India heat studies:
Findings and way forward

Presented by

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For the

INDIA HEAT TEAM

Department of Environmental Health Engg.

Faculty of Public Health,

SRIHER

Content overview……………

- Who are we??
- Global & Indian heat scenario
- Need for heat studies in India
- Our Research foot prints in heat research
    - The Evidence
- Key findings
- Collaboration and future steps

We are recognized by…

SRIHER

ILO
International Labour Organization

2008

2016

ICMR, India
Centre for Advanced Research on Air Quality, climate and Health

WHO
Collaborating Centre For Occupational and Environmental Health

2007 - till date

2022

NIHR, UK
Centre on Non-Communicable Diseases and Environmental Change

NIHR | National Institute for Health Research

Research grants, Industrial Hygiene and Academics

110
Industrial Consultancies

10
PhD Scholars guidance

5000
WBGT Measurements

12
Post graduate Courses & guidance

$1,25,573
Total grant generated from projects for OSH research

Key positions

- **Elected board Member**, CENCAM.
- **Scientific Advisory Member**, La isla network.
- **Steering committee member**, DEGREE & NIHR.
- **Expert CC member**, GOI

Heatwaves in India…..

- The Lancet Countdown on Health and Climate Change: A 50% increase in heat-related deaths in India demonstrates that health is at the mercy of fossil fuels.

- Between 2000 and 2004, an average of 20,000/annum of over-65s died of heat-related causes; this number has increased to 31,000/annum between 2017 and 2021.

- TIMES OF INDIA

Heat status in India…

In Maharashtra heatstroke deaths, the critical factor of humidity

AMITABH SINHA
NEW DELHI, APRIL 17

THIRTEEN PEOPLE died from an apparent heatstroke while attending a government award function in an open space in Navi Mumbai Sunday. This is possibly the biggest-ever heatwave-related death toll from a single event in the country, and brings back the spotlight on potential risks from heatwaves, whose intensity and frequency is expected to rise because of climate change.

This year, heatwave conditions developed even in February, an unprecedented occurrence. After a relatively cool March, the summer is expected to be extremely hot, and several parts of the country are likely to experience multiple spells of heatwaves.

Notably, Mumbai, where the deaths took place on Sunday, is not even facing heatwave conditions at present. According to India Meteorological Department (IMD), heatwave conditions are currently prevailing in some areas of Gangetic West Bengal, coastal Andhra Pradesh, and Bihar. In most parts of Mumbai, maximum temperatures on Sunday were in the range of 30-35 degrees Celsius, and conditions are expected to remain this way for the next few days.

The huge crowd that gathered for the event in Navi Mumbai on Sunday. *Deepak Joshi*

Humidity crucial

However, high temperature in itself is not fatal. The combination of high temperature and high humidity, referred to as the wet bulb temperature, is what makes heatwaves deadly. High moisture content in the atmosphere makes it difficult for the sweat to evaporate and bodies to cool down, as a result of which the internal body temperature increases sharply, and is often fatal.

Though the humidity levels at the venue are not clearly known, Anup Kumar Srivastava, a former senior consultant with the National Disaster Management Authority, said there could be several reasons for this unusually high death toll from the event, attended by thousands of people.

"It is possible that many people travelled large distances to come to this event and were exhausted. That makes people more vulnerable to heat strokes. Residents of generally cooler places, like coastal areas, are particularly susceptible to prolonged exposure to heat. People with underlying health conditions are also a high-risk group," said Srivastava, who has worked on devising and monitoring heat action plans in states and districts for several years.

"Also, in such a large gathering, it is difficult to ensure that everyone has immediate access to drinking water or oral rehydration solutions (ORS). These can be lifesavers in such situations. We do not know how quickly the people received medical attention. Timely medical intervention is extremely important," he said.

Norms for political gatherings

Prodded by the NDMA, the Election Commission had, just ahead of the general elections in 2019, circulated a detailed advisory on precautions to be taken to conduct the polls in heatwave-like conditions. Electoral officers were advised to ensure that every polling booth had provisions for drinking water, functional clean toilets, facilities for people to sit, some areas under shade, and essential medical kits.

There are advisories for political parties organising political events or campaign rallies during the election season. Parties are supposed to ensure that water, ORS packets, medical kits, and mobile ambulances are readily available at all such events. These advisories are relevant for Karnataka, which is in the midst of an election campaign. There are no immediate forecasts of heatwave-like conditions in Karnataka right now, but the state is not immune from heatwaves.

HEAT-LINKED DEATHS

Year	Deaths
2010	269
2011	12
2012	729
2013	1,433
2014	548
2015	2,040
2016	1,111
2017	384
2018	25
2019	226
2020	4
2021	4
2022	33

Compiled from Ministry of Earth Sciences, NDMA and Ministry of Health

Fewer heat-related deaths

Monitoring and management of heatwaves has undergone a big improvement in the past few years and that has resulted in a sharp decline in deaths caused by heatwaves. Almost every vulnerable state now has a heat action plan in place, consisting mainly of early warning, provision of water and ORS at public places, and flexible working hours in offices and education institutions. Special arrangements are made for people working outdoors.

In the 10 years between 2010 and 2020, reported heatwave-related deaths in India came down by more than 90 per cent. Heatwave fatalities had peaked in 2015, when more than 2,000 deaths were reported. This was the time when states and district administrations started implementing heat action plans. The death count dropped rapidly in the next few years, and in 2020 and 2021, only four heatwave deaths were reported, according to government figures.

Last year, however, 33 deaths were recorded. Officials say the increase in heatwave-related deaths could also be because of improved monitoring and reporting of incidents. But there is no parallel to the Navi Mumbai incident. In June of 2019, more than 100 heatwave-related deaths were reported from three districts of Bihar alone. Unlike the fatalities in Mumbai on Sunday, these deaths did not come from a single event and were spread over a week.

More intense heatwaves

The summer this year is predicted to be excessively hot because of the end of the strong La Nina phase in equatorial Pacific Ocean, something that has a general cooling effect on the earth's atmosphere. New forecasts suggest that El Nino, which has the opposite impacts of La Nina, is expected to kick in from the May-July period itself, earlier than expected. El Nino also tends to result in suppression of monsoon rainfall over India. A shortfall in rains is already being apprehended, which could exacerbate the effects of a hot summer, even though the India Meteorological Department has predicted a normal monsoon.

Over a longer term, heatwaves are predicted to become more intense, prolonged and frequent because of climate change. Srivastava said the Mumbai incident should be a wake-up call for the authorities.

"Heat related deaths can be prevented easily. Relatively simple measures like access to water, ORS, and shade can prevent hundreds of deaths. But these do not happen on their own. The local administration needs to be vigilant and pro-active. And the implementation needs to be monitored by higher authorities on a daily basis. Karnataka elections can be a good test of our strategy. We were winning this battle just a couple of years ago. There is no reason why we should slide back," Srivastava said.

The Indian EXPRESS Tue, 18 April 2023
https://epaper.indianexpress.com/c/72204864

In April, 2023, at an open-air award ceremony **in Mumbai, 13 people died from heatstroke and 600 admitted in the hospital.** This could represent the country's largest heatwave-related mortality toll, emphasising heatwave challenges.

Mercury touches 39.1°C

Guj reporting rate of heat ailments highest in India

With 82 percent of all cases reported, Guj tops the list among states; over 1,900 of the 2,300 centres upload daily reports on IHIP portal

Brendan.Dabhi
@ahmedabadmirror.in
TWEETS @BrendanMIRROR

A month after the Centre directly began collecting data on heat-related ailments and deaths, Gujarat has emerged as the state with the highest reporting turnout in the country. The data collection began from March 1 under the National Digital System for Heat Health Surveillance. Incidentally, Mercury touched 39.1°Celsius in Ahmedabad on Sunday, the highest in April so far.

Gujarat's public sector health centres have been reporting heat stroke, and other ailments and even sending nil reports daily to the national system. A senior health official said Gujarat's reporting rate was 82% in the first month between March 1 and 31.

JIGNESH VORA

Gujarat has th
in India as over 1,
tres continued to
on the Integrated
Platform (IHIP). T
Integrated Dis
Programme (IDSI
Gujarat's heat
is at least 25% h

other states or Union Territories (UTs) in India. Apart from Gujarat, the list of best reporting regions include the UT of Dadra and Nagar Haveli which has more than 50% of centres reporting heat-related ailments.

Chennai's scorching summers get hotter

Though on an upward trend, meteorologists and experts note that it is not at an alarming level. When coronavirus infections are spreading rapidly, the rising temperature and its health impact should not be forgotten, say doctors

April 11, 2021 01:24 am | Updated 03:56 pm IST

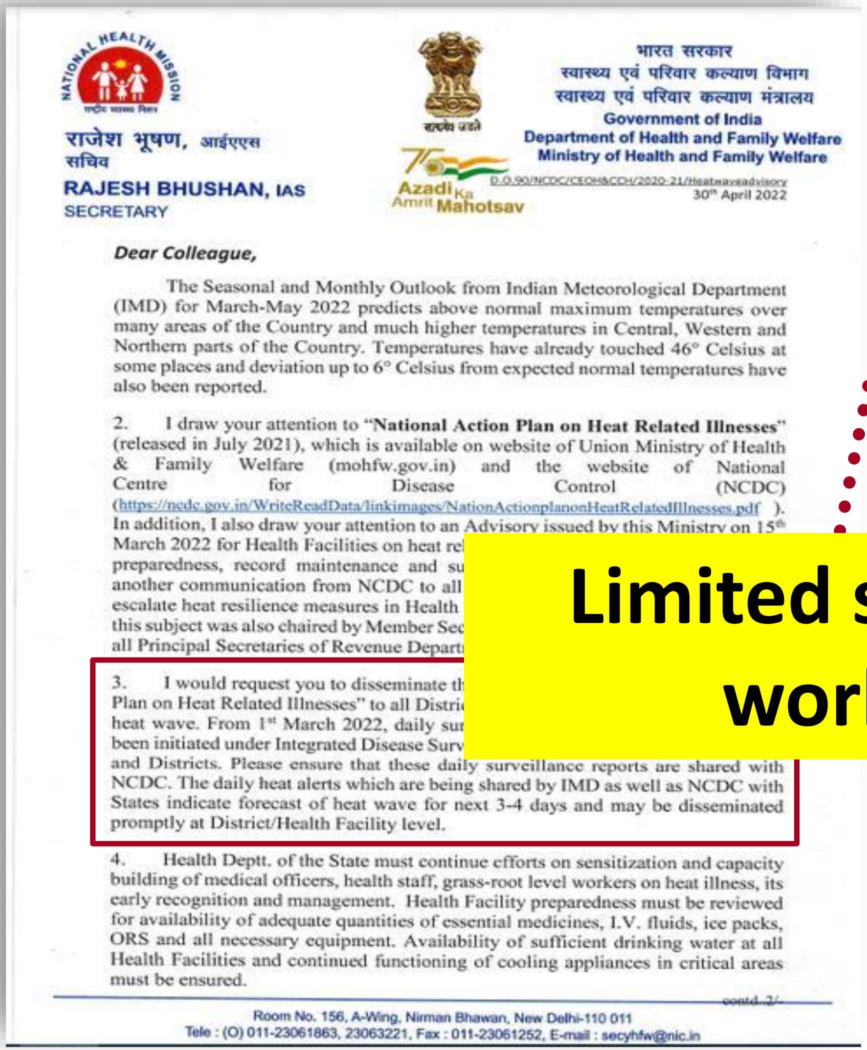
K. LAKSHMI, SERENA JOSEPHINE M.

COMMENTS SHARE READ LATER

April was **Chennai's** hottest month, with a high of **41.2°C, 7.4 degrees above average.**

Government of India - Initiatives

Central



भारत सरकार
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स्वास्थ्य एवं परिवार कल्याण मंत्रालय
Government of India
Department of Health and Family Welfare
Ministry of Health and Family Welfare

राजेश भूषण, आईएएस
सचिव
RAJESH BHUSHAN, IAS
SECRETARY

D.O.90/NCDC/CEOH&CCH/2020-21/Heatwaveadvisory
30th April 2022

Dear Colleague,

The Seasonal and Monthly Outlook from Indian Meteorological Department (IMD) for March-May 2022 predicts above normal maximum temperatures over many areas of the Country and much higher temperatures in Central, Western and Northern parts of the Country. Temperatures have already touched 46° Celsius at some places and deviation up to 6° Celsius from expected normal temperatures have also been reported.

2. I draw your attention to "**National Action Plan on Heat Related Illnesses**" (released in July 2021), which is available on website of Union Ministry of Health & Family Welfare (mohfw.gov.in) and the website of National Centre for Disease Control (NCDC) (https://ncdc.gov.in/WriteReadData/linkimages/NationActionplanonHeatRelatedIllnesses.pdf). In addition, I also draw your attention to an Advisory issued by this Ministry on 15th March 2022 for Health Facilities on heat re[...] preparedness, record maintenance and su[...] another communication from NCDC to all [...] escalate heat resilience measures in Health [...] this subject was also chaired by Member Se[...] all Principal Secretaries of Revenue Depart[...]

3. I would request you to disseminate th[...] Plan on Heat Related Illnesses" to all Distri[...] heat wave. From 1st March 2022, daily su[...] been initiated under Integrated Disease Surv[...] and Districts. Please ensure that these daily surveillance reports are shared with NCDC. The daily heat alerts which are being shared by IMD as well as NCDC with States indicate forecast of heat wave for next 3-4 days and may be disseminated promptly at District/Health Facility level.

4. Health Deptt. of the State must continue efforts on sensitization and capacity building of medical officers, health staff, grass-root level workers on heat illness, its early recognition and management. Health Facility preparedness must be reviewed for availability of adequate quantities of essential medicines, I.V. fluids, ice packs, ORS and all necessary equipment. Availability of sufficient drinking water at all Health Facilities and continued functioning of cooling appliances in critical areas must be ensured.

contd..2/-

Room No. 156, A-Wing, Nirman Bhawan, New Delhi-110 011
Tele : (O) 011-23061863, 23063221, Fax : 011-23061252, E-mail : secyhfw@nic.in

National Heat Action Plan Dissemination

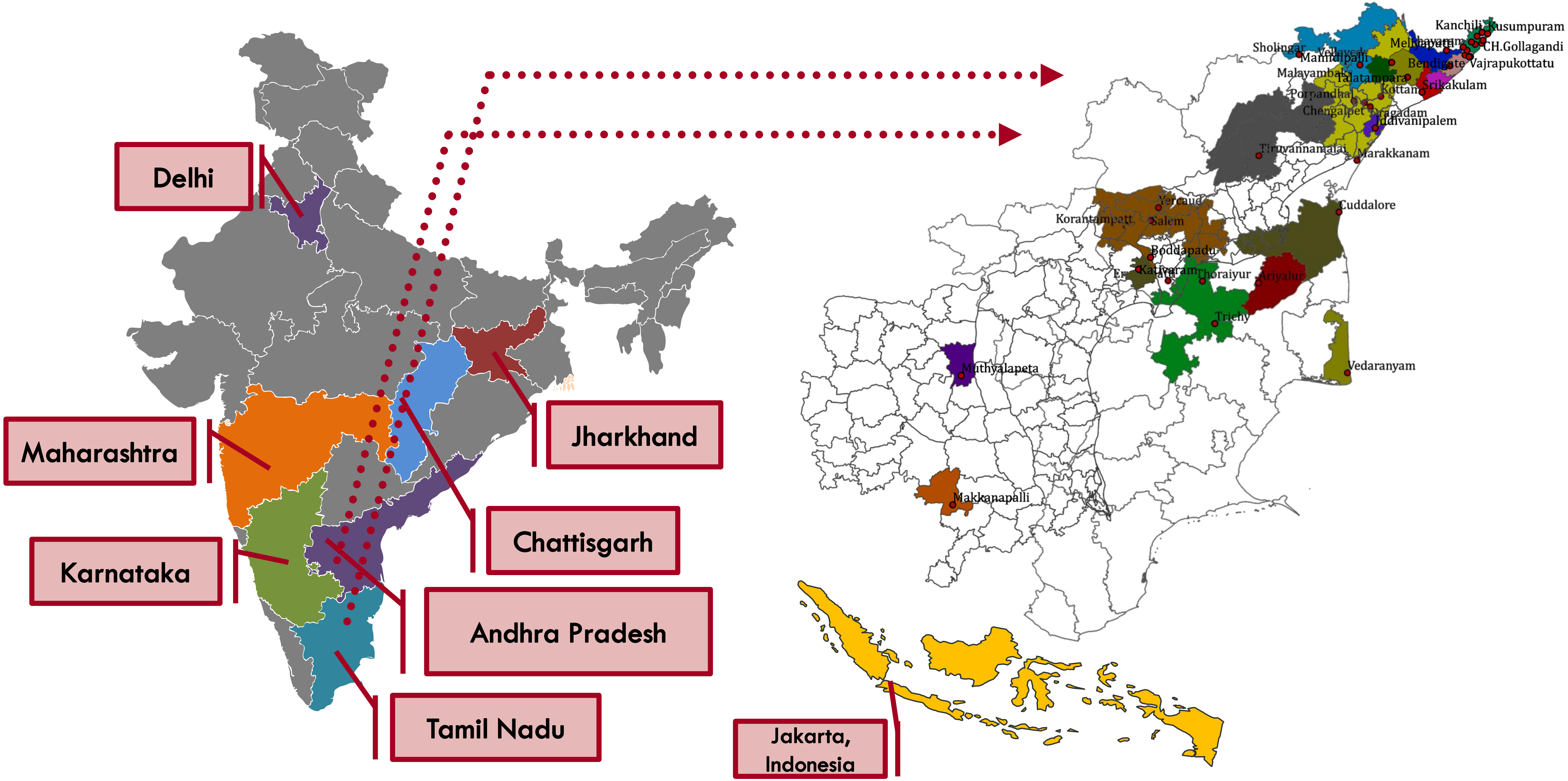
State

Public Health Education/Health Promotion in the state of Tamil Nadu

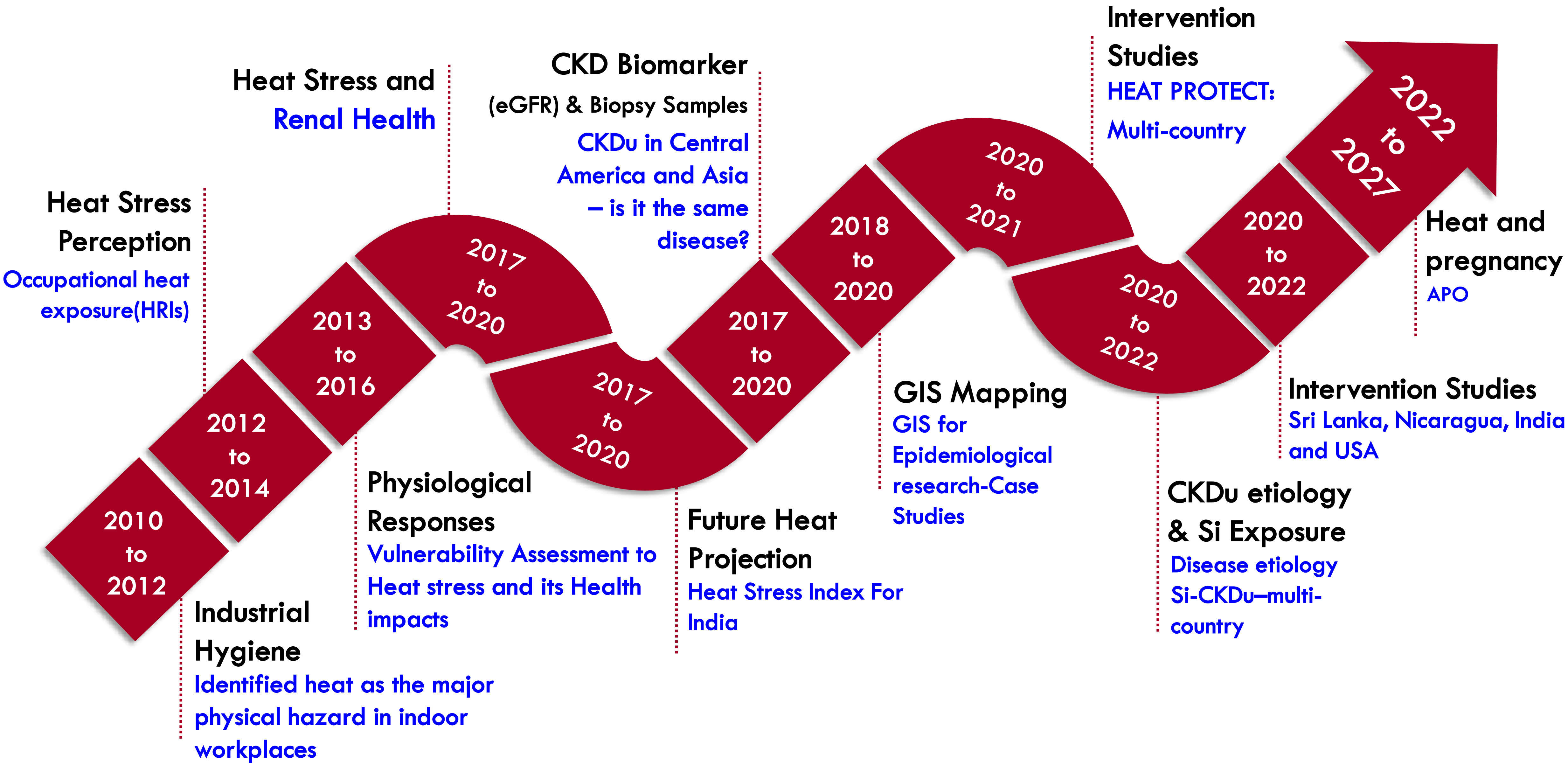
Mobile Drinking water vans are stationed in Ahmedabad Municipal Corporation

Limited scope in HAP for the working population

Our research foot prints …



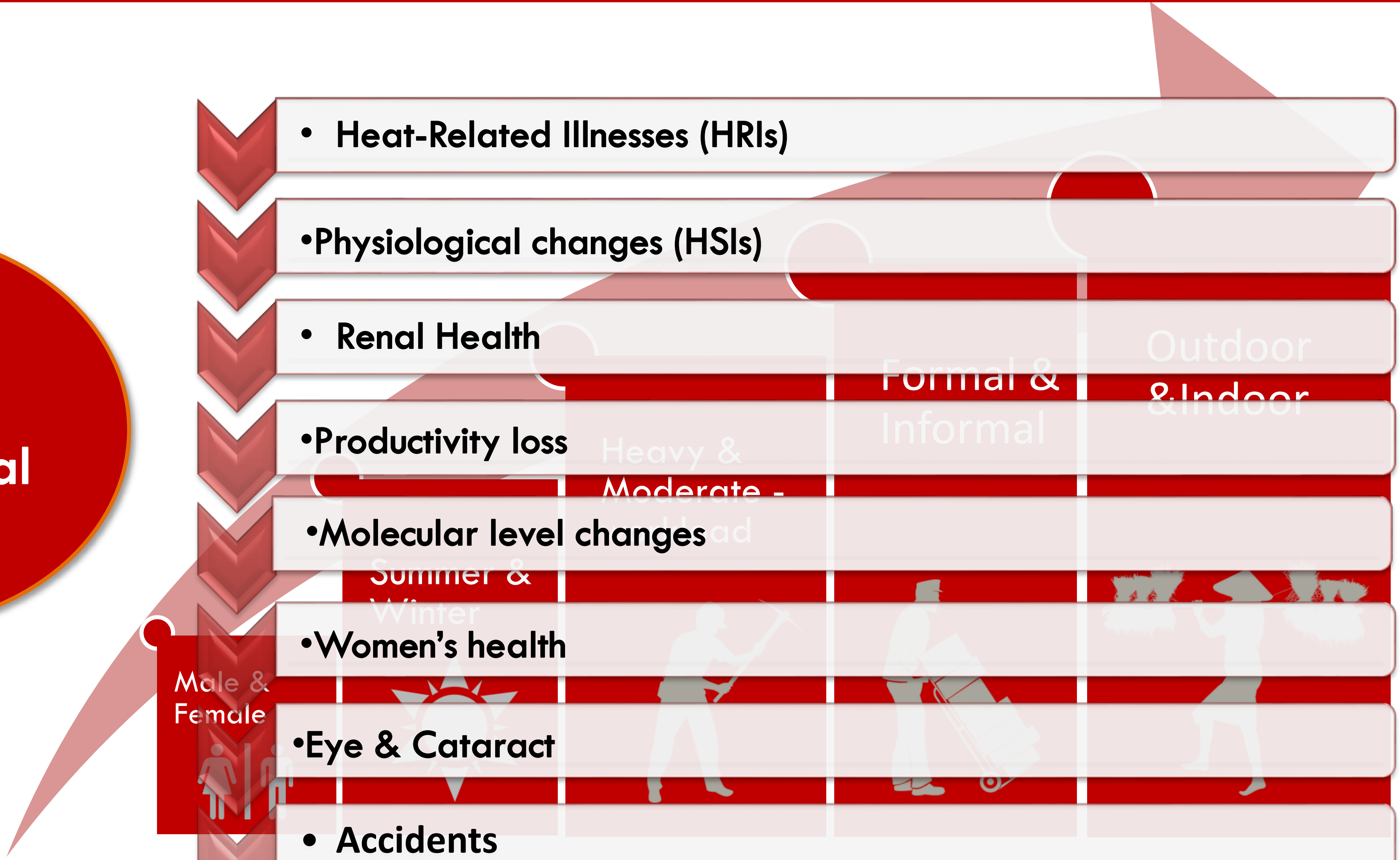
We spread our wings in HEAT RESEARCH……



Breadth and depth of our heat research …

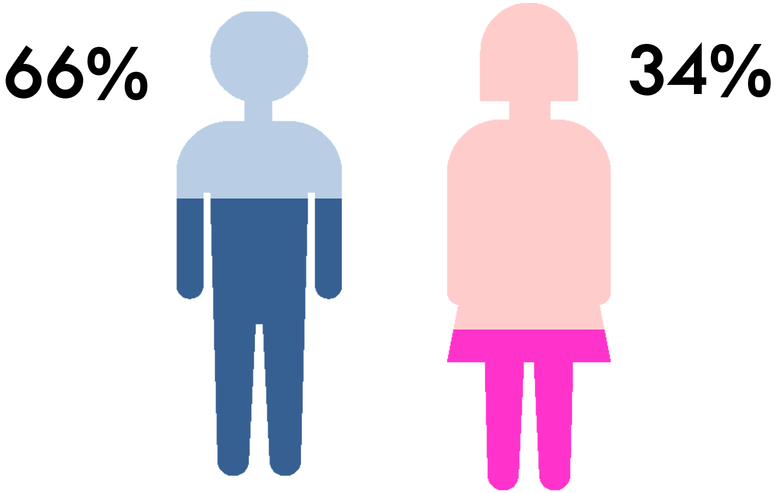
Heat & Occupational Health

- Heat-Related Illnesses (HRIs)
- Physiological changes (HSIs)
- Renal Health
- Productivity loss
- Molecular level changes
- Women's health
- Eye & Cataract
- Accidents

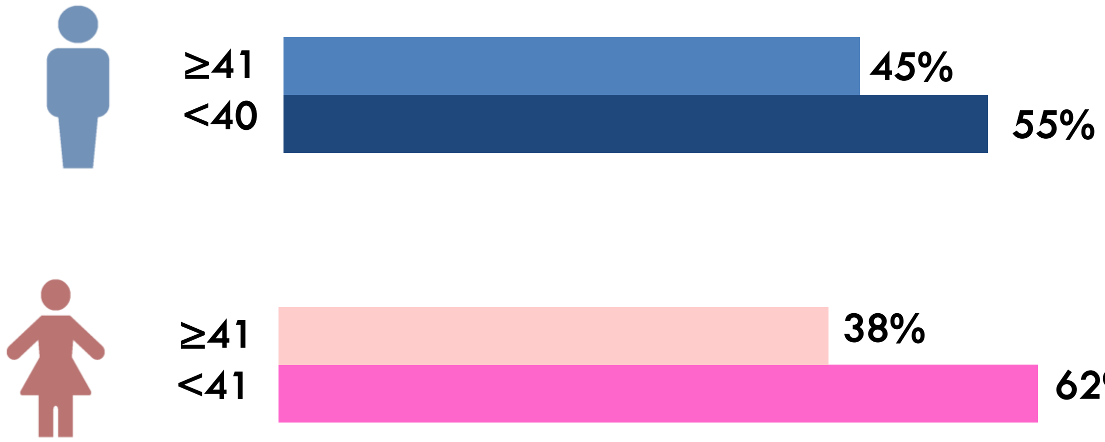


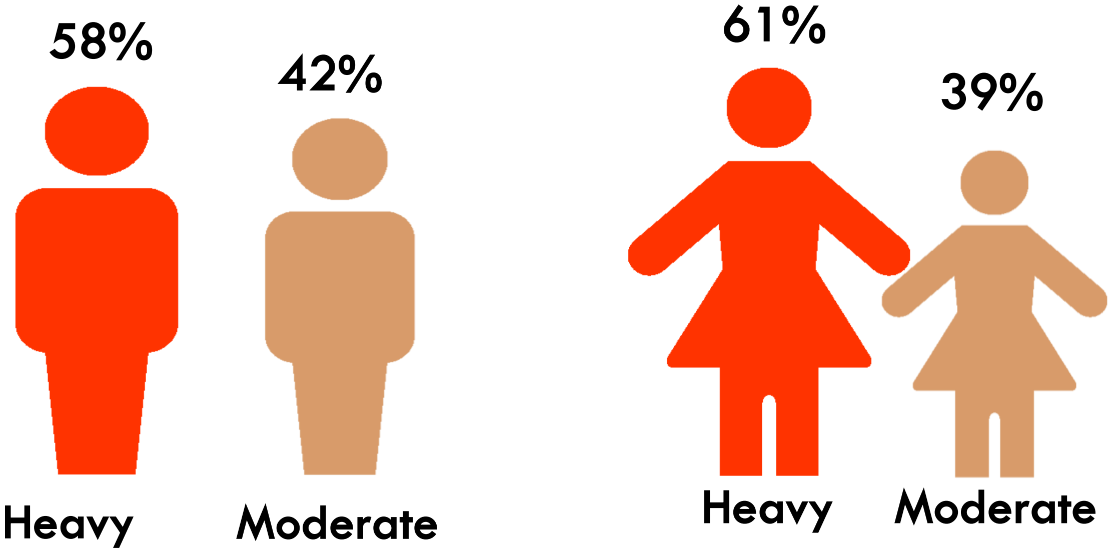
Demographics (N~4000)

Gender and Age Distribution

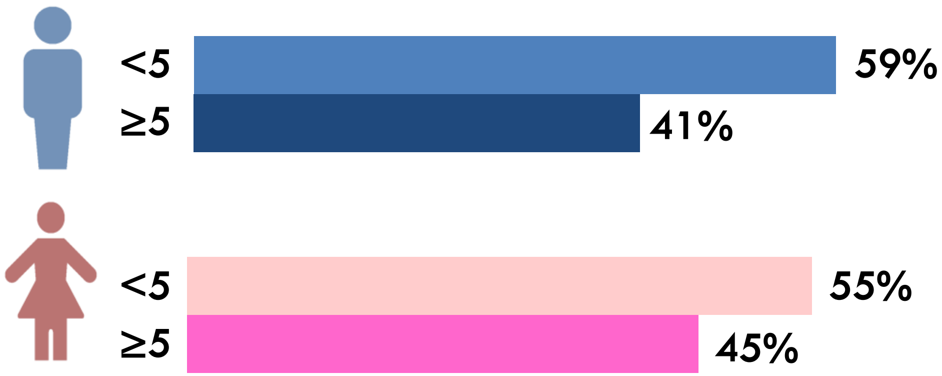


Age



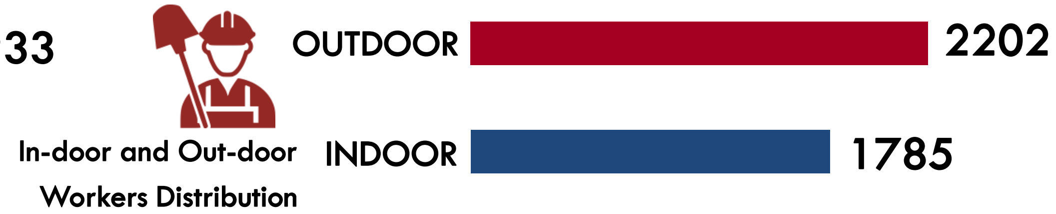


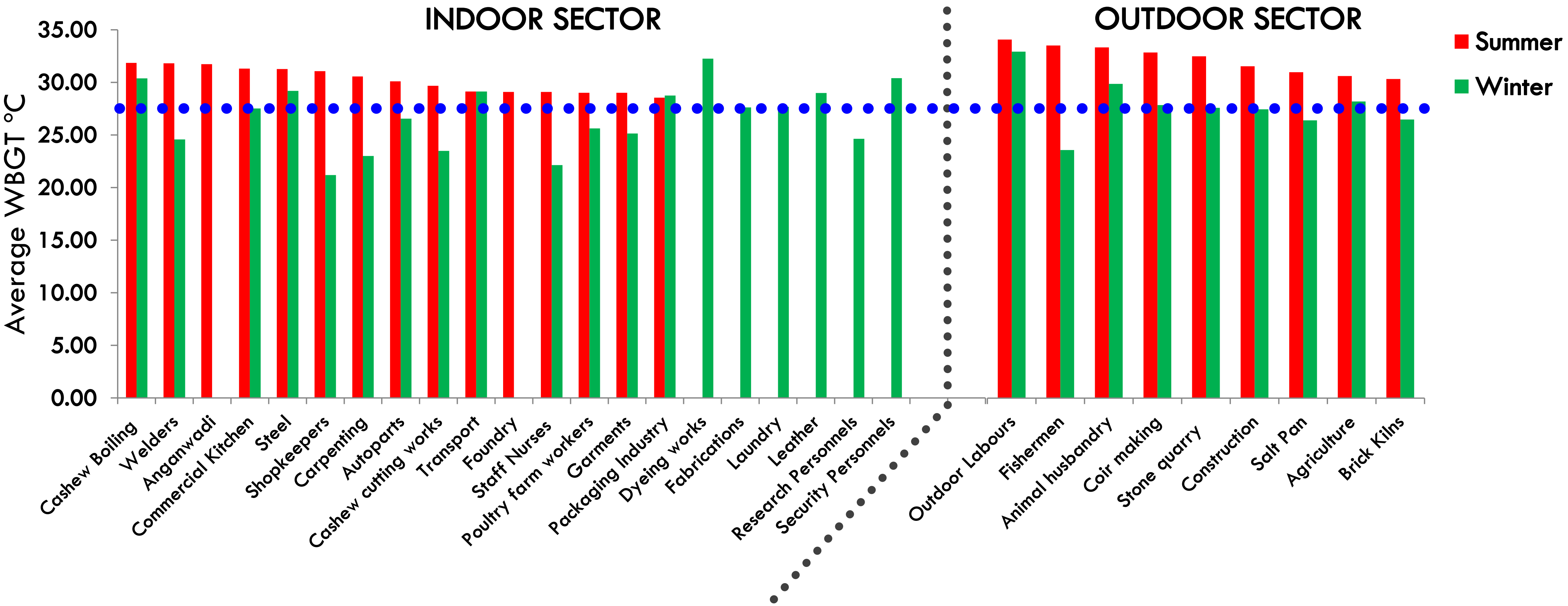
Years of Exposure



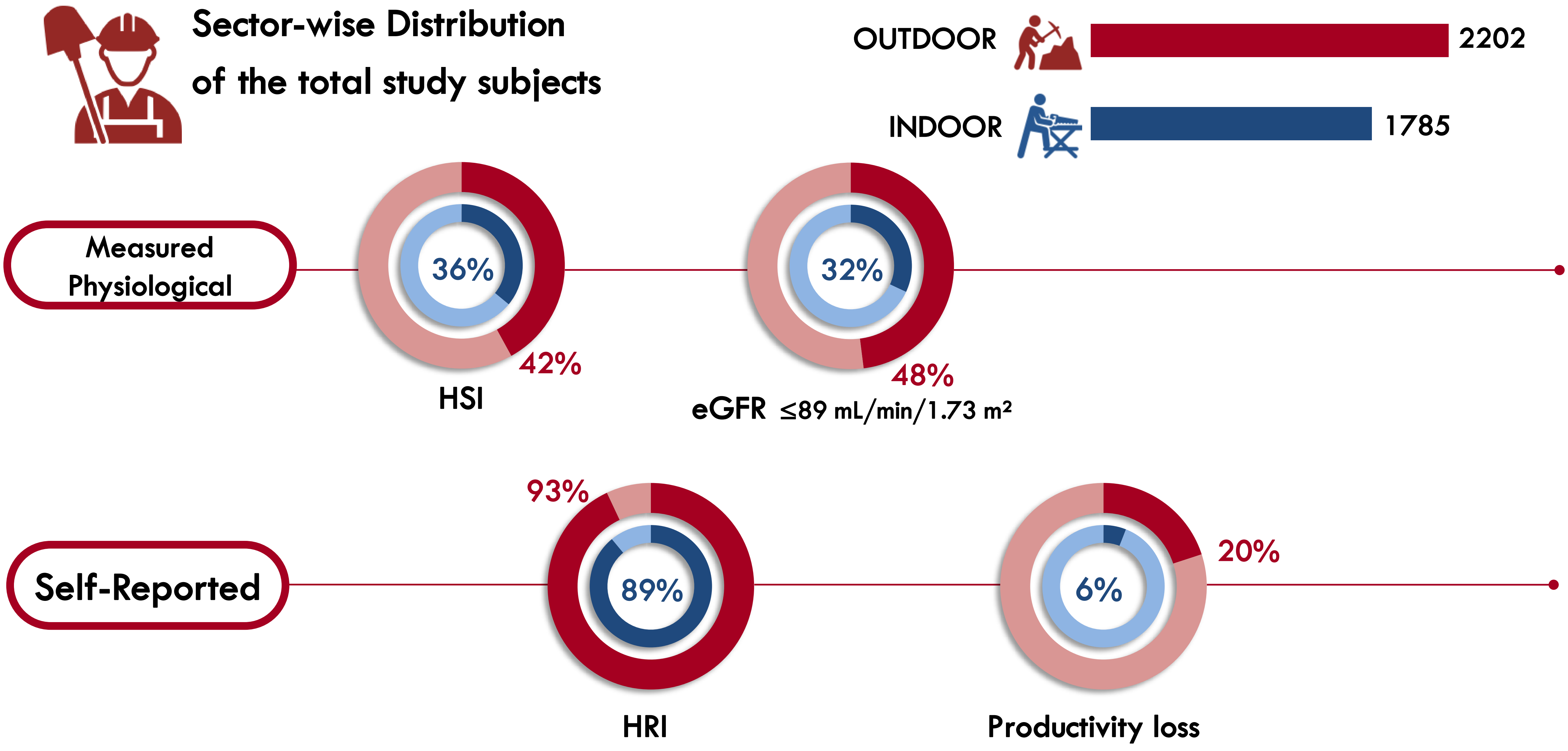
WBGT exposure in the study sectors

31 Occupation sectors





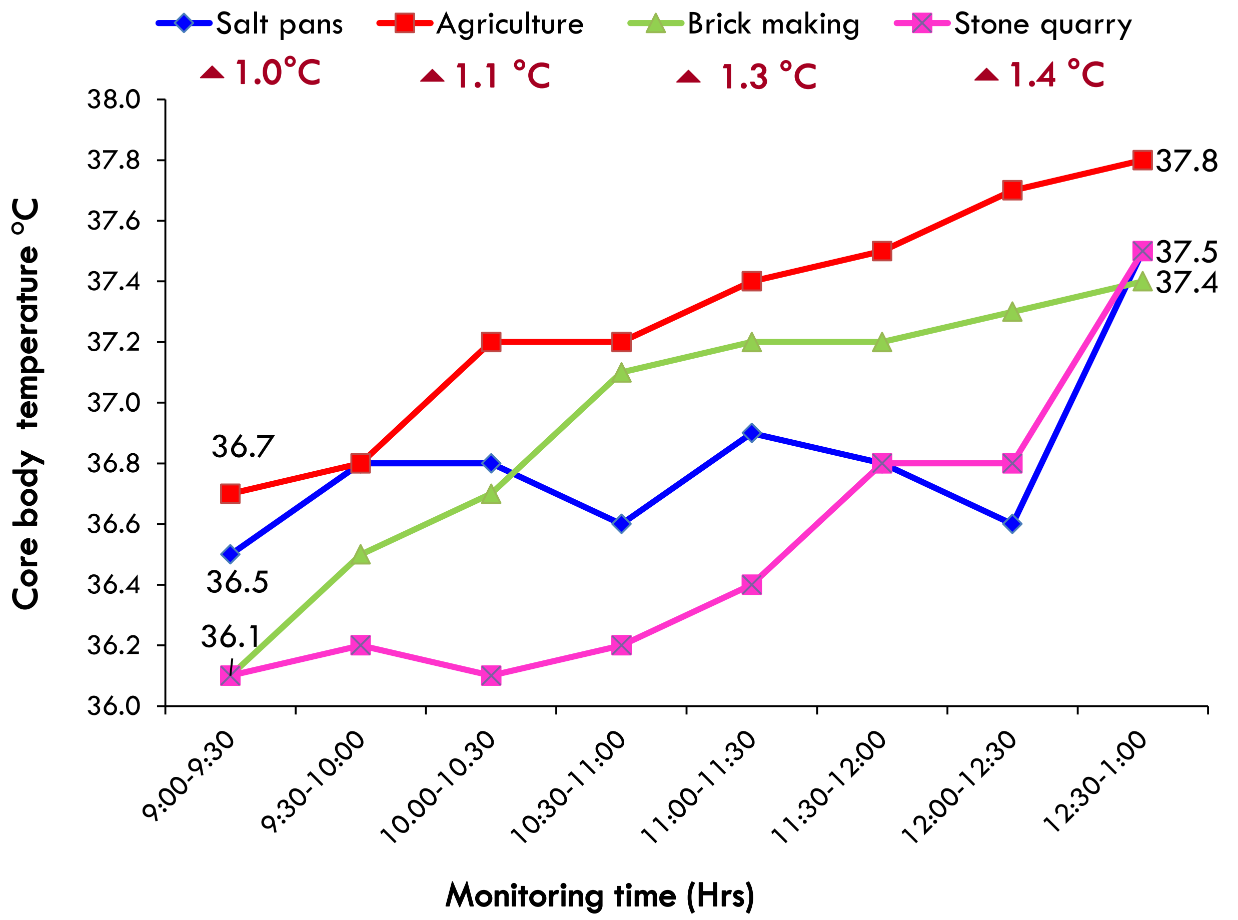
Self-reported and physiological changes



Cross-shift changes in HSIs - OUTDOOR WORKERS

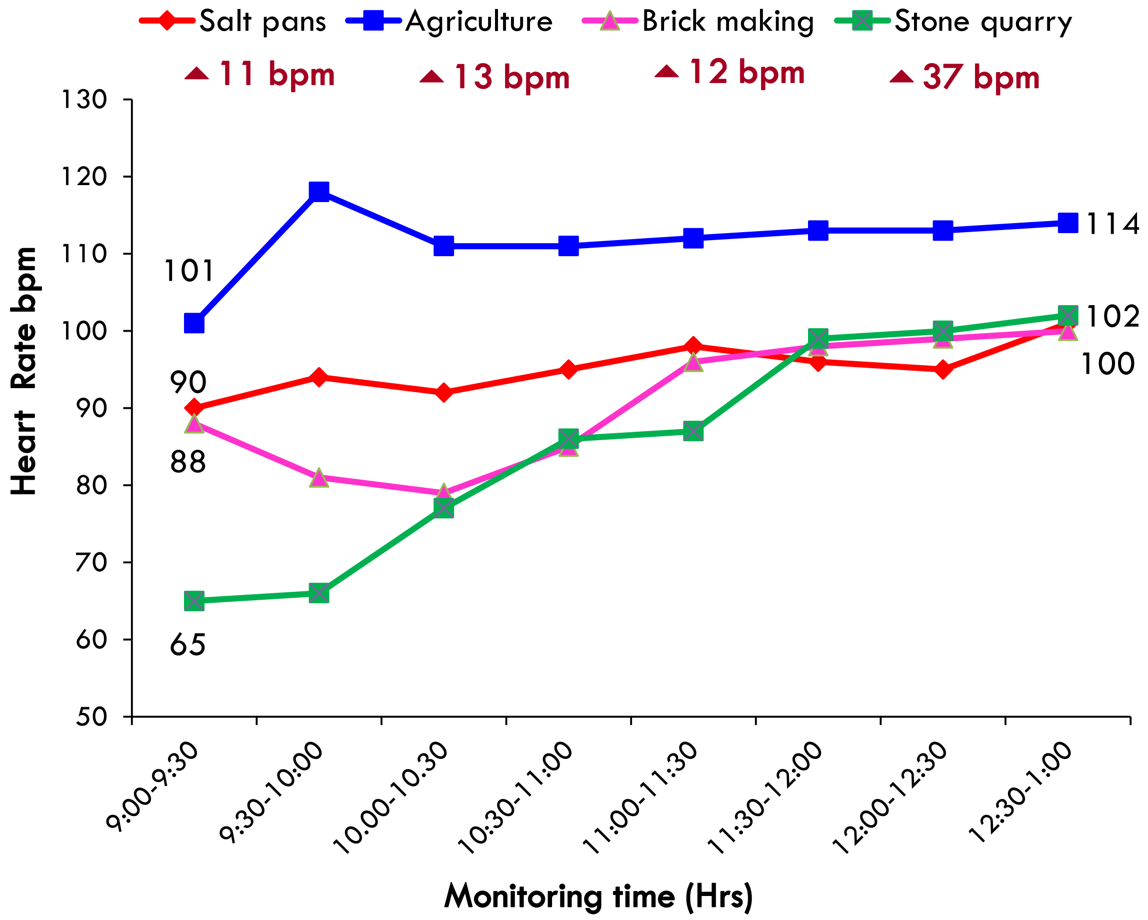
Core Body Temperature

CBT Difference ≥1: 11%



Heart rate

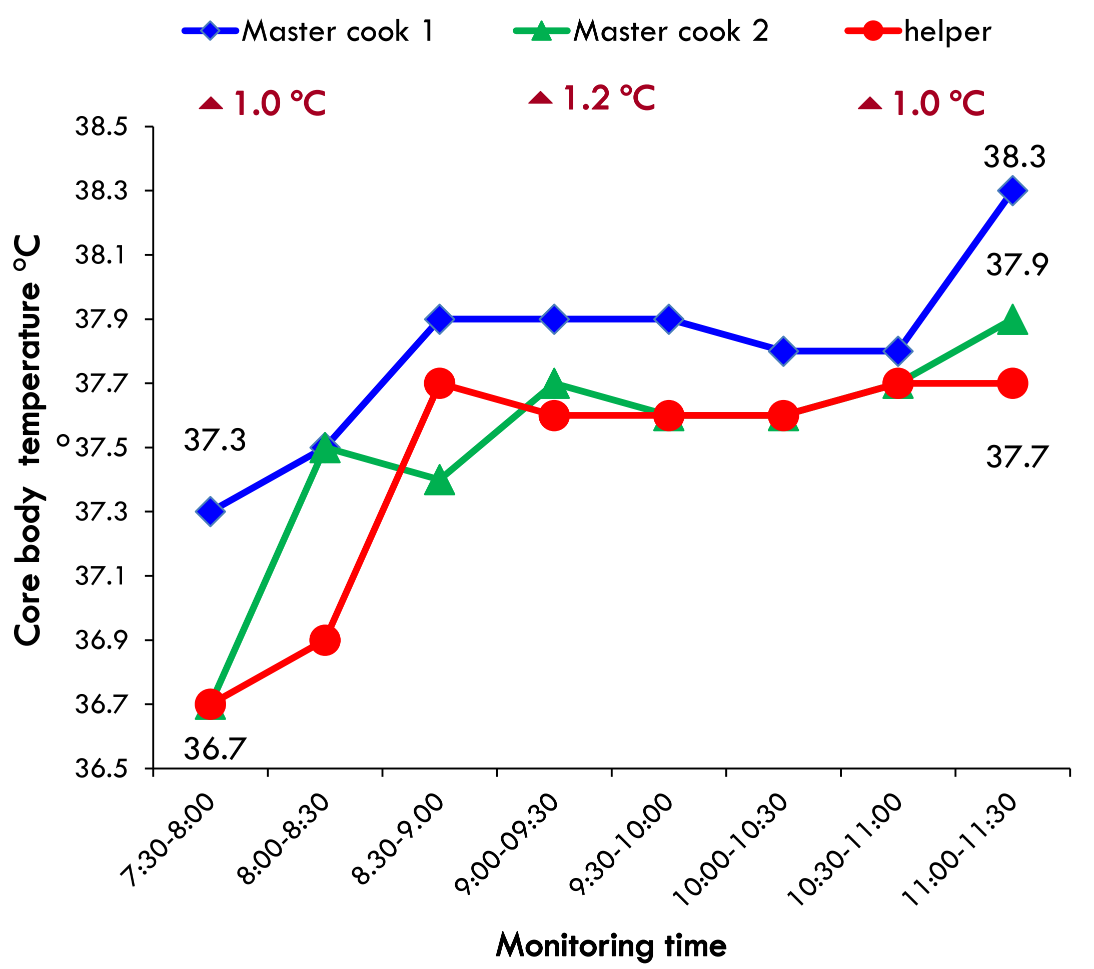
Post HR ≥100 bpm : 10 %



Trend for CBT & HR changes - INDOOR WORKERS (commercial kitchen)

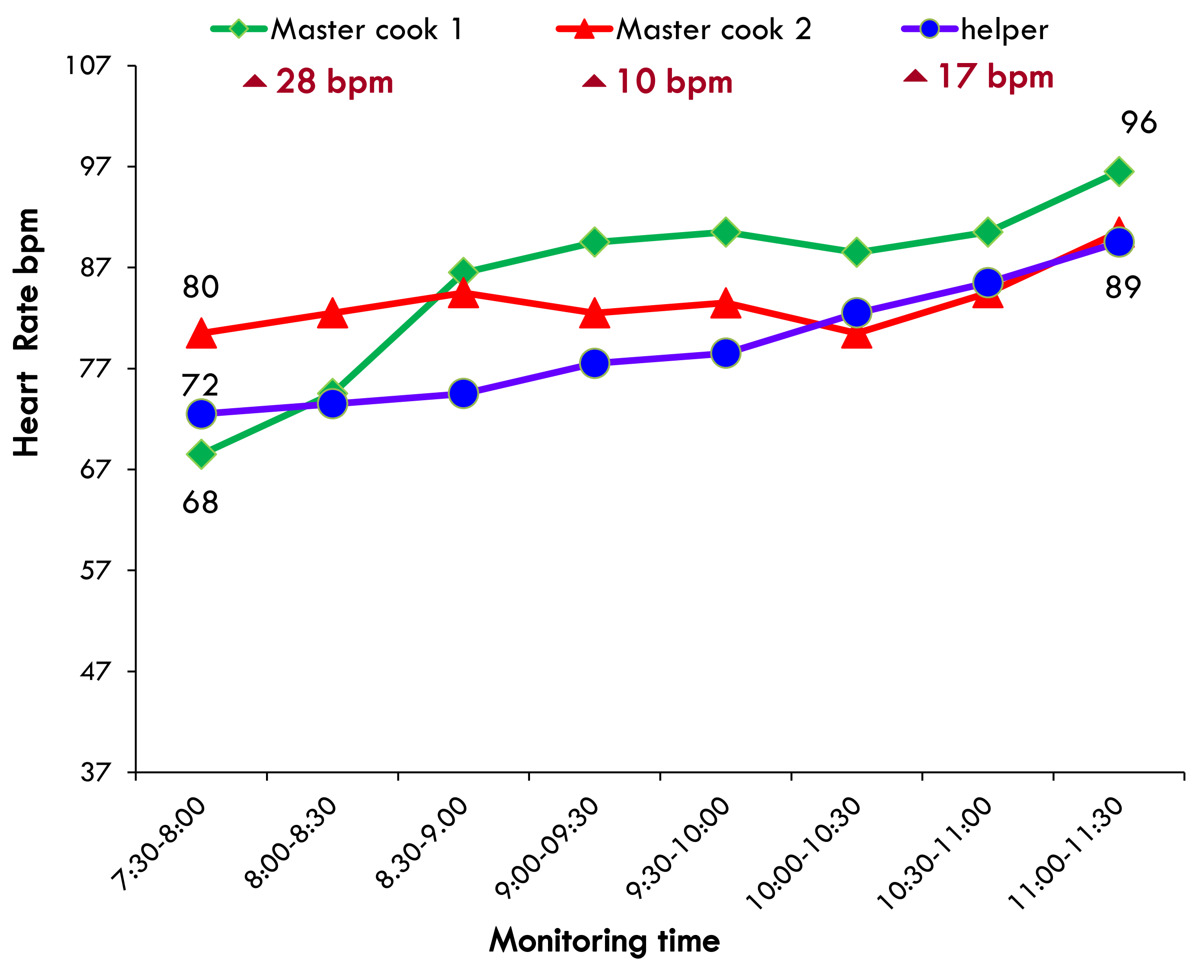
Core Body Temperature

CBT Difference ≥1 : 30 (10 %)



Heart rate

Diff in HR ≥10 bpm : 16%

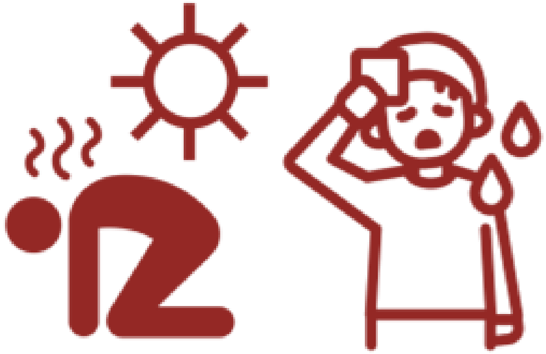


At-risk worker groups………

Study variables	Outdoor vs Indoor (ref)	Heavy vs Moderate (ref)	Informal vs Formal (ref)	Summer vs Winter (ref)	Male vs Women (ref)
	% AOR	% AOR	% AOR	% AOR	% AOR
HSI (Any one)	71 vs 29 **1.3;** (1.1- 1.5)	70 vs 30 **1.2;** (1.0 – 1.4)	68 vs 32 0.7; (0.6 – 0.8)	42 vs 29 **1.5** (1.1-1.5)	67 vs 33 **1.4** (1.1-1.6)
Kidney Health eGFR ≤89 mL/min/1.73 m^2	86 vs 14 **2.3;** (1.7 - 3.0)	70 vs 30 **1.4;** (1.1 – 1.8)	85 vs 15 0.4; (0.3 - 0.6)	63 vs 37 **2.1;** (1.6 - 2.7)	64 vs 35 **3.9;** (3.1 – 4.8)
Productivity Loss	66 vs 34 **1.4;** (1.1 - 1.7)	72 vs 28 **1.8;** (1.5 - 2.2)	66 vs 34 **1.8;** (1.5 - 2.2)	67 vs 37 **1.2;** (1.0 - 1.5)	59 vs 41 NA

Note: *AOR: Adjusted for smoking, alcohol & Years of Exposure*

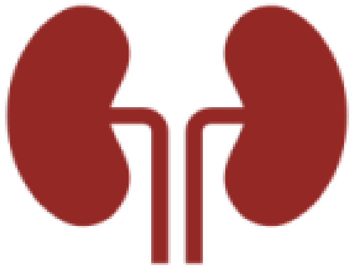
Heat Exposure consequences….
(N~4000)



HSI & HRI symptoms

AOR: 1.3*

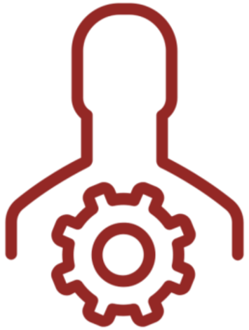
95% CI: 1.1 – 1.5



Kidney Health

AOR: 2.3*

95% CI: 1.7 – 3.0



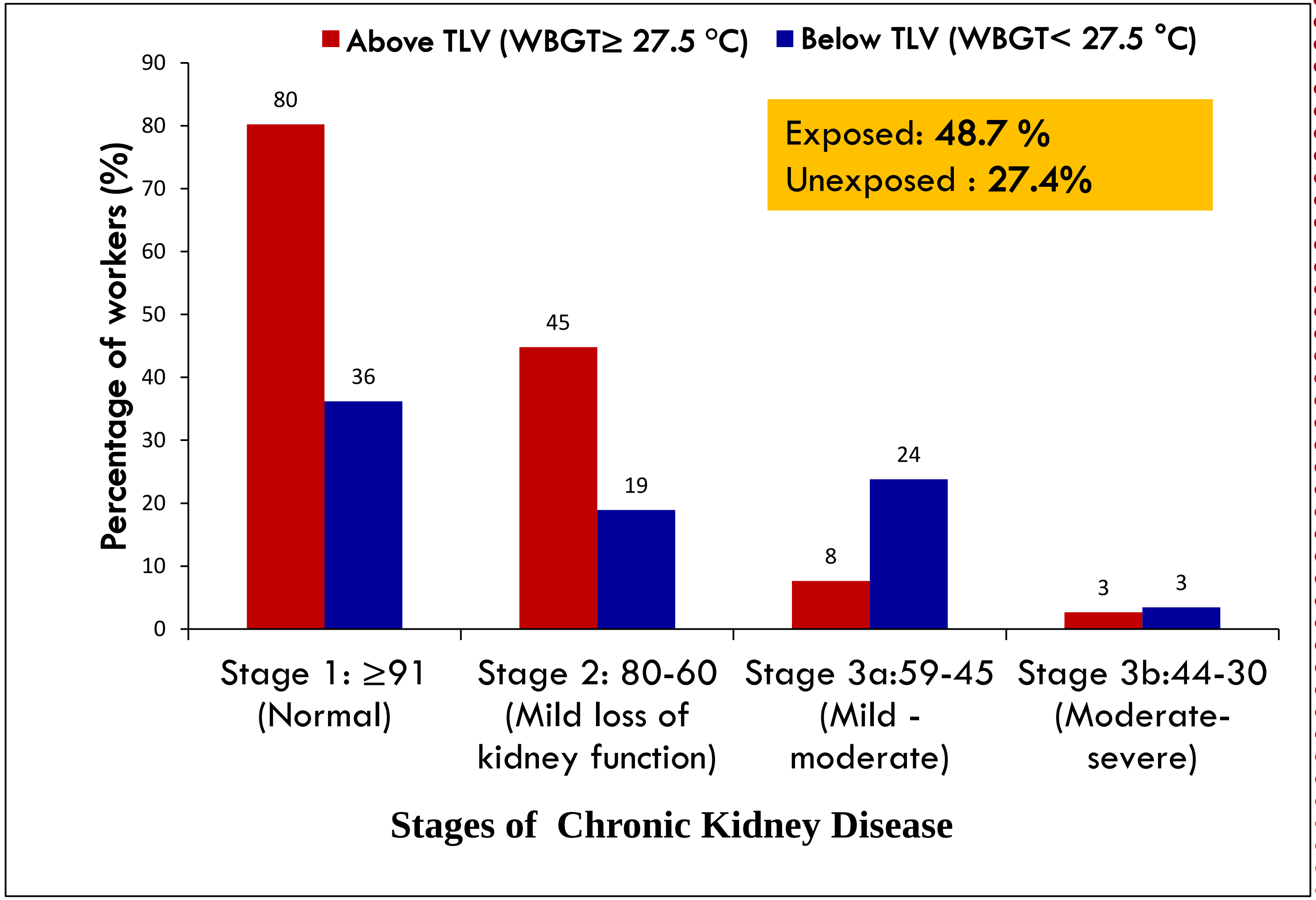
Productivity Loss

AOR: 1.4*

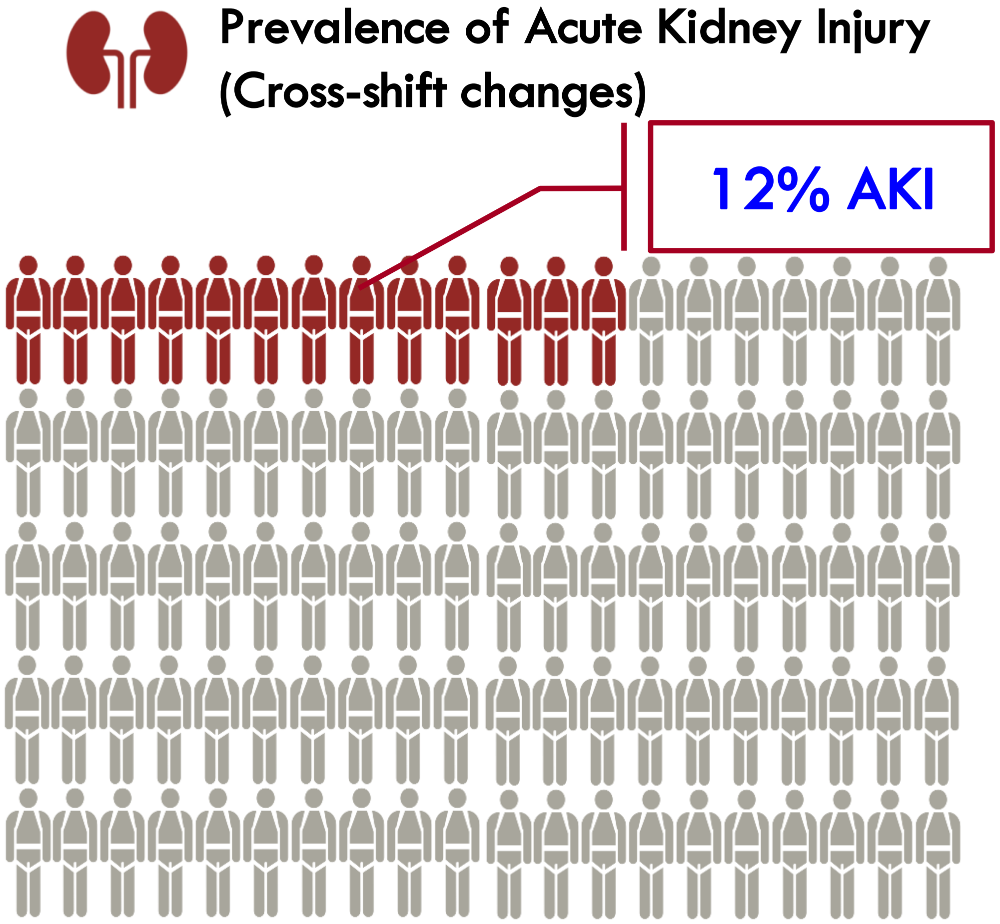
95% CI: 1.1 – 1.7

Heat and kidney health (eGFR) (N~1550)

Chronic conditions



Acute conditions



Heat & kidney stones in indoor occupational settings

340 workers from steel industry

91 steel workers subjected to renal ultrasound

Clinical judgment & referral of a qualified Occupational Health physician.

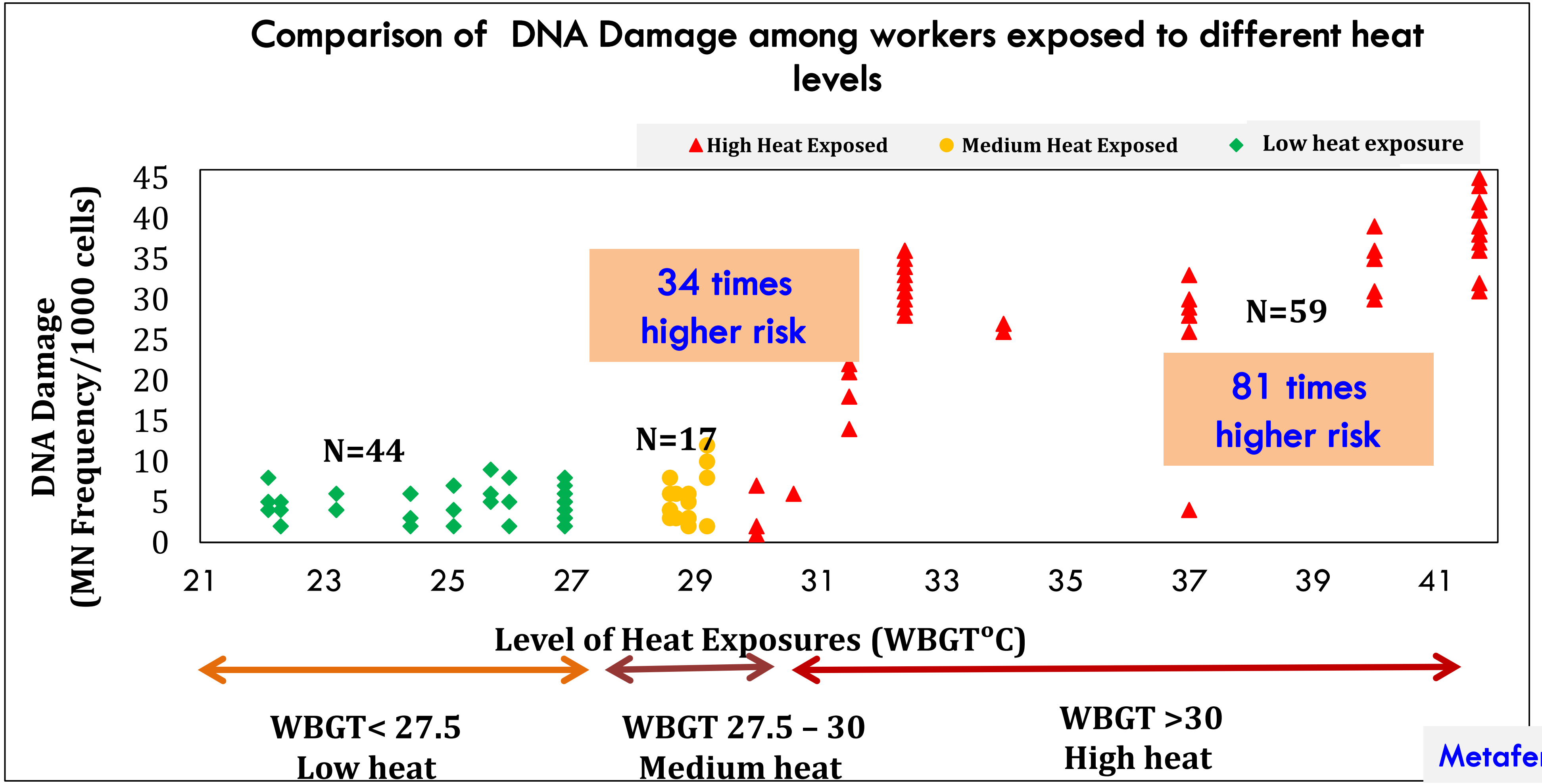
33%

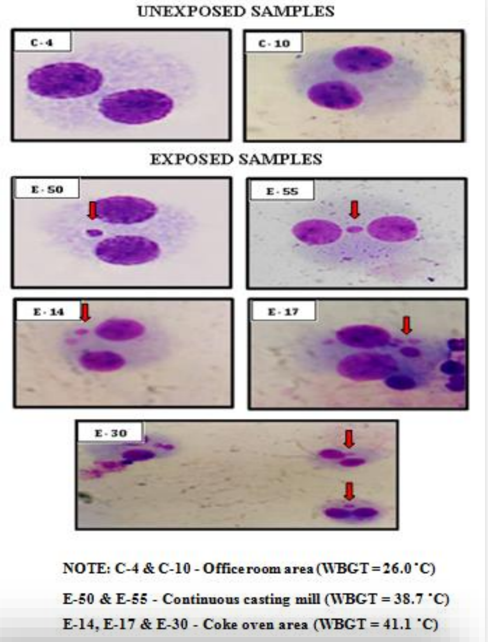
30 had positive results for structural renal anomalies (cystic kidney, kidney/urethral stones, urethral stricture)

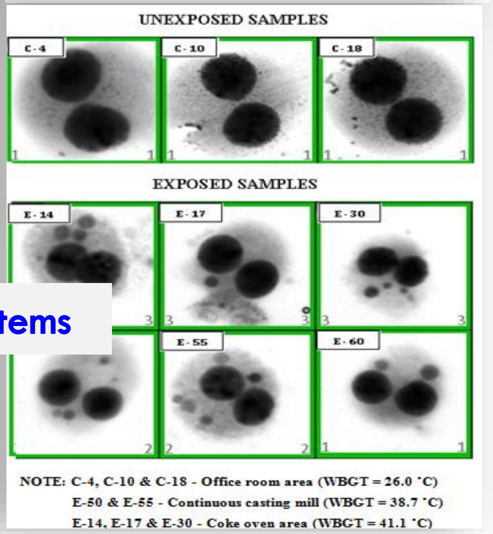
Of the 30 workers, **25 workers diagnosed with renal stones.** Workers were from the hot zones.

9% Prevalence of kidney stones

Heat impacts @ molecular level..







Metafer Systems

Note: ∞ Adjusted for smoking, alcohol & Years of Exposure;. N: DNA damage present

Heat & Women's Health…..

Heat & lack of toilets

66% About **597** women had inadequate access to toilet facilities @ work.

- 94% — HRIs & HSI
  AOR: 1.7*
  95% CI: 1.2 – 2.7
- 76.5% — Urinogenital issues
  AOR: 1.5*
  95% CI: 1.1 – 2.1

Heat Impact on pregnancy

3 Trimesters

32% AOR: 3.5*
95% CI: 1.7 – 6.9

Of the **250** pregnant mothers **39** mothers had Adverse Pregnancy Outcomes.

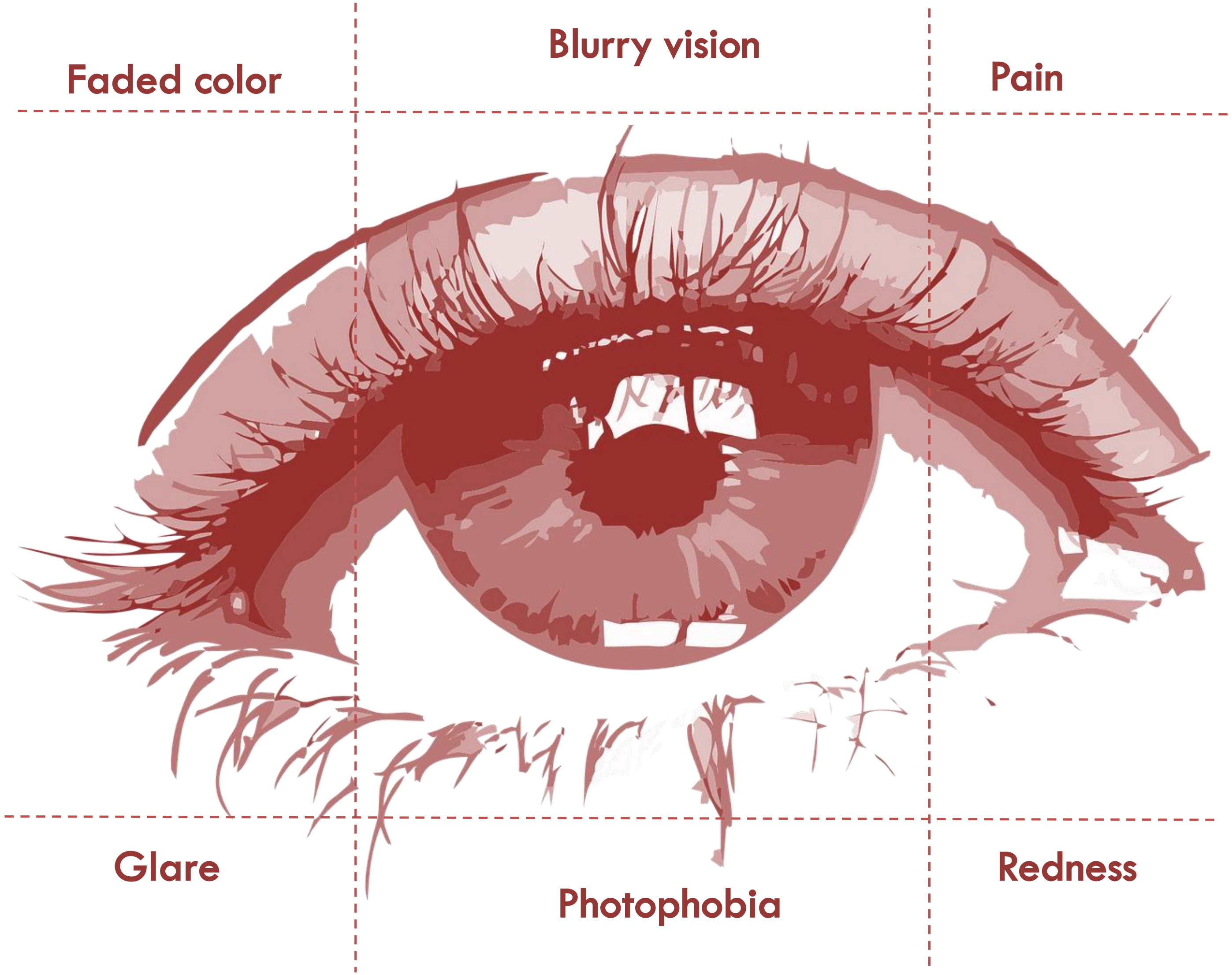
- 87% — Urinogenital & HRIs/HSI
- 22% — Adverse outcome at birth
  AOR: 2.7*
  95% CI: 1.2 – 6.3
- 10% — Miscarriage or Spontaneous abortion
  AOR: 3.8*
  95% CI: 1.1 – 13.0

Adverse Pregnancy outcomes (APO)

- All adverse Pregnancy outcomes (Miscarriage, PTB, still birth, IUGR, birth defect)
- Adverse outcome at birth: PTB, LBW, still birth, IUGR, birth defect
- Miscarriage or Spontaneous abortion

Note: *$^{\infty}$ Adjusted for Age, Education, SES, & BMI*

Heat & eye disorders (N~3000)



Heat Exposed Group population has symptoms of eye-related illnesses.

13.3%

Odds Ratio
1.5
CI: 1.1 – 1.8

Heat and accidents (N~3000)

Workers with Heavy workload had higher incidence of accidents, injuries and disabilities.

7%

Odds Ratio

3.8

95% CI: 1.8 – 16.8

Key findings……..

Exposure

65.2% of the workers are working above the ACGIH-TLV, with over **34.8%** workers working >TLVs in summer.

Self-Reported

Among the heat-exposed workers, **92.5%** reported experiencing **heat strain symptoms** irrespective of the season.

15% reported **productivity loss**

Measured Physiological changes

Prevalence of HSI **(43.4%)** was higher in **summer** and for workers with **heavy workload.**

Renal Health

49% prevalence of eGFR ≤89 mL/min/1.73 m^2 and **significantly associated** with level of heat exposure, work category, and occupation

Women Health

Lack of **sanitation** and **toilet** facilities – additional risk factors **32%** reported APO and was significantly associated with heat exposure after adjusting for potential confounders.

Vulnerable groups: Informal workers, performing heavy workload & outdoors

Evidence for Heat on Renal health

Contents lists available at ScienceDirect

OSHRI

Safety and Health at Work

journal homepage: www.e-shaw.org

SH@W

Original Article

Occupational Heat Stress Impacts on Health and Productivity in a Steel Industry in Southern India

CrossMark

Manikandan Krishnamurthy, Paramesh Ramalingam, Kumaravel Perumal, Latha Perumal Kamalakannan, Jeremiah Chinnadurai, Rekha Shanmugam, Krishnan Srinivasan, Vidhya Venugopal*

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A R T I C L E I N F O

Article history:
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4 August 2016
Accepted 5 August 2016
Available online 3 November 2016

Keywords:
climate change
health risks
occupational heat stress
productivity loss
steel industry

A B S T R A C T

Background: Workers laboring in steel industries in tropical settings with high ambient temperatures are subjected to thermally stressful environments that can create well-known risks of heat-related illnesses and limit workers' productivity.

Methods: A cross-sectional study undertaken in a steel industry in a city nicknamed "Steel City" in Southern India assessed thermal stress by wet bulb globe temperature (WBGT) and level of dehydration from urine color and urine specific gravity. A structured questionnaire captured self-reported heat-related health symptoms of workers.

Results: Some 90% WBGT measurements were higher than recommended threshold limit values (27.2–41.7°C) for heavy and moderate workloads and radiational heat from processes were very high in blooming-mill/coke-oven (67.6°C globe temperature). Widespread heat-related health concerns were prevalent among workers, including excessive sweating, fatigue, and tiredness reported by 50% workers. Productivity loss was significantly reported high in workers with direct heat exposures compared to those with indirect heat exposures ($\chi^2 = 26.1258$, degrees of freedom = 1, $p < 0.001$). Change in urine color was 7.4 times higher among workers exposed to WBGTs above threshold limit values (TLVs).

Conclusion: Preliminary evidence shows that high heat exposures and heavy workload adversely affect the workers' health and reduce their work capacities. Health and productivity risks in developing tropical country work settings can be further aggravated by the predicted temperature rise due to climate change, without appropriate interventions. Apart from industries enhancing welfare facilities and designing control interventions, further physiological studies with a seasonal approach and interventional studies are needed to strengthen evidence for developing comprehensive policies to protect workers employed in high heat industries.

PDF

0223 Occupational heat exposures in industries and renal health – findings from india FREE

Vidhya Venugopal , Latha Kamalkannan , Rekha Shanmugam , Manikandan Krishnamoorthy , Jeremiah Chinnadurai , Kumaravel Perumal

Abstract

Statement of the Problem: Workers labouring in high thermally stressful environments are subjected to heat-strain and risks of heat-related health issues.

Methodology A cross-sectional study was conducted with ~700 workers engaged in heavy/moderate labour from various organised occupational sectors in India. Wet Bulb Globe Temperatures(WBGT) and heat-strain indicators such as Core-body-temperature(CBT), Heart-Rate(HR), Sweat-Rate(SwR), Urine-Specific-Gravity(USG) were measured. A questionnaire captured self-reported health symptoms of workers.

Findings About 73% of the WBGT measurements were above prescribed limits(Range:26.5°C–38.7°C) and WBGT>31.0°C was associated with significantly more heat-related health concerns among workers(89% vs 34%). Measured heat-strain indicators were above accepted levels for 60% workers, 72% had symptoms of dehydration and 49% suffered from urogenital issues. Workers had 1.4 times higher odds of heat-strain at WBGTs>29.0°C(CI 1.06 to 1.95; p=0.019), that was more pronounced during hotter seasons (CI 1.41 to 2.53; OR=1.9, p<0.0001) with significant increases in heat-related illnesses(X2=66.088; p=4.311e-16) and productivity losses(X2=62.68;p=0.024*1012). High prevalence of kidney stones and adverse renal issues(9%) in steel industry was significantly associated with years of chronic heat exposures(t=−2.3823, df=66.628, p-value=0.02006, 95% CI 0.44–0.03).

Conclusion The results demonstrate that high-heat conditions and minimum cooling interventions that are common in many occupations could create a 'silent epidemic' of kidney-related illnesses without appropriate work practices in tropical settings. The study results warrant an urgent need for further in-depth research with a multi-targeted seasonal approach to identify causalities and to develop and implement appropriate preventive measures to avert adverse effects of heat on the working population in the rising temperature scenario as Climate Change proceeds.

Evidence for Heat & DNA damage, Indoor/Outdoor vulnerability

TEMPERATURE
https://doi.org/10.1080/23328940.2019.1632144
Taylor & Francis
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RESEARCH PAPER

Association between occupational heat stress and DNA damage in lymphocytes of workers exposed to hot working environments in a steel industry in Southern India

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ABSTRACT
Occupational heat stress apart from adverse heat-related health consequences also induces DNA damage in workers exposed to high working temperatures. We investigated the association between chronic heat exposures and Micronuclei (MN) frequency in lymphocytes of 120 workers employed in the steel industry. There was a significant increase in the MN-frequency in exposed workers compared to the unexposed workers (**X^2 = 47.1; p < 0.0001**). While exposed workers had higher risk of DNA damage **(Adj. OR = 23.3, 95% CI 8.0–70.8)** compared to the unexposed workers, among the exposed workers, the odds of DNA damage was much higher for the workers exposed to high-heat levels **(Adj. OR = 81.4; 95% CI 21.3–310.1)** even after adjusting for confounders. For exposed workers, years of exposure to heat also had a significant association with higher induction of MN **(Adj. OR = 29.7; 95% CI 2.8–315.5)**. Exposures to chronic heat stress is a significant occupational health risk including damages in sub-cellular level, for workers. Developing protective interventions to reduce heat exposures is imperative in the rising temperature scenario to protect millions of workers across the globe.

ARTICLE HISTORY
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KEYWORDS
Occupational heat stress; physiological strain; DNA damage; lymphocyte; micronucleus

Introduction

Globally, a rise in temperatures has paved the way for health threats for millions of people [1,2]. Excess heat exposures is not only an environmental threat but also an occupational hazard for a large worker population engaged in hard manual labor in tropical settings [3] exposed to heat stress and strain [4]. Workers in high-heat industries such as iron and steel, foundries, smelters, brick-firing and ceramic, glass and rubber, bakeries, commercial kitchens, and mining are already subjected to high heat exposures on a day-to-day basis and have high potential for heat-related illnesses like heat exhaustion, heat stroke, and death [5–9] which is likely to increase in the future climate change scenario [10,11].

According to the reports of global climate risk index [12], India is classified under the most vulnerable regions exposed to extreme weather conditions with resulting huge economic loss due to heat-induced decreased health, work capacity, productivity consequences, and fatalities [8,13,14]. In particular, the southern region is most influenced by climatic fluctuations [15], has high-heat conditions for the most part of the year that largely influences the indoor workplace temperatures [16] further worsened by heat generated from the processes with consequent undesirable health and productivity [10,17–19].

Earlier reports have shown that heat stress not only inhibits DNA repair processes but can also act as a DNA damaging agent [20,21]. Some animal and human studies concluded that oxidative stress is the main factor responsible for DNA damage caused by heat stress [20,22]. The oxidative stress and resultant altered cellular redox environment within the cells cause protein degradation, DNA damage, cell death [23], compromised sperm quality and an increased risk of infertility [24,25]. It was reported that workers exposed to high heat conditions had high levels of DNA damage and over-expression of HSP70 levels [26,27]. Rocket et al. [28] showed that the expression of a number of DNA repair genes such Ogg1, XPG and Rad54 were all down-regulated when DNA

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LETTER

Heat-health vulnerabilities in the climate change context—comparing risk profiles between indoor and outdoor workers in developing country settings

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Keywords: climate change, occupational heat stress, physiological heat strain, dehydration, indoor organized sector, outdoor unorganized sector

Abstract
Occupational heat stress is a crucial risk factor for a range of Heat-Related Illnesses (HRI). Outdoor workers in unorganized work sectors exposed to high ambient temperatures are at increased risk in developing countries. We aim to compare HRI, Productivity Loss (PL), and reduced renal health risk between workers from outdoor unorganized (N = 1053) and indoor organized (N = 1051) work sectors. Using descriptive methods and a large epidemiological cross-sectional study using mixed methods, we compared risk patterns between the two groups. We analyzed the risk of self-reported HRI symptoms, Heat Strain Indicators (HSIs), PL, and reduced kidney function using Multivariate Logistic Regression (MLR) models. Although Wet Bulb Globe Temperature (WBGT) exposures were high in both the outdoor and indoor sectors, significantly more Outdoor Unorganized Workers (OUWs) reported heat stress symptoms (45.2% vs 39.1%) among 2104 workers. OUWs had a significantly higher share of the heavy workload (86.7%) and long years of heat exposures (41.9%), the key drivers of HRIs, than the workers in indoor sectors. MLR models comparing the indoor vs outdoor workers showed significantly increased risk of HRI symptoms (Adjusted Odds Ratio) ($AOR_{outdoor}$ = 2.1; 95% C.I:1.60–2.77), HSI ($AOR_{outdoor}$ = 1.7; 95% C.I:1.00–2.93), PL ($AOR_{outdoor}$ = 11.4; 95% C.I:7.39–17.6), and reduced kidney function (Crude Odds Ratio) ($COR_{outdoor}$ = 1.4; 95% C.I:1.10–1.84) for the OUWs. Among the heat-exposed workers, OUW had a higher risk of HRI, HSI, and PL even after adjusting for potential confounders. The risk of reduced kidney function was significantly higher among OUWs, particularly for those with heat exposures and heavy workload ($AOR_{outdoor}$ = 1.5; 95% C.I: 0.96–2.44, p = 0.073) compared to the indoor workers. Further, in-depth studies, protective policies, feasible interventions, adaptive strategies, and proactive mitigation efforts are urgently needed to avert health and productivity risks for a few million vulnerable workers in developing nations as climate change proceeds.

Publications on Heat o Women's health

CLIMANOSCO
Climate Science for Everyone

Heat stress and inadequate toilet access at work places in India – a potential hazard to working women in a changing climate

By Vidhya Venugopal, Rekha Shanmugam, Priscilla Johnson, Rebekah Ann Isabel Lucas and Kristina Jakobsson, 1 October 2019

Article information

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RESEARCH

In the past few decades, increasingly blistering heat d
change has created more illnesses and claimed more
issue mostly ignored because it's an invisible hazard a
document disaster. Victims are usually vulnerable populations, including workers exposed on a daily basis to heat, who not only suffer from heat illnesses but also from an exacerbation of existing health problems aggravated by heat and dehydration. Research has proved that heat is a

and Research (deemed to be University), Chennai, Tamil Nadu, India
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PMCID: PMC5025522
PMID: 27633034

Heat stress and inadequate sanitary facilities at workplaces – an occupational health concern for women?

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Background

Health concerns unique to women are growing with the large number of women venturing into different trades that expose them to hot working environments and inadequate sanitation facilities, common in many Indian workplaces.

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Heat Stress a Risk Factor for Poor Maternal Health- Evidence from South India

Authors : Vidhya Venugopal, Rekha S.

Abstract : Introduction: Climate change and the growing frequency of higher average temperatures and heat waves hav
detrimental health effects, especially for certain vulnerable groups with limited socioeconomic status (SES) or physiologic
capacity to adapt to or endure high temperatures. Little research has been conducted on the effects of heat stress on pregna
women and fetuses in tropical regions such as India. Very high ambient temperatures may worsen Adverse Pregnanc
POs) and are a major worry in the scenario of climate change. The relationship between rising temperatures an
better understood in order to design more effective interventions. Methodology: We conducted an observation
involving 865 pregnant women in various districts of Tamil Nadu districts between 2014 and 2021. Physiologic
ndicators (HSI) such as morning and evening Core Body Temperature (CBT) and Urine Specific Gravity (USG
ed using an infrared thermometer and refractometer, respectively. A validated, modified version of the HOTHAP
was utilised to collect self-reported health symptoms. A follow-up was undertaken with the mothers to collec
regarding birth outcomes and APOs, such as spontaneous abortions, stillbirths, Preterm Birth (PTB), birt
, and Low Birth Weight (LBW). Major findings of the study: According to the findings of our study, ambien
(mean WBGT°C) were substantially higher (>28°C) for approximately 46% of women performing moderate dai
82% versus 43% of these women experienced dehydration and heat-related complaints. 34% of women had US
ch is symptomatic of dehydration. APOs, which include spontaneous abortions, were prevalent at 2.2%
term birth/birth abnormalities were prevalent at 2.2%, and low birth weight was prevalent at 16.3%. Wit
WBGT>28°C, the incidence of miscarriage or unexpected abortion rose by approximately 2.7 times (95% C
ddition, higher WBGT exposures were associated with a 1.4-fold increased risk of unfavorable birth outcome
ence Interval [CI]: 1.02-1.09). The risk of spontaneous abortions was 2.8 times higher among women wh
ring the hotter months (February - September) compared to those women who conceived in the cooler month
anuary) (95% CI: 1.04-7.4). Positive relationships between ambient heat and APOs found in this study necessitat
further exploration into the underlying factors for extensive cohort studies to generate information to enable the formulation o
policies that can effectively protect these women against excessive heat stress for enhanced maternal and fetal health.

Keywords : heat exposures, community, pregnant women, physiological strain, adverse outcome, interventions
Conference Title : ICOG 2023 : International Conference on Obstetrics and Gynaecology
Conference Location : Ottawa, Canada
Conference Dates : July 03-04, 2023

NEED FOR ACTION

With or without evidence – Urgent Intervention

Intervention studies by the collaborators…….

PROJECT HEAT-PROTECT

Heat Action Plan

Vulnerable groups

Understand the issue and needs

- **Identify** the heat vulnerable working population
- Gather **stakeholder awareness** on HRIs, its symptoms, coping mechanism, if any.
- Monitor workers' **cumulative heat exposures** and HRIs/HSIs and CKDu.
- **Observe** existing interventions and feasible solutions
- **Stakeholder** needs for workplace heat intervention

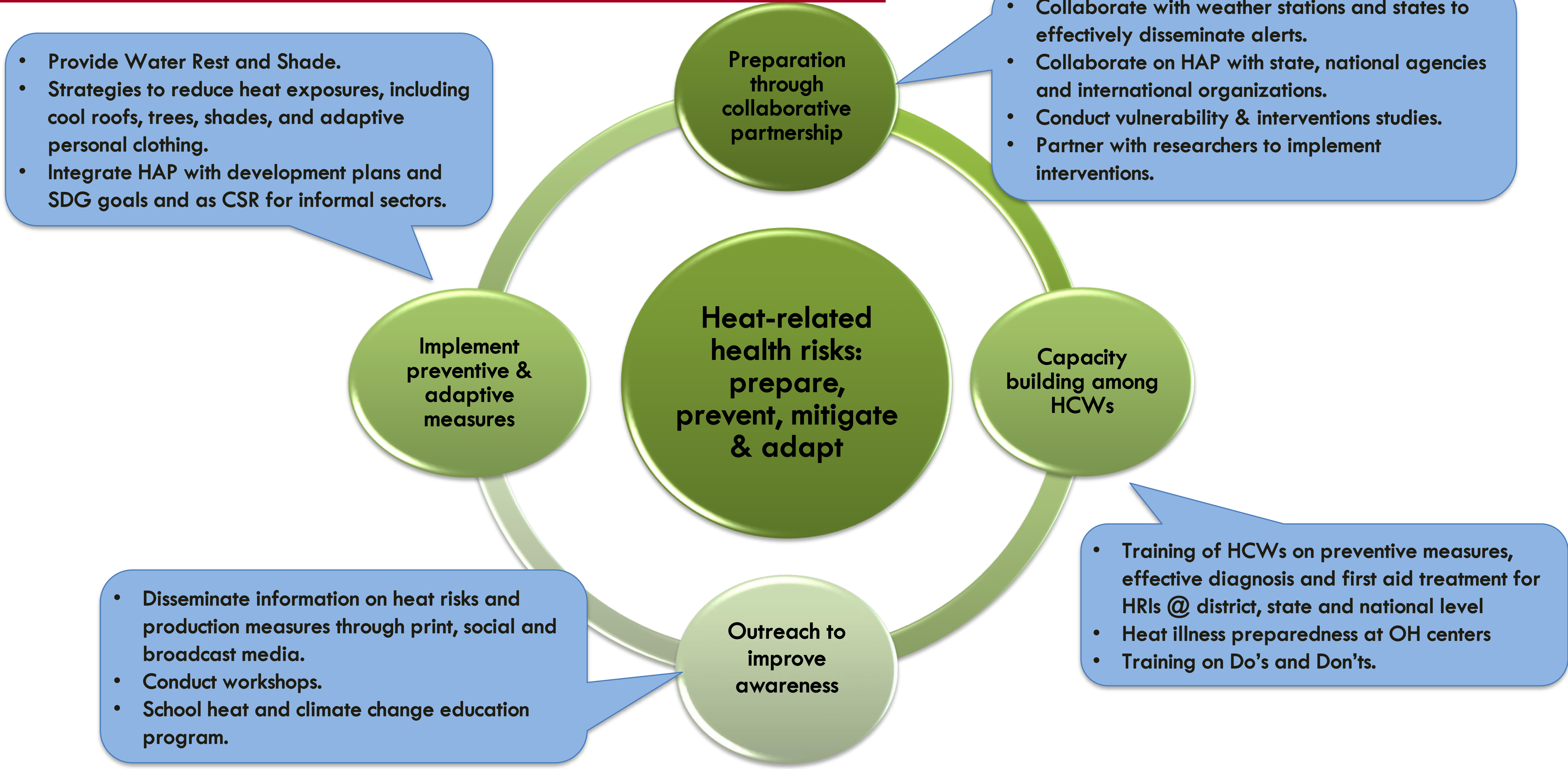
Implementation methods

- **Heat waves:** early warning and health promotion.
- **Tailored interventions** to suit individual and workplace needs.
- **Outdoor workplace** : Rest-Water-Shade-Sanitation (RWS-S) – Glaser & Flouris
- Ice slurries and clothing – Jason Lee
- **Indoor workplace:** Industrial Hygiene

Effectiveness

- **Change in heat exposure levels and their response evaluation** (worker-perception, HRI episodes, expense-reduction. improved efficiency, physiological indicators)
- Published case definitions (*Wegman et al., 2018*)
- What is **accepted**, **feasible** and **sustainable**?

PROJECT HEAT-PROTECT



Intervention in collaboration with…….

Academics

- FAME Laboratory (Department of Exercise Science University of Thessaly), Greece
- National University of Singapore
- Department of Remote Sensing, Anna University, Chennai

Government department

- Labour ministry (DGFASLI), GOI
- Directorate of Medical Services (Occupational Health Cell),
- Medium and Small-Scale Enterprises (MSMEs), Chennai
- Department of Atmospheric Sciences, IIT Delhi

NGOs

- LaIsla Network, USA
- Unorganized Worker Federation (UWF)
- Dvara Health Finance (DHF)
- Rotary Club of Chennai

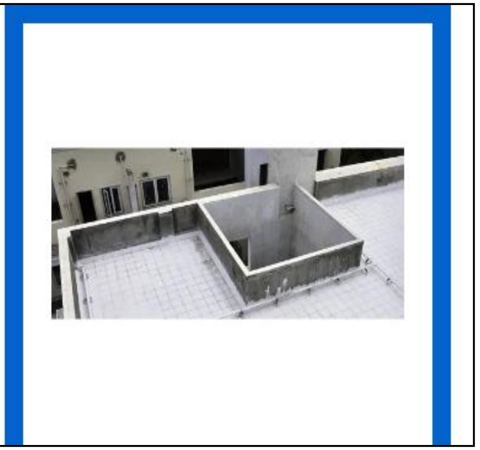
Indoor interventions…………..

Heat shields

Energy efficient HVLS fans

Core Kooler® Rehab Chair (Rs. 9000)

Arm cooling



Cool paints and tiles

Outreach activities: Education & Awareness

Cooling interventions for out door workers: Chicas, R., Xiuhtecutli, N., Dickman, N.E., Scammell, M.L., Steenland, K., Hertzberg, V.S. and McCauley, L., 2020. Cooling intervention studies among outdoor occupational groups: A review of the literature. *American Journal of Industrial Medicine*, 63(11), pp.988-1007.

COLLABORATION & FUTURE STEPS

Heat and biomarkers

WRS, Passive cooling

Swedish Research Council
Heat, Air Pollution & Biomarkers

NIHR
Heat stress and Kidney Health

La Isla, FAME, NSU
Heat Stress Interventions

SRIHER Centre for CC, Heat and Human Factors

NGOs(SEWA/ SNEHA & Welcome trust
Women's Health & pregnancy outcome

Swedish Research Council
Kidney Biopsy

Arvind Eye Hospitals Group
Heat & Cataract

Heat, Renal health Productivity & Economic loss

India Heat Team at work…



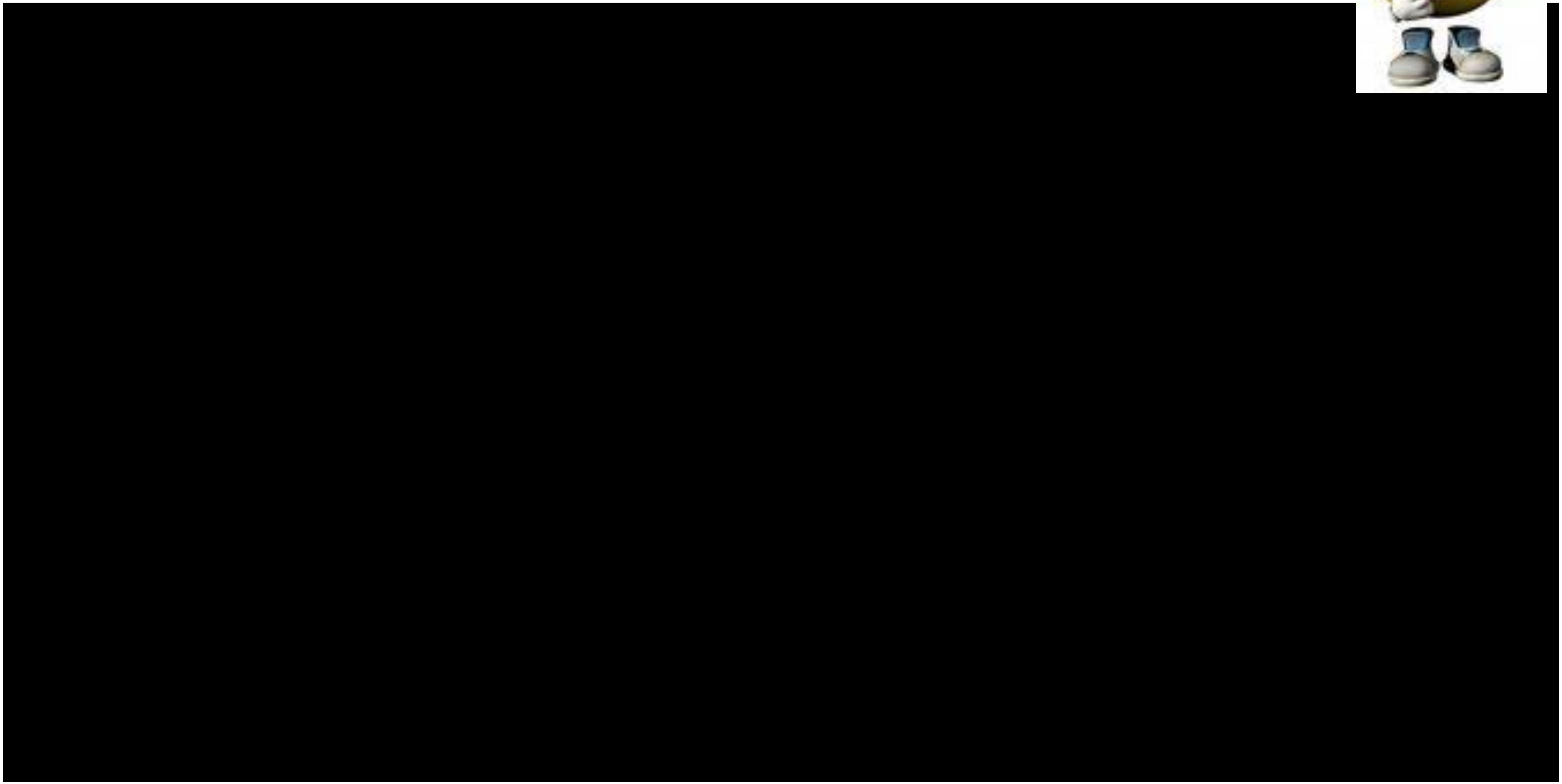









Can we make a change?



POLICIES

PROTECTION

PREPARDNESS

THANK YOU

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