a1 extension: Association between the study variables and the personal cooling startegy (awarness and not aware)

Sl. no	Variable	Category	Attitude towards about the coping mechanisms to reduce heat impact Personal cooling mechanism (Aware and Not aware)																									
			Wearing less/thinner/cotton clothes			drinking more fluids			taking showers more frequently			cooling arms with water			using wet towels			cooling feet with water			Moving to shady place			Sitali breathing system (Yoga method)			Local body cooling by ice gel packs		
			n	(%)	p-value	n	(%)	p-value	n	(%)	p-value	n	(%)	p-value	n	(%)	p-value	n	(%)	p-value	n	(%)	p-value	n	(%)	p-value	n	(%)	p-value
1	Gender	Male (174)	154	89	0.021	165	95	0.082	159	91	0.001	95	55	0.369	101	58	0.843	91	52	0.597	165	95	0.001	19	11	0.021	46	26	0.023
		Female (244)	231	95		220	90		182	75		144	59		144	59		134	55		200	82		12	5		42	17	
2	Age	≥30 years (307)	286	93	0.184	283	92	0.923	240	78	0.003	179	58	0.438	179	58	0.833	162	53	0.471	263	86	0.092	18	6	0.044	58	19	0.072
		<30 years (111)	99	89		102	92		101	91		60	54		66	59		63	57		102	92		13	12		30	27	
3		≥40 years (207)	192	93	0.627	191	92	0.901	152	73	0.001	127	61	0.088	127	61	0.26	114	55	0.614	179	86	0.607	12	6	0.211	35	17	0.04
		<40 years (211)	193	91		194	92		189	90		112	53		118	56		111	53		186	88		19	9		53	25	
4	Work category	Heavy (269)	246	91	0.505	240	89	0.003	201	75	0.001	144	54	0.043	164	61	0.19	133	49	0.016	229	85	0.071	20	7	0.984	69	26	0.002
		Moderate &Light (149)	139	93		145	97		140	94		95	64		81	54		92	62		136	91		11	7		19	13	
5	Years of exposure	≥3 years (333)	304	91	0.222	304	91	0.222	261	78	0.001	185	56	0.185	198	59	0.487	171	51	0.045	285	86	0.035	25	8	0.888	69	21	0.742

Sl. no	Variable	Category	Attitude towards about the coping mechanisms to reduce heat impact Personal cooling mechanism (Aware and Not aware)																									
			Wearing less/thinner/cotton clothes			drinking more fluids			taking showers more frequently			cooling arms with water			using wet towels			cooling feet with water			Moving to shady place			Sitali breathing system (Yoga method)			Local body cooling by ice gel packs		
			n	(%)	p-value	n	(%)	p-value	n	(%)	p-value	n	(%)	p-value	n	(%)	p-value	n	(%)	p-value	n	(%)	p-value	n	(%)	p-value	n	(%)	p-value
		<3 years (85)	81	95		81	95		80	94		54	64		47	55		54	64		80	94		6	7		19	22	
6		≥9 years (185)	168	91	0.382	166	90	0.109	125	68	0.001	111	60	0.299	112	61	0.476	97	52	0.611	152	82	0.005	9	5	0.076	34	18	0.233
		<9 years (233)	217	93		219	94		216	93		128	55		133	57		128	55		213	91		22	9		54	23	

Table 7b1: Association between the study variables and the personal cooling startegy belief (≥50% and <50%)

Sl. no	Variable	Category	Attitude towards about the coping mechanisms to reduce heat impact Personal cooling mechanism (Believe >=50% and less than 50%)																									
			Wearing less/thinner/cotton clothes			drinking more fluids			taking showers more frequently			cooling arms with water			using wet towels			cooling feet with water			Moving to shady place			Sitali breathing system (Yoga method)			Local body cooling by ice gel packs		
			n	(%)	p-value	n	(%)	p-value	n	(%)	p-value	n	(%)	p-value	n	(%)	p-value	n	(%)	p-value	n	(%)	p-value	n	(%)	p-value	n	(%)	p-value
1	Gender	Male (174)	124	71	0.004	149	86	0.046	137	79	0.001	72	41	0.115	73	42	0.652	71	41	0.904	134	77	0.007	21	12	0.034	23	13	0.032
		Female (244)	203	83		190	78		152	62		120	49		97	40		101	41		158	65		15	6		17	7	
2	Age	≥30 years (307)	243	79	0.447	246	80	0.4	203	66	0.027	145	47	0.376	131	43	0.167	123	40	0.455	216	70	0.71	23	7	0.175	25	8	0.1
		<30 years (111)	84	76		93	84		86	77		47	42		39	35		49	44		76	68		13	12		15	14	
3		≥40 years (207)	162	78	0.988	167	81	0.827	131	63	0.01	104	50	0.08	96	46	0.019	84	41	0.815	149	72	0.349	11	5	0.017	9	4	0.001
		<40 years (211)	165	78		172	82		158	75		88	42		74	35		88	42		143	68		25	12		31	15	
4	Work category	Heavy (269)	209	78	0.722	213	79	0.179	174	65	0.008	121	45	0.6	120	45	0.028	110	41	0.886	179	67	0.048	25	9	0.505	32	12	0.03
		Moderate &Light (149)	118	79		126	85		115	77		71	48		50	34		62	42		113	76		11	7		8	5	
5	Years of exposure	≥3 years (333)	260	80	0.106	267	80	0.342	219	66	0.003	153	46	0.992	138	41	0.526	136	41	0.801	226	68	0.08	31	9	0.315	33	10	0.64

Sl. no	Variable	Category	Attitude towards about the coping mechanisms to reduce heat impact Personal cooling mechanism (Believe >=50% and less than 50%)																									
			Wearing less/thinner/cotton clothes			drinking more fluids			taking showers more frequently			cooling arms with water			using wet towels			cooling feet with water			Moving to shady place			Sitali breathing system (Yoga method)			Local body cooling by ice gel packs		
			n	(%)	p-value	n	(%)	p-value	n	(%)	p-value	n	(%)	p-value	n	(%)	p-value	n	(%)	p-value	n	(%)	p-value	n	(%)	p-value	n	(%)	p-value
		<3 years (85)	67	72		72	85		70	82		39	46		32	38		36	42		66	78		5	6		7	8	
6		≥9 years (185)	154	83	0.027	142	77	0.044	107	58	0.001	92	50	0.166	93	50	0.001	73	39	0.532	125	68	0.364	10	5	0.038	15	8	0.366
		<9 years (233)	173	74		197	85		182	78		100	43		77	33		99	42		167	72		26	11		25	11	

Table 7a2 extension: Association between the study variables and the nutition cooling startegy (awarness and not aware)

Sl.no	Variable	Category	Attitude towards about the coping mechanisms to reduce heat impact Nutritional Intake (Aware and Not aware)																														
			Cucumber			Buttermilk			Ragi drinks			Tender coconuts			Mint			Yogurt			Sabja seeds			Fruits like melon, Lemon			Aloe vera			Chili			Fenugreek		
			n	n (%)	p-value	n	n (%)	p-value	n	n (%)	p-value	n	n (%)	p-value	n	n (%)	p-value	n	n (%)	p-value	n	n (%)	p-value	n	n (%)	p-value	n	n (%)	p-value	n	n (%)	p-value	n	n (%)	p-value
1	Gender	Male(174)	157	90	0.018	159	91	0.055	131	75	0.001	167	96	0.155	98	56	0.435	84	48	0.728	50	29	0.215	168	97	0.28	120	69	0.016	51	29	0.005	123	71	0.001
		Female(244)	200	82		234	96		220	90		226	93		128	52		122	50		57	23		230	94		140	57		43	18		135	55	
2	Age	≥30 years(307)	264	86	0.572	294	96	0.012	265	86	0.03	287	93	0.445	165	54	0.827	153	50	0.706	80	26	0.72	290	94	0.231	183	60	0.069	66	21	0.421	182	59	0.088
		<30 years(111)	93	84		99	89		86	77		106	95		61	55		53	48		27	24		108	97		77	69		28	25		76	68	
3	Age	≥40 years(207)	175	85	0.62	197	95	0.327	191	92	0.001	193	93	0.505	111	54	0.857	97	47	0.327	54	26	0.821	194	94	0.156	118	57	0.03	40	19	0.125	107	52	0.001
		<40 years(211)	182	86		196	93		160	76		200	95		115	55		109	52		53	25		204	97		142	67		54	26		151	72	
4	Work category	Heavy(269)	215	80	0.001	248	92	0.035	215	80	0.002	247	92	0.011	107	40	0.001	106	39	0.001	43	16	0.001	254	94	0.309	163	61	0.363	48	18	0.002	171	64	0.297
		Moderate & Light(149)	142	95		145	97		136	91		146	98		119	80		100	67		64	43		144	97		97	65		46	31		87	58	
5	Years of exposure	≥3 years(333)	280	84	0.13	315	95	0.327	287	86	0.015	311	93	0.286	176	53	0.325	169	51	0.235	85	26	0.946	315	95	0.24	207	62	0.974	68	20	0.045	205	62	0.894
		<3 years(85)	77	91		78	92		64	75		82	96		50	59		37	44		22	26		83	98		53	62		26	31		53	62	
6	Years of exposure	≥9 years(185)	150	81	0.026	178	96	0.092	165	89	0.01	170	92	0.103	93	50	0.166	88	48	0.533	43	23	0.326	174	94	0.322	97	52	0.001	34	18	0.073	99	54	0.002
		<9 years(233)	207	89		215	92		186	80		223	96		133	57		118	51		64	27		224	96		163	70		60	26		159	68	

Table 7b2: Association between the study variables and the nutition cooling startegy (Belive >=50% and less than 50%)

Sl.no	Variable	Category	Attitude towards about the coping mechanisms to reduce heat impact Nutritional Intake (Belive >=50% and less than 50%)																														
			Cucumber			Buttermilk			Ragi drinks			Tender coconuts			Mint			Yogurt			Sabja seeds			Fruits like melon, Lemon			Aloe vera			Chili			Fenugreek		
			n	n (%)	p-value	n	n (%)	p-value	n	n (%)	p-value	n	n (%)	p-value	n	n (%)	p-value	n	n (%)	p-value	n	n (%)	p-value	n	n (%)	p-value	n	n (%)	p-value	n	n (%)	p-value	n	n (%)	p-value
1	Gender	Male(174)	147	84	0.345	152	87	0.53	111	64	0.001	158	91	0.455	71	41	0.639	61	35	0.523	42	24	0.496	163	94	0.074	93	53	0.036	31	18	0.003	104	60	0.001
		Female(244)	214	88		218	89		194	80		216	89		94	39		93	38		52	21		216	89		105	43		20	8		93	38	
2	Age	≥30 years(307)	263	86	0.491	278	91	0.03	231	75	0.082	271	88	0.184	118	38	0.471	114	37	0.837	74	24	0.189	274	89	0.098	143	47	0.592	34	11	0.243	136	44	0.054
		<30 years(111)	98	88		92	83		74	67		103	93		47	42		40	36		20	18		105	95		55	50		17	15		61	55	
3	Age	≥40 years(207)	173	84	0.1	187	90	0.248	168	81	0.001	182	88	0.307	75	36	0.18	76	37	0.957	51	25	0.298	183	88	0.115	91	44	0.168	19	9	0.062	80	39	0.001
		<40 years(211)	188	89		183	87		137	65		192	91		90	43		78	37		43	20		196	93		107	51		32	15		117	55	
4	Work category	Heavy(269)	227	84	0.114	235	87	0.32	177	66	0.001	239	89	0.576	72	27	0.001	70	26	0.001	37	14	0.001	249	93	0.074	121	45	0.19	26	10	0.034	138	51	0.022
		Moderate & Light(149)	134	90		135	91		128	86		135	91		93	62		84	56		57	38		130	87		77	52		25	17		59	40	
5	Years of exposure	≥3 years(333)	287	86	0.834	302	91	0.006	248	74	0.17	298	89	0.983	131	39	0.912	130	39	0.066	75	23	0.973	299	90	0.221	155	47	0.506	37	11	0.178	155	47	0.637
		<3 years(85)	74	87		68	80		57	67		76	89		34	40		24	28		19	22		80	94		43	51		14	16		42	49	
6	Years of exposure	≥9 years(185)	161	87	0.725	170	92	0.054	143	77	0.076	162	88	0.258	69	37	0.418	70	38	0.707	39	21	0.54	163	88	0.109	72	39	0.002	17	9	0.094	70	38	0.001
		<9 years(233)	200	86		200	86		162	70		212	91		96	41		84	36		55	24		216	93		126	54		34	15		127	55	