



THERMAL STRESS INFORMATION SERVICE IN HONG KONG (香港热压力资讯服务)

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*The development of the Hong Kong
Heat Index for enhancing the heat stress
information service of the Hong Kong
Observatory*

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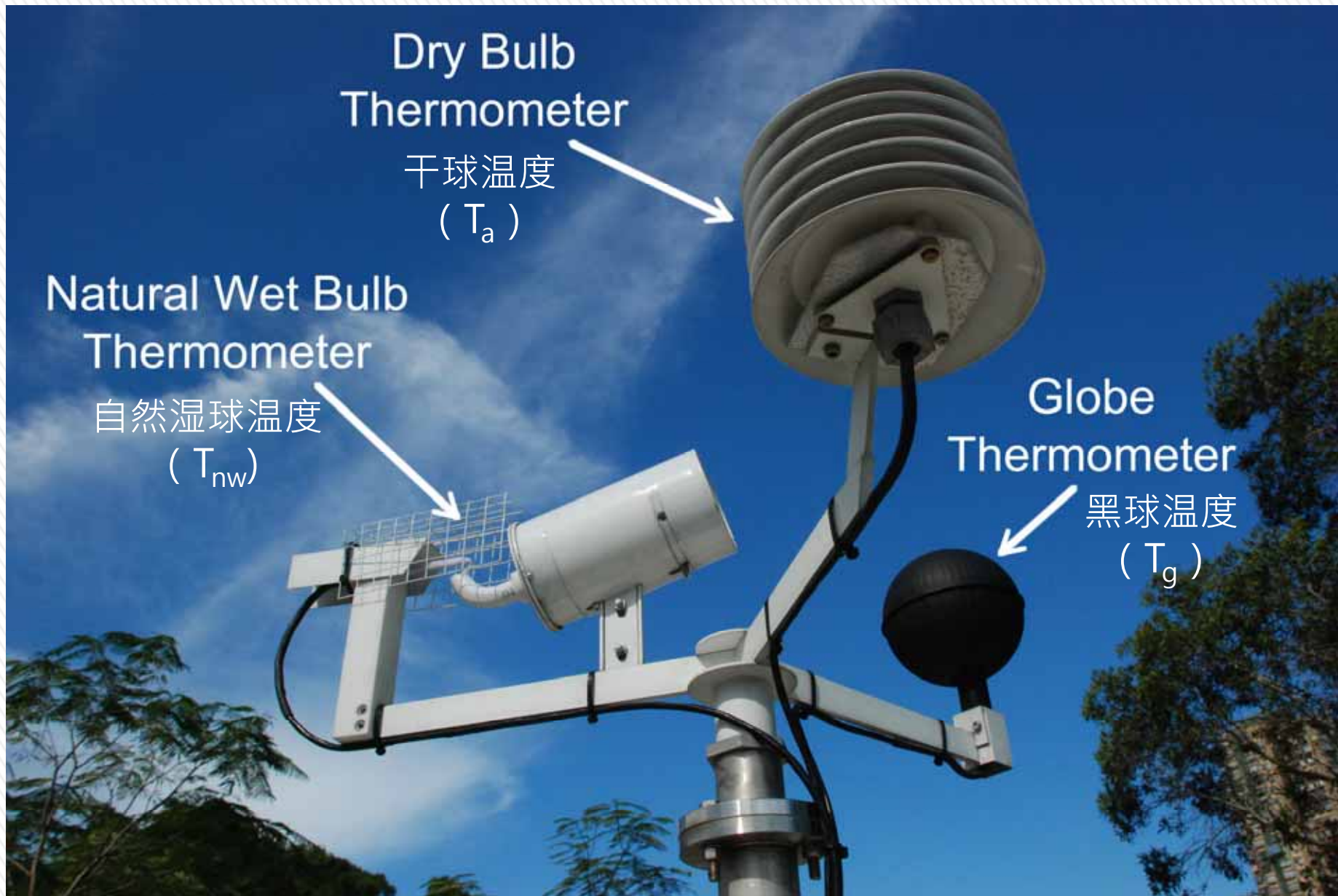


 Springer

Purpose



- » Enhance the original Very Hot Weather Warning (VHWW , 酷热天气警告) with the adoption of a new heat stress index as a component of criteria.
- » Introduce a new special advisory to the public to supplement the VHWW.
 - To cover occasional cases in summer that the weather is rather hot but yet marginally below the criteria of issuing VHWW.
 - To serve as additional advice to remind (through Observatory's Special Weather Tips) the public to take due attention.



WBGT is considered as more representative in heat stress assessment than air temperature alone since the three parameters take account of air temperature, humidity, wind, and solar radiation

Wet Bulb Globe Temperature (WBGT)



Natural Wet-Bulb Temperature (T_{nw})

- measured by a thermometer covered with a wetted wick and exposed to sunshine
- not shielded - represents the integrated effect of air temperature, humidity, wind, and solar radiation



Air Temperature (T_a)

- *ordinary air temperature measured by a thermometer shielded from direct sunshine*
- *standard temperature normally quoted in weather observations and forecasts*



Black Globe Temperature (T_g)

- measured by a thermometer installed inside a black hollow globe made of copper
- not shielded and thus it represents the integrated effects of air temperature, wind, and solar radiation

$$\text{WBGT} = 0.7 T_{nw} + 0.2 T_g + 0.1 T_a$$

Location of stations with heat stress measurement in Hong Kong



WBGT working mechanism



- » It measures directly / indirectly the following basic parameters on heat stress.
 - > air temperature
 - > mean radiant temperature
 - > air speed
 - > relative humidity
- » But it does not take into the account of:
 - > Metabolic rate
 - > Clothing thermal characteristics ISO 7933

Shortfall of using WBGT



- » an empirical index developed in western countries, but not derived based on the weather conditions of Hong Kong;
- » effectiveness and validity in environment of high humidity (e.g. HK), has been challenged in literature;
- » WBGT guidelines in other countries or regions may not be directly applicable to HK.

The Project:



> To identify a **heat stress index** that correlates best (better than WBGT) with the hospitalization rate in Hong Kong.

Hong Kong Heat Index (HKHI) :

$$\text{HKHI}_i = a T_{nw} + b T_g + c T_a$$

Natural Wet-Bulb Temperature (T_{nw})

Globe Temperature (T_g)

Air Temperature (T_a)

where

a,b,c = weighting factors (between 0 and 1, each in steps of 0.05)

Different i stands for different combination of a, b and c

$$a + b + c = 1$$

To find an optimal combination of the three temperature parameters.

$$\text{HKHI}_1 = 0 \times T_{nw} + 0 \times T_g + 1 \times T_a$$

:

$$\text{HKHI}_{208} = 0.7 T_{nw} + 0.2 T_g + 0.1 T_a$$

:

$$\text{HKHI}_{231} = 1 \times T_{nw} + 0 \times T_g + 0 \times T_a$$

← **WBGT**

Data



» Period:

May – September in each year during 2007-2011

Different day groups: (A) Working Days (B) Saturdays and public holidays (C) Sundays

» Data:

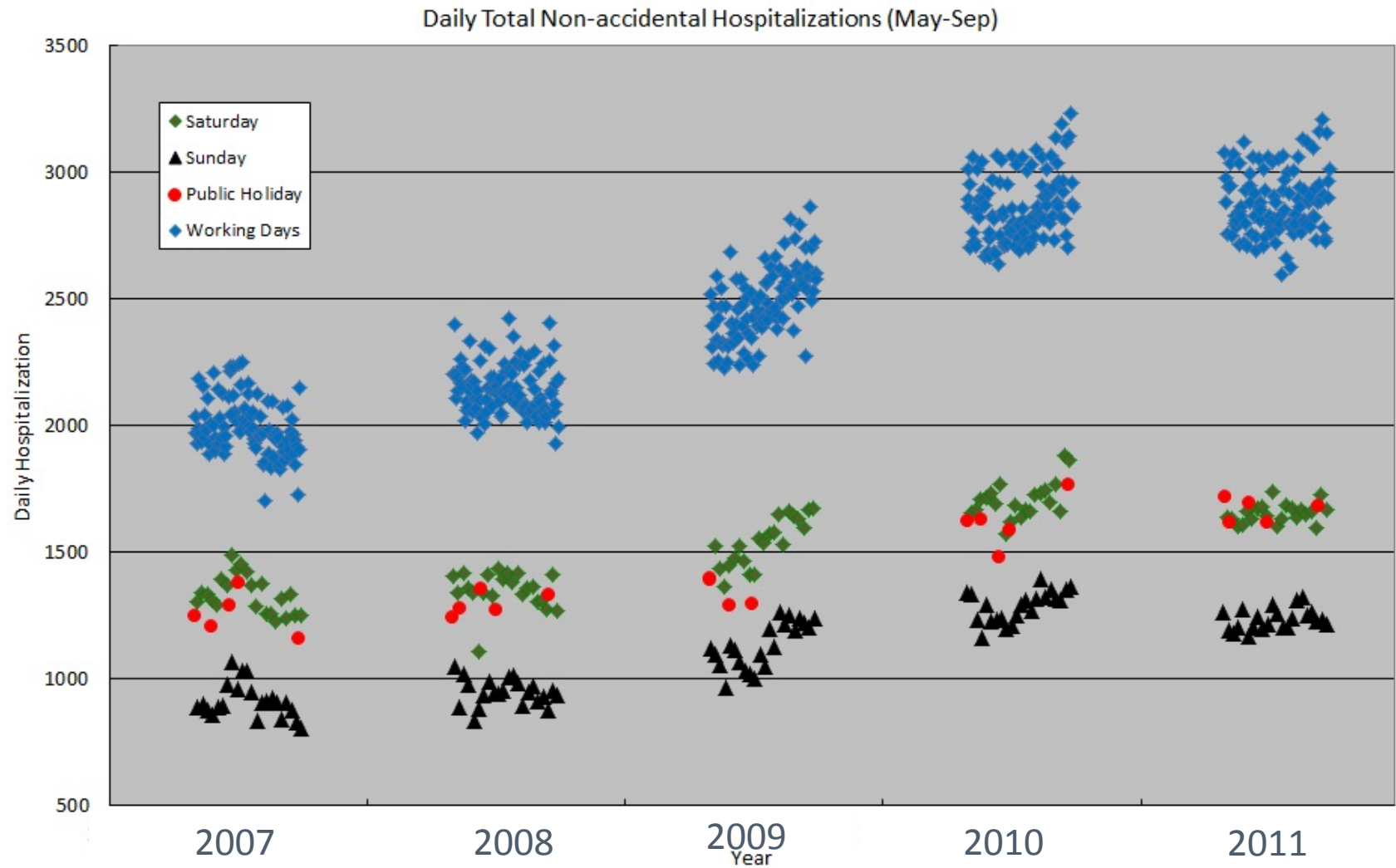
Local Heat stress data (HKHI_i)

- 10-minute running mean data at 1-minute interval
- Measured at King's Park
- *Daily maximum HKHI_i chosen for study*

Local Hospitalization data

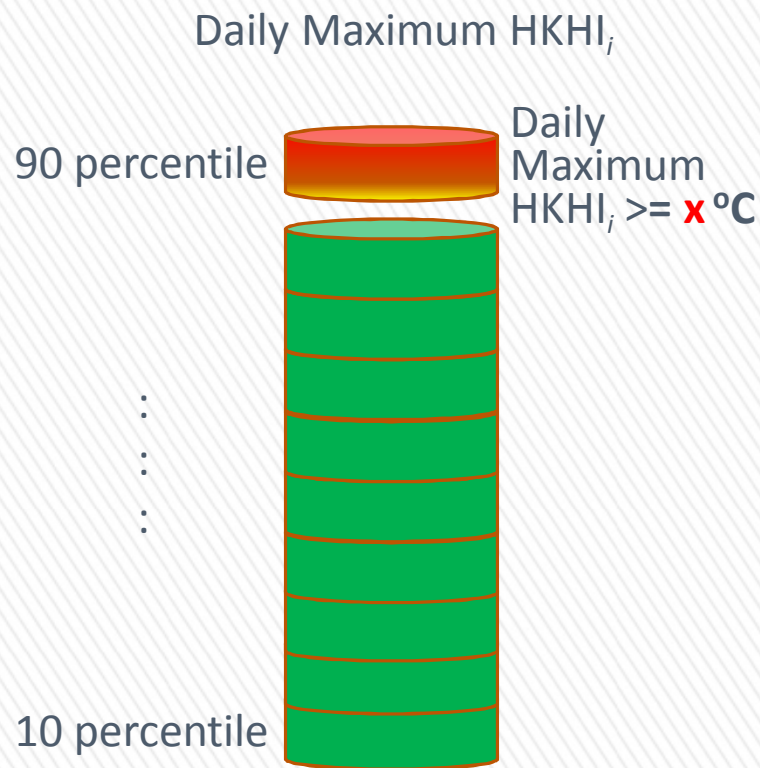
- Daily hospital admission solicited from HK Hospital Authority (HA)
- Data due to accidental causes ignored
- Also separate into different age groups
 - (i) Age under 15
 - (ii) Age between 15-59
 - (iii) Age between 60-74
 - (iv) Age 75 or above

Time series of the hospitalization rate

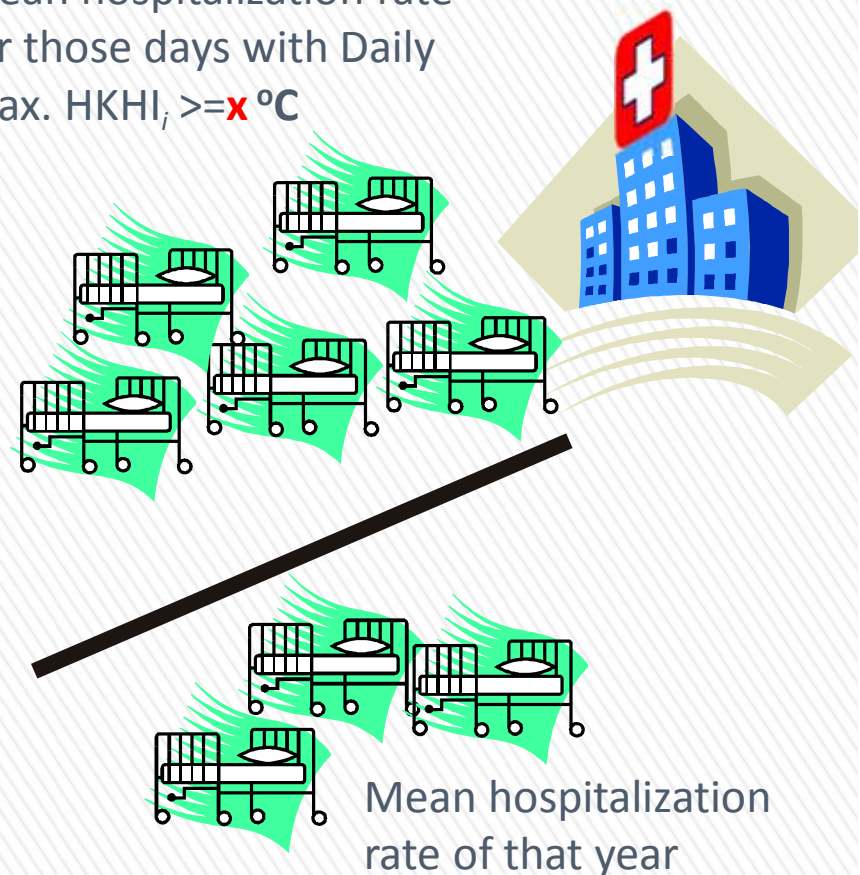


Analysis Method

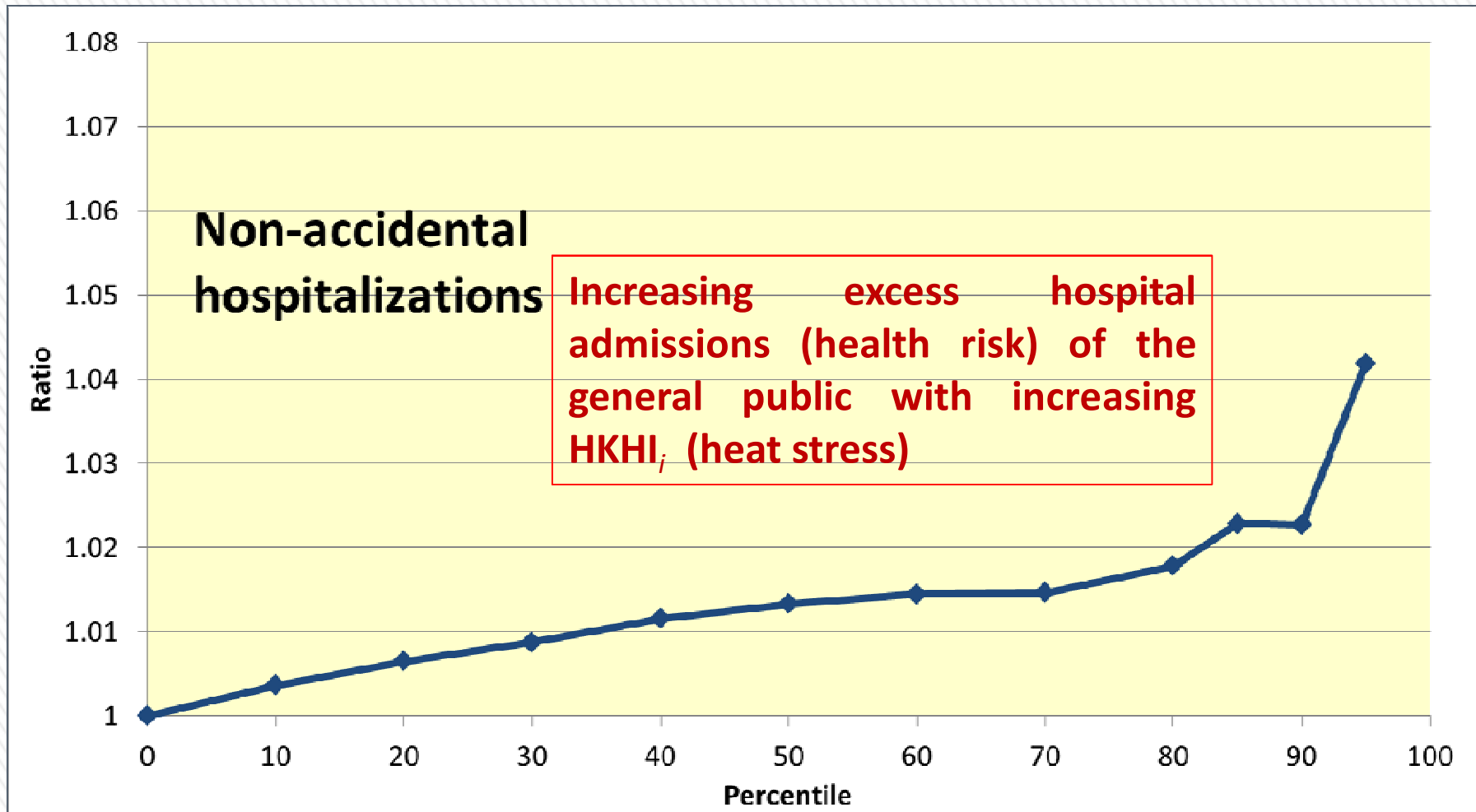
To obtain the aggregated increase in hospital admission risks of increasing heat stress, the hospitalization rates corresponding to different percentiles of daily maximum HKHI are computed for each year and for each day group; and then compared with the mean hospitalization rate to derive the **Excess Hospitalization Ratio**.



Mean hospitalization rate for those days with Daily Max. HKHI_i ≥ x °C

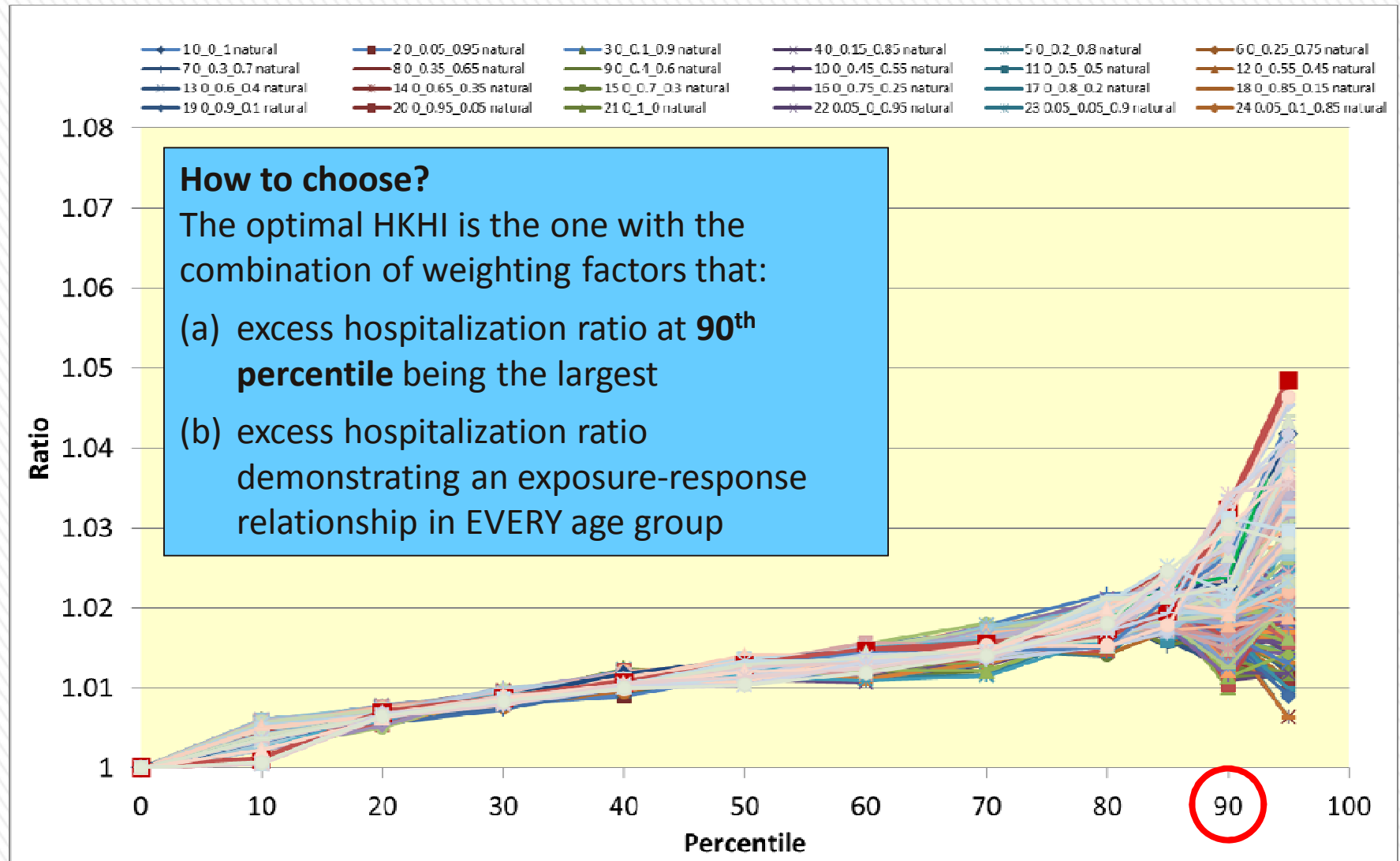


Excess hospitalization ratio with different percentiles of daily maximum HKHI, maximum HKHI,



Data:
Daily non-accidental hospitalizations during working days

Excess hospitalization ratio with different percentiles of daily maximum HKHI



Data:
 Daily non-accidental hospitalizations during working days

In line with other climate and health studies which take 90th percentile threshold in defining heat waves or extreme high temperature events

Results



$$\text{HKHI} = 0.8 T_{nw} + 0.05 T_g + 0.15 T_a$$

Natural Wet-Bulb Temperature (T_{nw})

Globe Temperature (T_g)

Air Temperature (T_a)

Compare the coefficients with WBGT

$$\text{WBGT} = 0.7 T_{nw} + 0.2 T_g + 0.1 T_a$$

- This is not surprising as Hong Kong is located in the subtropical region with relatively high humidity.
- This result generally agreed with other publications in emphasizing the importance of the weightings of T_{nw} to reflect the heat tolerance level.

Results

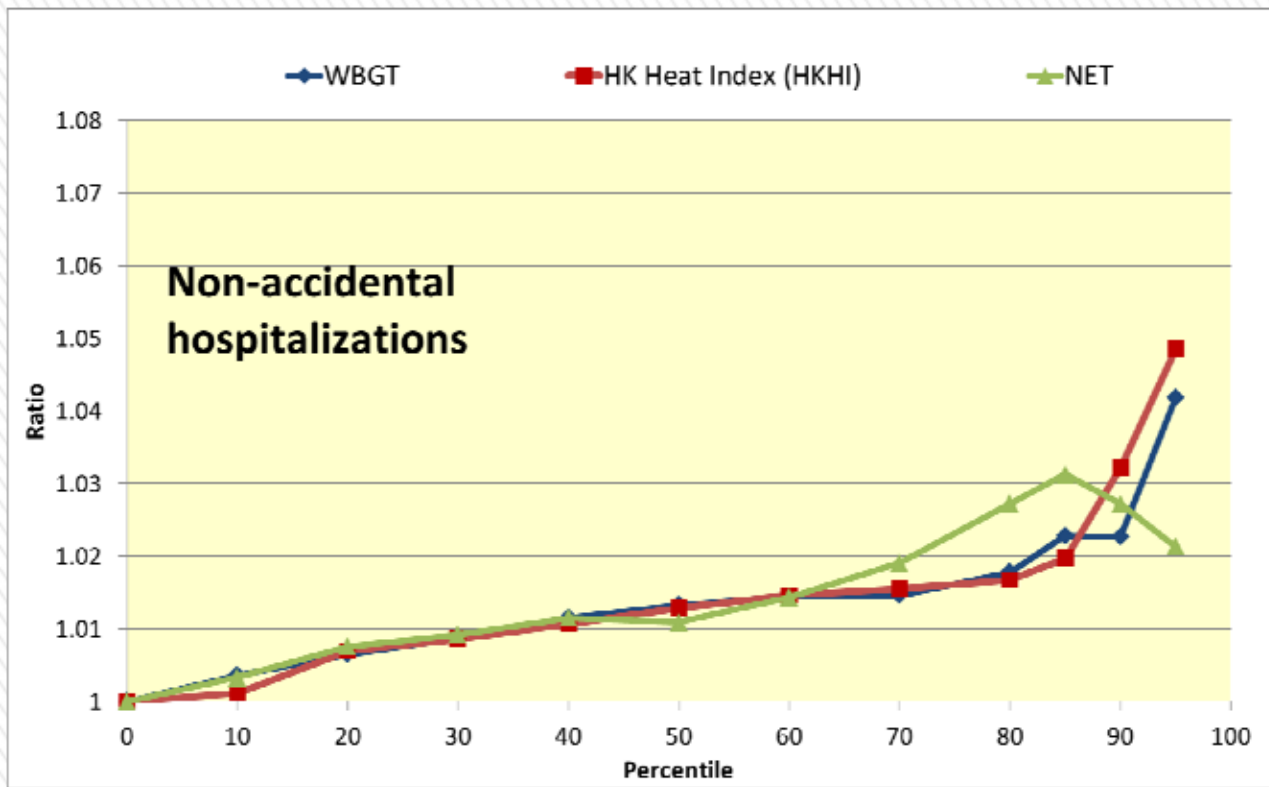


$$\text{HKHI} = 0.8 T_{nw} + 0.05 T_g + 0.15 T_a$$

Natural Wet-Bulb Temperature (T_{nw})

Globe Temperature (T_g)

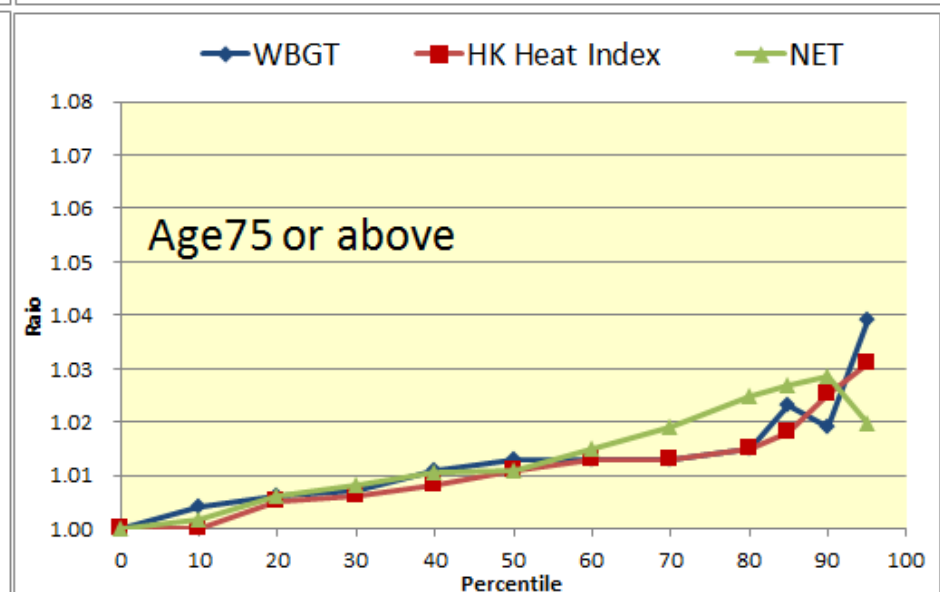
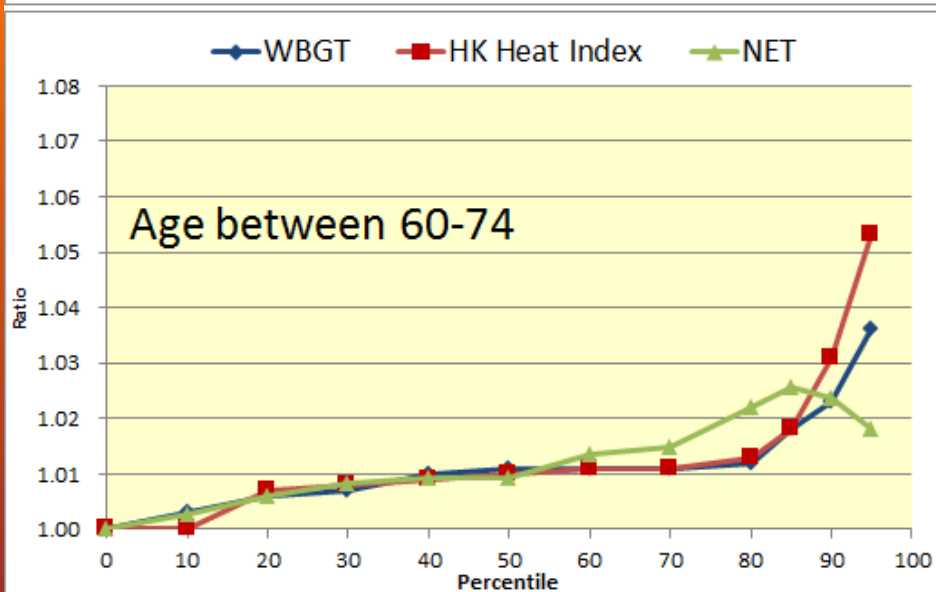
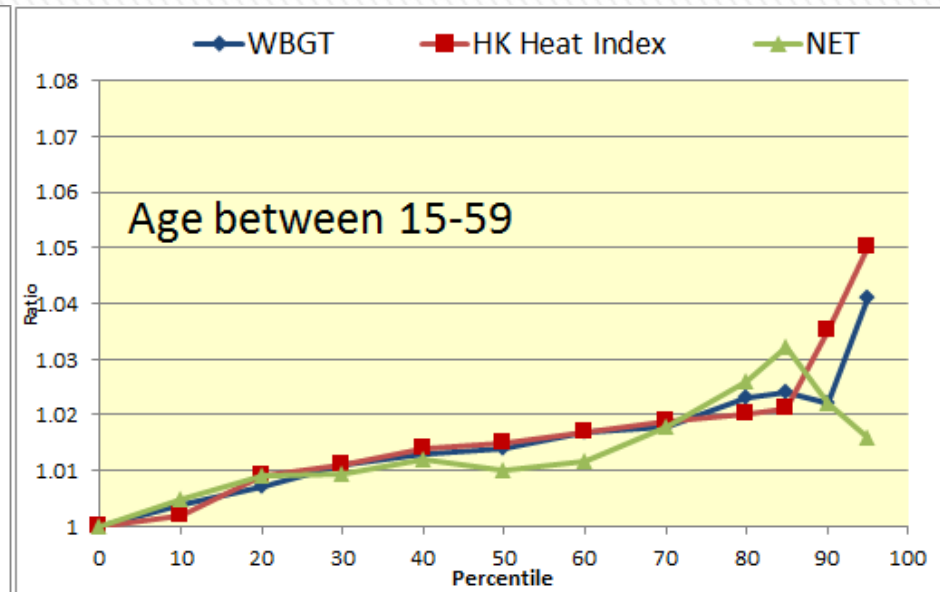
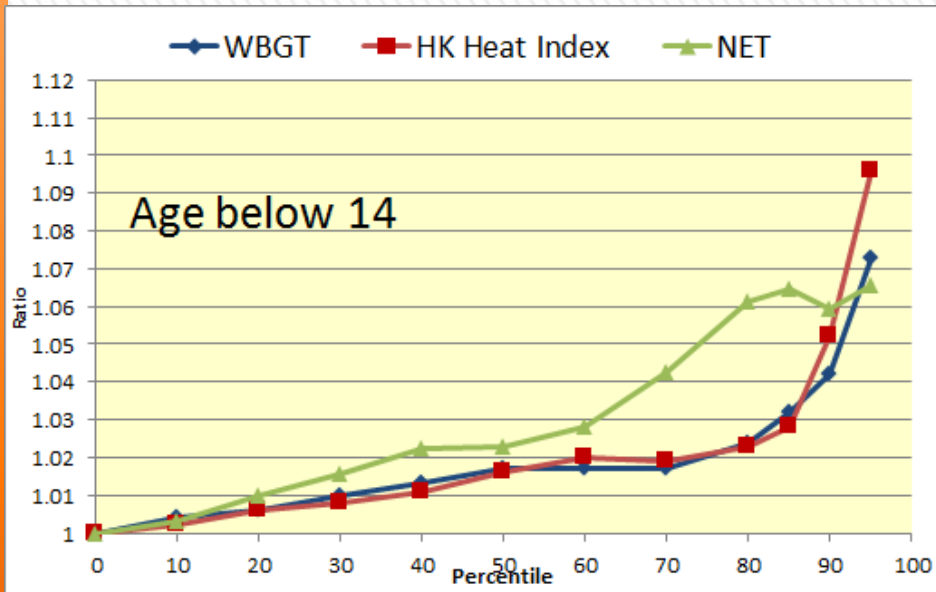
Air Temperature (T_a)



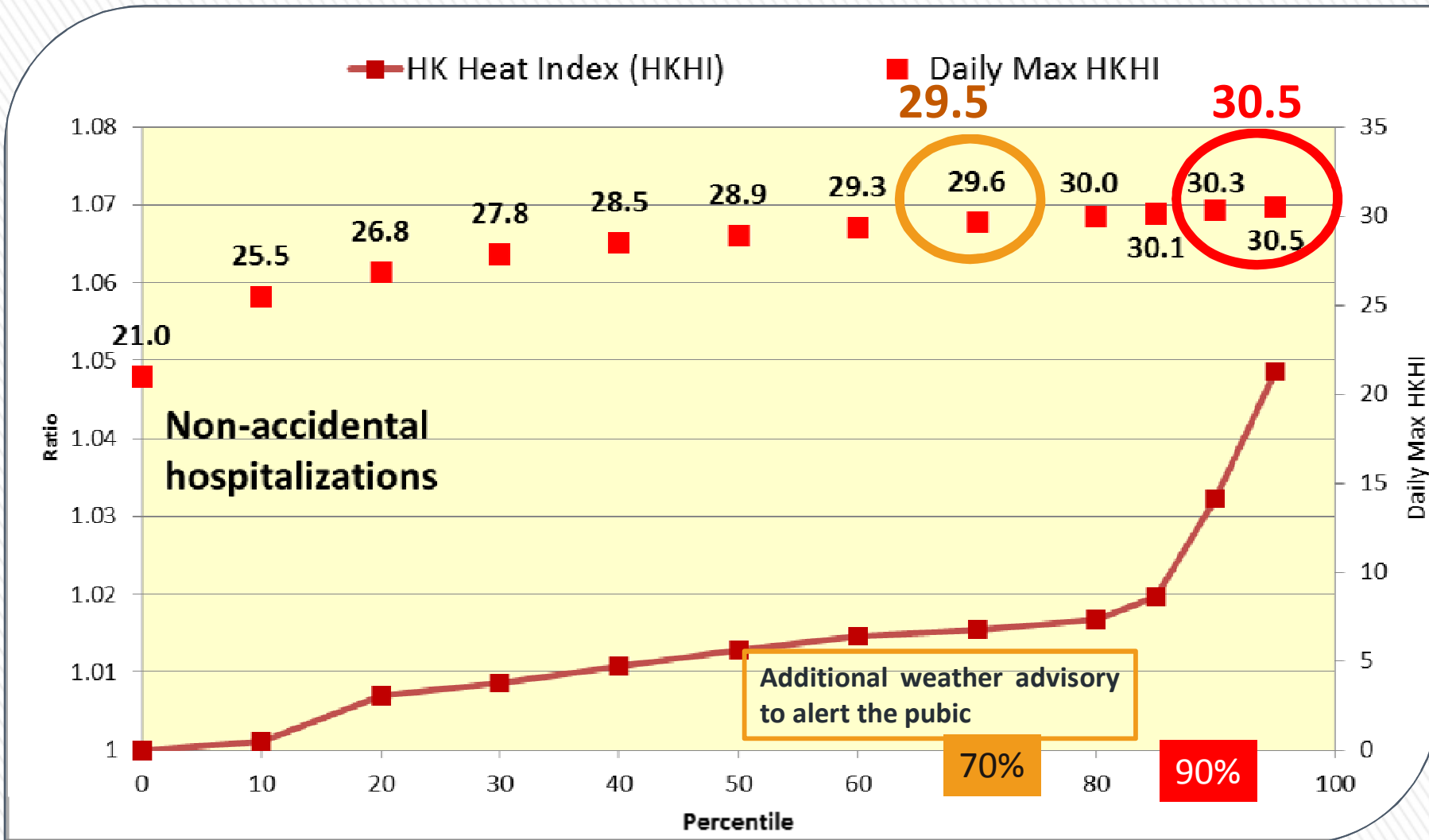
- Net Effective Temperature (NET) was one of the criteria of issuing VHWW.
- HKHI has incorporated directly or indirectly all the meteorological elements for NET.
- Explore replacing NET by HKHI in the criteria of issuing VHWW.

Results

HKHI performed better than WBGT and NET in terms of excess hospitalization ratio for most age groups, **exhibiting better exposure-response relationship**. It is also evident that the excess hospitalization ratio **rises rapidly when HKHI is above the 90th percentile**



Excess hospitalization ratio with different percentiles of daily maximum HKHI



Data:
Daily total non-accidental hospitalizations during working days

Two-tier Heat Stress Information Service



Hot
Advisory

Tier 1

Issuing a Hot Weather Special Advisory (炎热天气特别提示) for hot weather, which is based on HKHI (with threshold of 29.5: round to the nearest multiple of 0.5 of the 70th percentile value of 29.6 for operational convenience) in addition to dry bulb temperatures at HKO and at other regional automatic weather stations



Tier 2

Issuing of Very Hot Weather Warning (酷热天气警告), which will be based on HKHI (with threshold of 30.5: round to the nearest multiple of 0.5 of the 90th percentile value of 30.3 for operational convenience) in addition to dry bulb temperatures at HKO and at other regional automatic weather stations

Two-tier Heat Stress Information Service



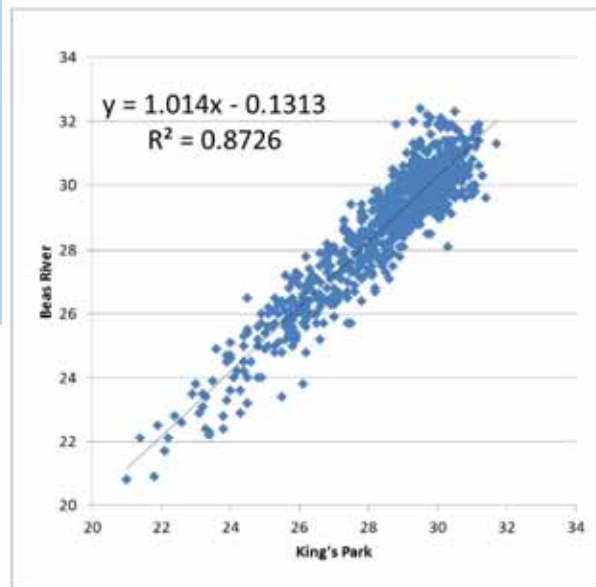
Hot Weather Special Advisory

1. When engaged in outdoor work or activities, pay attention to health conditions. Bring along water and sunscreen.
2. Reduce prolonged exposure under sunlight.
3. Ensure good air ventilation in indoor environment.
4. Beware of health and wellbeing of elderly or persons with chronic medical conditions. If you know of them, call or visit them occasionally to check if they need any assistance.

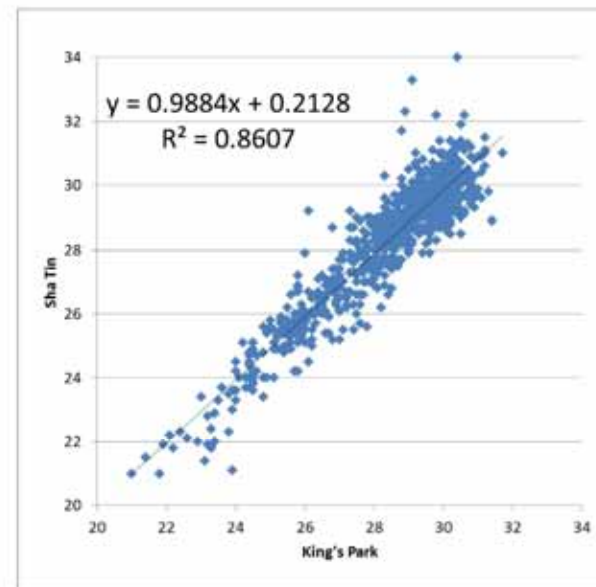


Very Hot Weather Warning

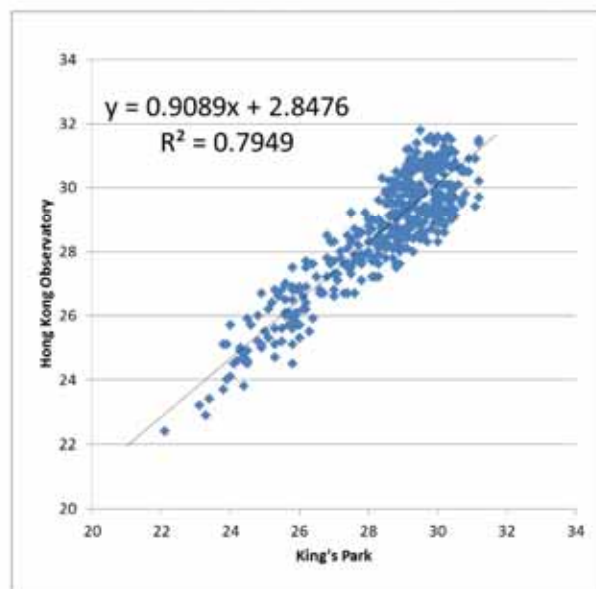
1. When engaged in outdoor work or activities, drink plenty of water and avoid over exertion. If not feeling well, take a rest in the shade or cooler place as soon as possible.
2. People staying indoors without air-conditioning should keep windows open as far as possible to ensure that there is adequate ventilation.
3. Avoid prolonged exposure under sunlight. Loose clothing, suitable hats and UV-blocking sunglasses can reduce the chance of sunburn by solar ultraviolet radiation.
4. Swimmers and those taking part in outdoor activities should use a sunscreen lotion of SPF 15 or above, and should re-apply it frequently.
5. Beware of health and wellbeing of elderly persons or persons with chronic medical conditions staying alone. If you know of them, call or visit them occasionally to check if they need any assistance.



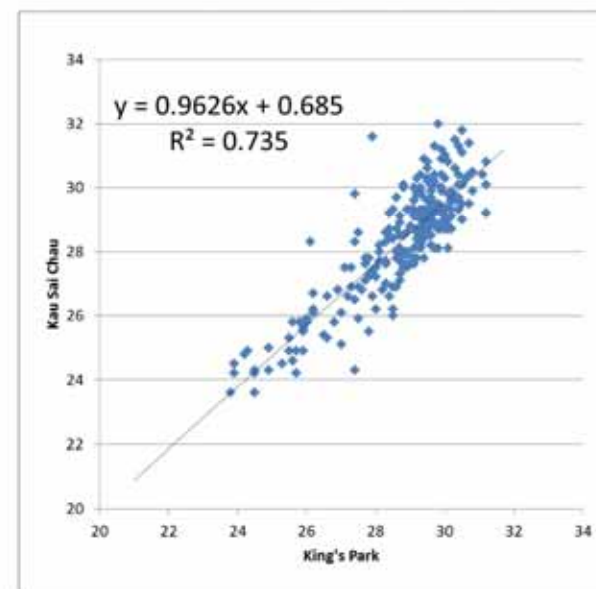
(a)



(b)



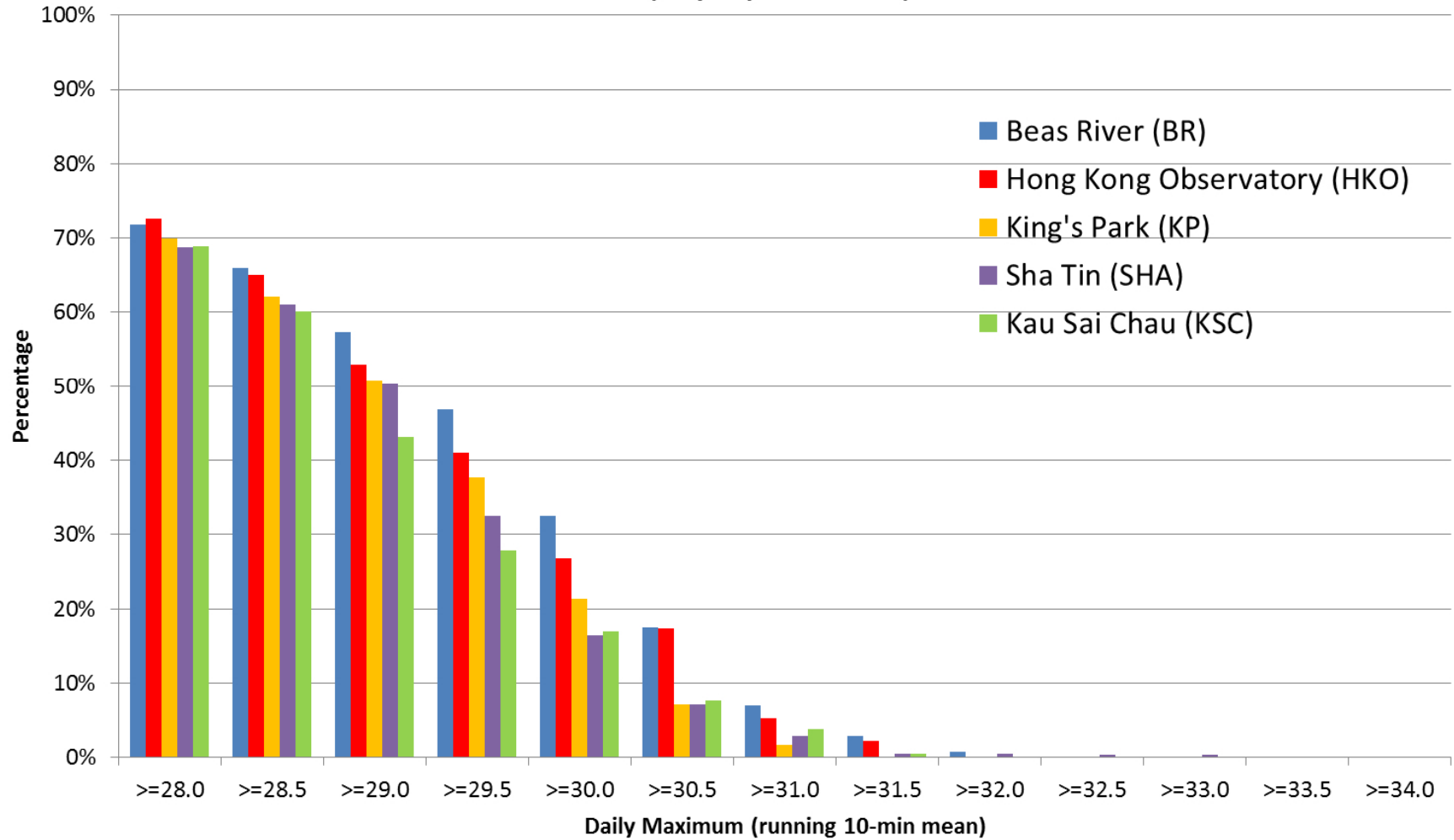
(c)



(d)

Daily Maximum of Hong Kong Heat Index (HKHI)

(May-Sep, 2007-2012)



Conclusion



- » By making use of **local heat stress data** and **hospitalization data**, the HKHI, which consists of a set of optimized coefficients for T_{nw} , T_g , and T_a , was developed to **reflect local heat stress condition** and to facilitate the issuance of **early alert of hot weather** in Hong Kong.
- » Retrospective analysis also indicates that the **HKHI performed better** than WBGT and NET in reflecting the health risk under high temperature conditions as indicated by the **exposure-response** of the excess hospitalization ratio for most age groups.
- » Based on the response of hospitalization rate to the HKHI, the **criteria** of HKHI were also identified for the **two-tier approach** of the heat stress information service. The findings of this study provide the scientific basis for the development of the new HKHI and the **enhancement of the original heat stress information services** by introducing the **two-tier approach** with a **Hot Weather Special Advisory** and a **Very Hot Weather Warning** for very hot weather.

New service on "Hot Weather Special Advisory" (May 2014)



Hong Kong Observatory
The Government of the Hong Kong Special Administrative Region
Innovative with Science. Service with Heart.

27 May 2014 | Tue | Gregorian/Lunar Calendar

Special Weather Tips
Hot weather might cause adverse health effects. The Observatory advises the public to stay on the alert. (27-05-2014 07:00)

Today's Warnings | Weather & Rainfall map | Airport weather | Earthquake/Tsunami | Tropical Cyclone | Others

Current Weather at 11 a.m.
HKO : Temp 30 °C RH 76 %
King's Park : UV Index 7 (high)

North Point Sea Surface Temp : 27 °C

9-day Weather Forecast Updated at 09:45 HKT

Date	27 May Tue	28 May Wed	29 May Thu	30 May Fri	31 May Sat	1 Jun Sun	2 Jun Mon	3 Jun Tue	4 Jun Wed
Weather									
Temp (°C)	28 - 32	27 - 32	28 - 32	28 - 33	28 - 33	28 - 32	27 - 32	26 - 30	26 - 30
RH (%)	70 - 95	75 - 95	70 - 90	70 - 90	70 - 90	70 - 90	70 - 95	75 - 95	75 - 95

Hong Kong Observatory
The Government of the Hong Kong Special Administrative Region

King's Park Meteorological Station
24-hour Time Series of Hong Kong Heat Index (Beta Version)
(於香港時間 2014年5月29日10時00分更新) (Updated at 10:00H on 29 May 2014)

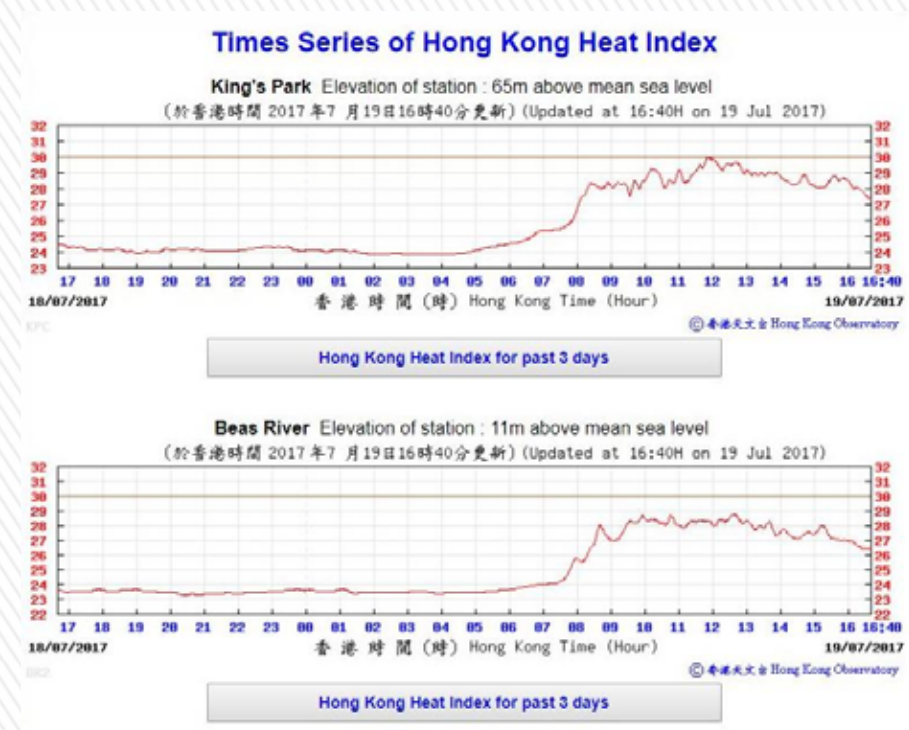
29/05/2014 | 香港時間 (時) Hong Kong Time (Hour)

Remark :

- The Hong Kong Heat Index was calculated from the measured Natural Wet Bulb Temperature (T_w), Globe Temperature (T_g) and Dry Bulb Temperature (T_a). Its value is given by $0.80T_w + 0.05T_g + 0.15T_a$.
- Generally speaking, the public should take appropriate **precautions** when the index reaches around 30 or above to prevent from adverse health effects brought by hot weather.
- The data displayed above is provisional as there is only limited quality check.

Reference: <http://www.hko.gov.hk/whatsnew/f1/HotWxSpecialAdvisory.htm>

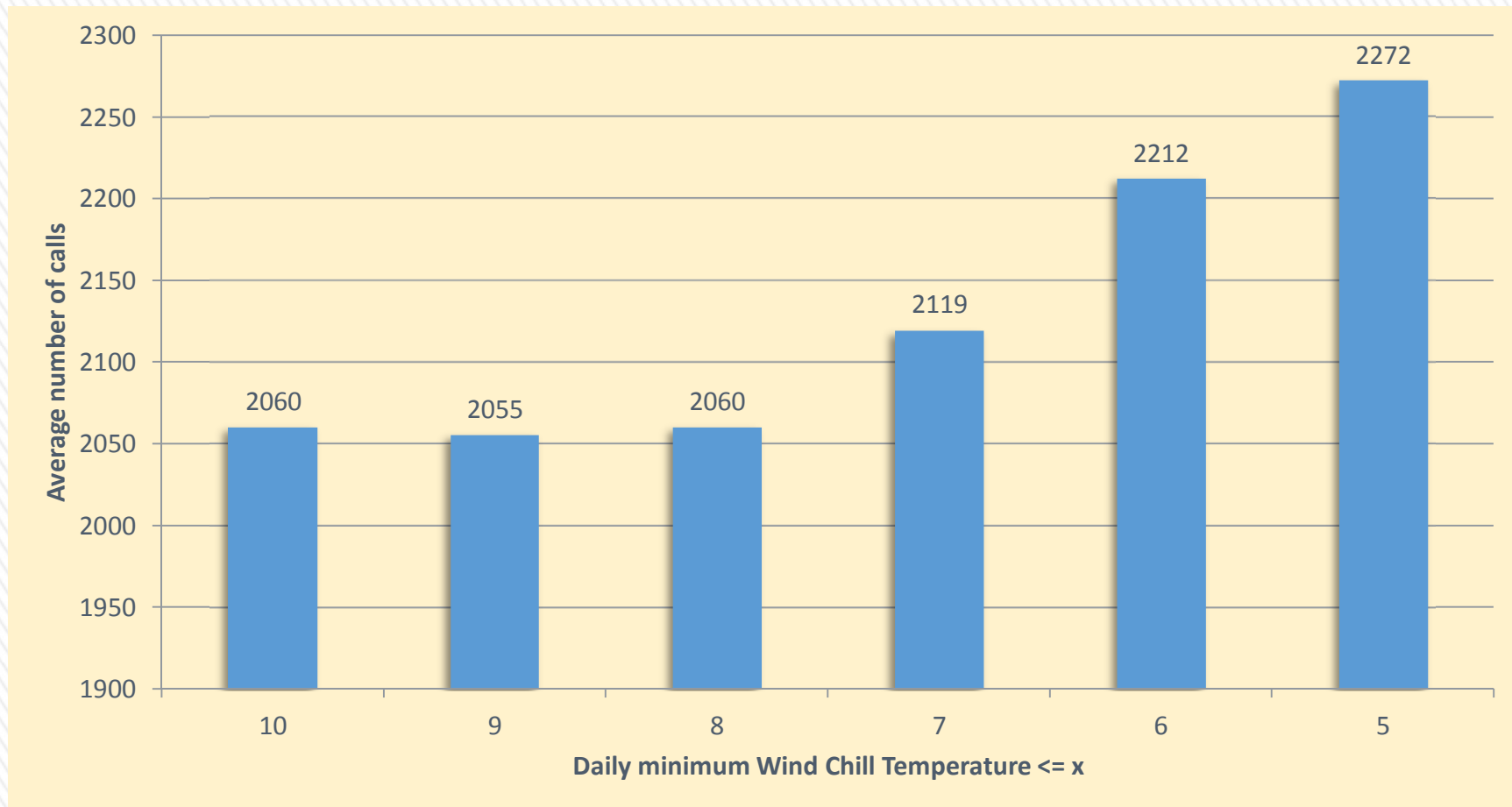
Enhancement of the Hong Kong Heat Index information service (August 2017)



Reference: <http://www.hko.gov.hk/whatsnew/f1/wn20170814.htm>

Looking ahead: Study of windchill effect on health >

Preliminary results:



Personal Emergency Link (PEL) call statistics from the [Senior Citizen Home Safety Association \(长者安居协会\)](#)



Thank you