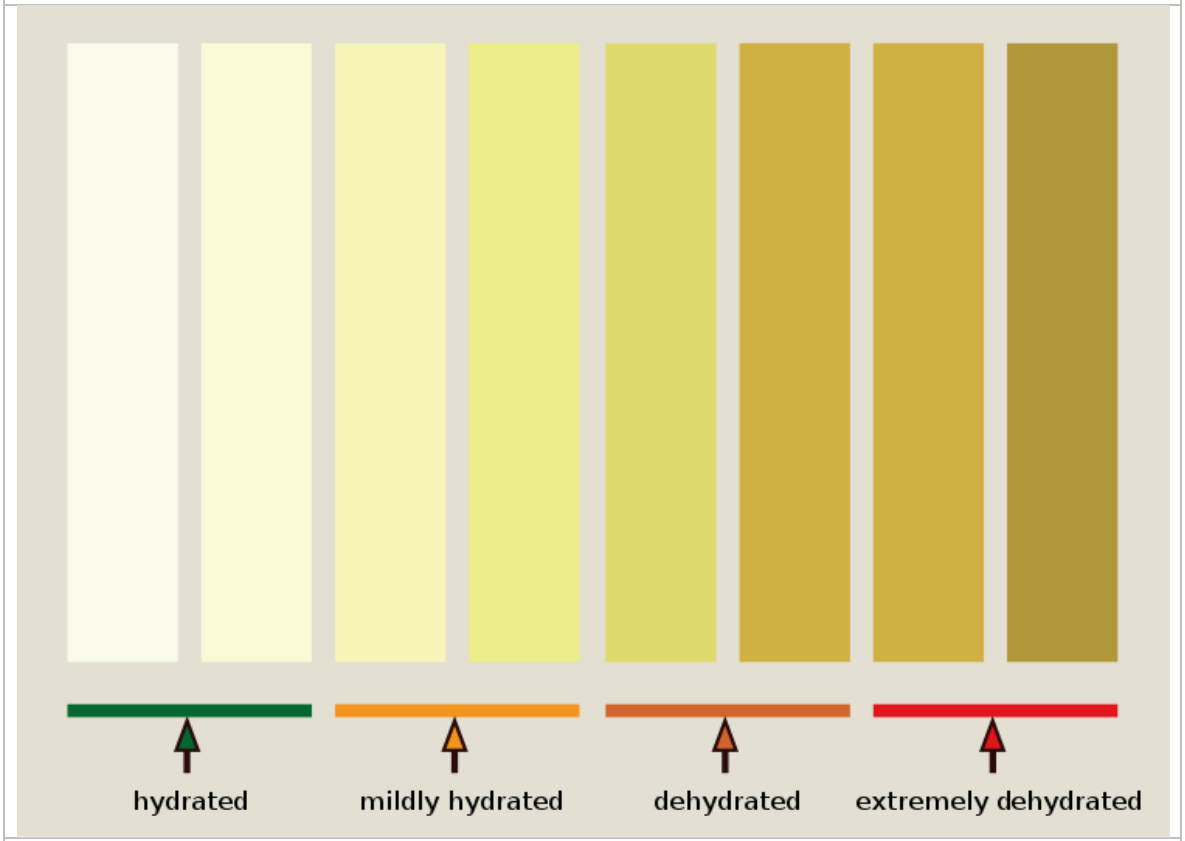
Hydration

When hiking for some hours, or walking in high temperatures, it is important to remain hydrated.

In general, humans drink adequately to maintain body water balance, that is, fluid replacement to offset losses, under normal resting, non-stressful conditions. However, situations often arise in which perturbations in fluid balance occur because of large fluid losses from the body. For example, heat exposure in an occupational setting or exercise for competitive sport or recreation can induce significant increases in thermal sweat loss. (1)

The simplest way to spot dehydration is by observing the color of urine, Fig.1. Other signs include thirst, headaches, a lack of appetite, less urine, confusion, fatigue.

Fig.1 The Colour of Urine and State of Hydration/Dehydration



Note: https://en.wikipedia.org/wiki/File:Urine_Hydration_chart.svg

Source: Wikipedia (above), Conceptasia, August 2022

With respect to daily water drinking, drinking sufficiently to eliminate thirst, checking one's urine color if concerned, and generally relaxing and living a balanced life is probably fine for most. My personal trainer recommends that I drink around three 500 milliliter bottles of water a day.

Fig.2 shows the typical intake and output of fluids daily. Men tend to be bigger, have higher energy output, and have relatively more muscle and less fat (muscle has a higher water content than fat).

Fig.2 Daily Fluid Balance (A)							
		Adult Male		**Adult Female**		**Child (10 years)**	
		Millilitres/day	%	Millilitres/day	%	Millilitres/day	%
Intake	Fluids	1,950	65	1,400	67	1,400	70
	Water in food	700	23	450	21	400	20
	Metabolic water (B)	350	10	250	12	200	10
	Total	3,000	100	2,100	100	2,000	100
Output	Urine	1,400	47	1,000	48	1,000	50
	Sweat (via sweat glands)	650	22	420	20	350	17
	Exhaled air	320	11	320	15	580	29
	Insensible losses (via skin)	530	17	270	13		
	Water in faeces	100	3	90	4	70	4
	Total	3,000	100	2,100	100	2,000	100
Footnote A: "Considerable variation is found among individuals or within the same individual on successive occasions; only a part of this variation can be attributed to changes in environment and to differences in age, sex, body weight, or surface area. [2]							
Footnote B: By oxidation of food. When carbohydrates, fats and proteins are oxidized to produce energy, water is a by-product							
Note: data from reference 2, presented in reference 3							
Source: Report of the Task Group on Reference Man [2] (see note above), Conceptasia, August 2022							

The data in Fig.2 comes from a landmark study, but one released over 45 years ago. Over the intervening years work has become less physical due to technological advances. It is possible as a result that the average adult male's fluid intake has decreased somewhat.

Please note the significant water contribution that comes in food, Fig.2. Fig.3 shows some examples of the water content in food.

Fig.3 The Water Content Range for Selected Foods	
Percentage	Food Item
100%	Water
90-99%	Fat-free milk, cantaloupe, strawberries, watermelon, lettuce, cabbage, celery, spinach, pickles
80-89%	Fruit juice, yogurt, apples, grapes, oranges, carrots, broccoli (cooked), pears, pineapple
70-79%	Bananas, avocados, cottage cheese, ricotta cheese, potato (baked), corn (cooked), shrimp
60-69%	Pasta, legumes, salmon, ice cream, chicken breast
50-59%	Ground beef, hot dogs, feta cheese, tenderloin steak (cooked)
40-49%	Pizza
30-39%	Cheddar cheese, bagels, bread
20-29%	Pepperoni sausage, cake, biscuits
10-19%	Butter, margarine, raisins
1-9%	Walnuts, peanuts (dry roasted), chocolate chip cookies, crackers, cereals, pretzels, taco shells, peanut butter
Zero	Oils, sugars
Note: original data attributed to reference 4	
Source: Optimal Composition of Fluid-Replacement Beverages, [1] (see note above), Conceptasia, August 2022	

Heat stroke

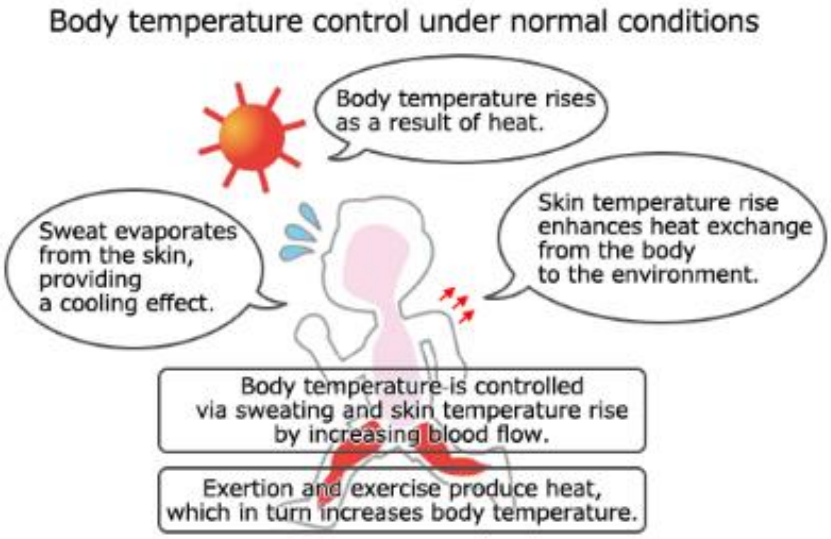
The body normally cools itself via evaporative and radiative heat loss to the environment by sweating and increasing the skin temperature, [5] Fig.4.

These mechanisms can be overwhelmed as the following factors interact:

1) Environmental factors, e.g., rising temperatures, increased humidity, an absence of wind, no air conditioning.
2) Physiological factors, e.g., being old, very young, being obese, having a chronic disease
3) Behavior-related factors, e.g., hard exercise and/or being outdoors for many hours

Heavy sweating depletes both water and salt causing dehydration if not replaced. Heat cramps, fainting, or worse (including death) is possible.

Fig.4 Body Temperature Control under Normal Circumstances



Note: https://www.wbgt.env.go.jp/en/doc_prevention.php
Source: Heat Illness Prevention Information, Ministry of the Environment, Conceptasia, August 2022

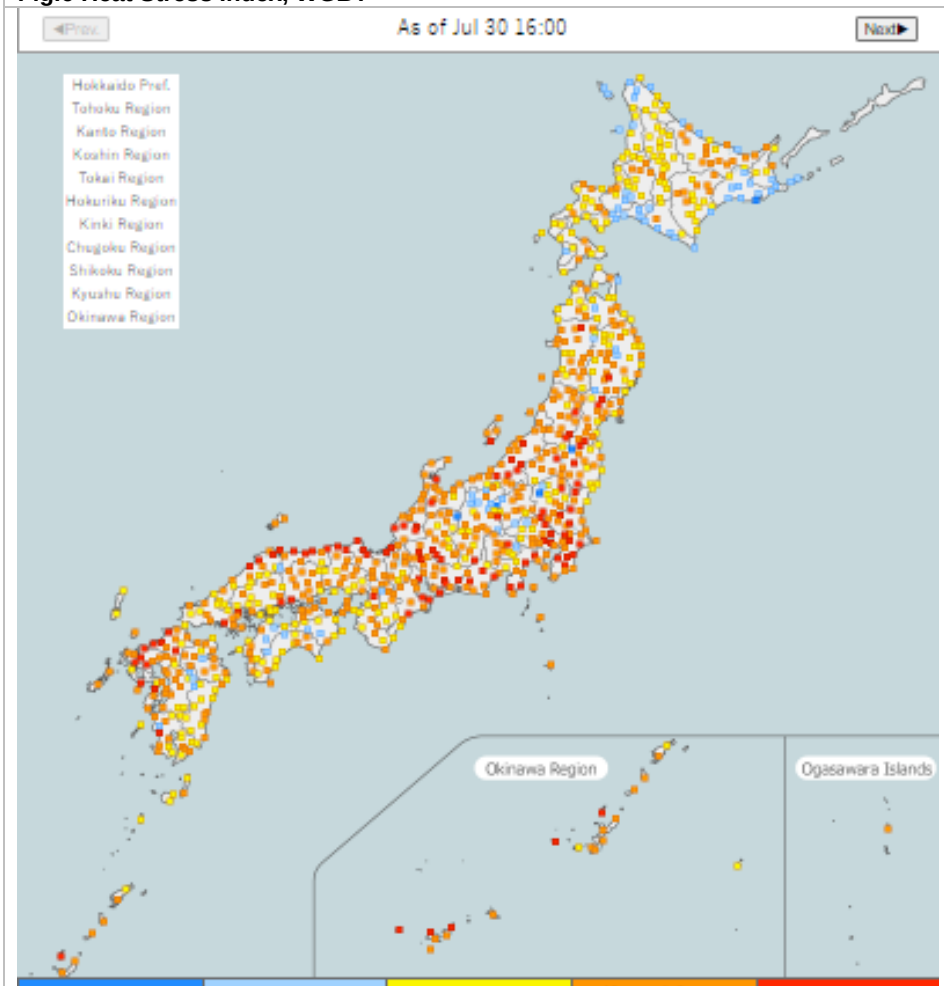
The Japanese government produces a “Heat stress Index”, Fig.6, and “Heat Stroke alerts”, Fig.7. The government utilizes 840 sites nationwide. The government is raising awareness to the health risks of severe heat. The five levels of the Heat Stress Index are shown in Fig.5.

Fig.5 The Five Levels of the Heat Stress Index (WBGT – see note below)

Level	Index level	Comments
Blue: Almost safe	Under 21	Appropriate water replenishment recommended
Sky: Caution	21-25	Water should be replenished often
Yellow: Warning	25-28	Rests should be provided often
Orange: Severe	28-31	Heavy exercise prohibited
Red: Danger	Above 31	Exercise prohibited

Note: https://www.wbgt.env.go.jp/en/
Wet Bulb Globe Temperature (WBGT) is an environmental index representing temperature, humidity, and radiation
Source: Heat Illness Prevention Information, Ministry of the Environment, Conceptasia, August 2022

Fig.6 Heat Stress Index, WGBT



WBGT monitoring as of Jul 30 16:00

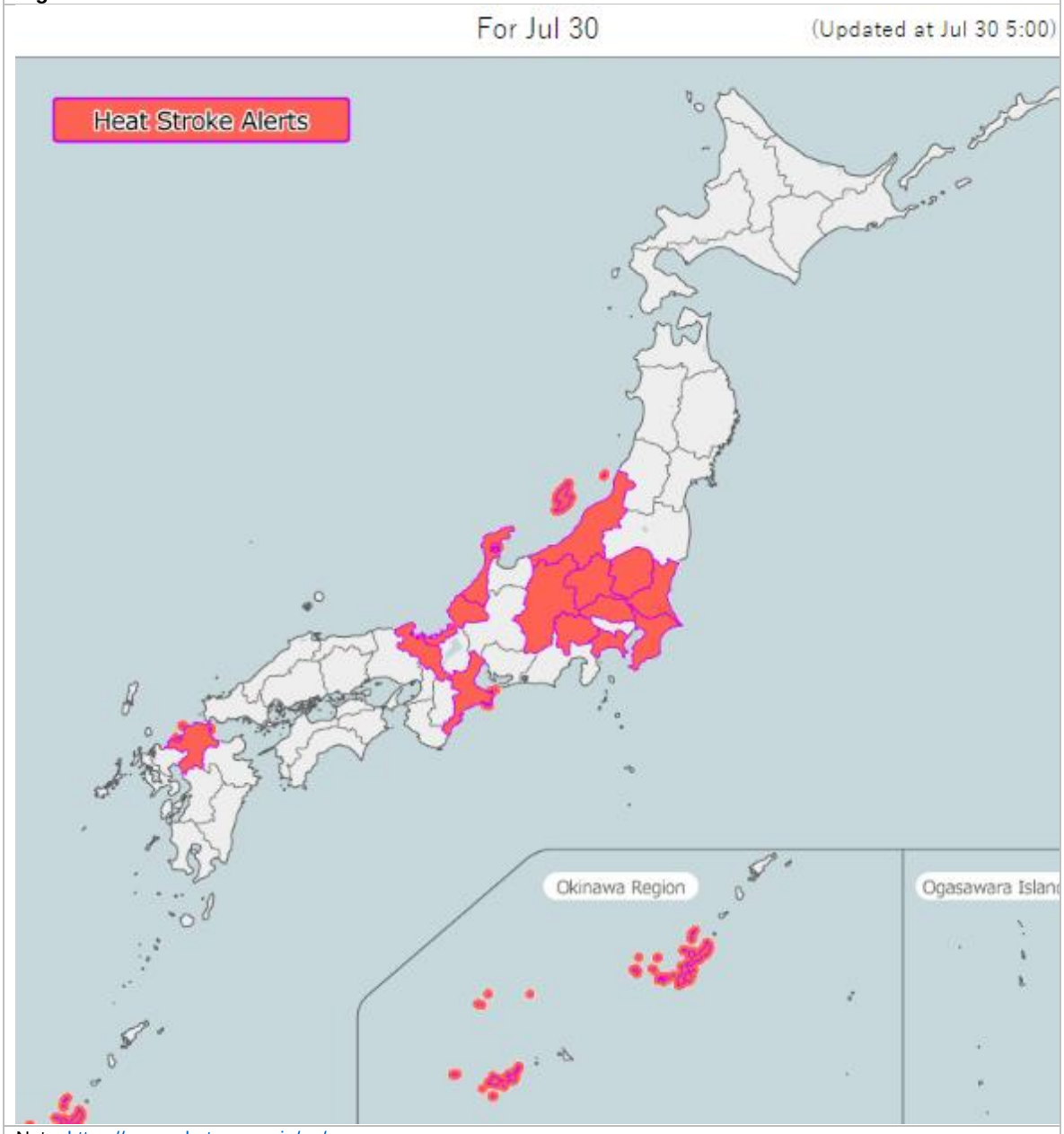
Sapporo	27.0	Sendai	27.8	Tokyo	31.0
Niigata	29.4	Nagoya	29.4	Osaka	29.3
Hiroshima	27.8	Kochi	27.8	Fukuoka	31.0
Kagoshima	28.7	Naha	29.0		

Note: https://www.wbgt.env.go.jp/en/

Wet Bulb Globe Temperature (WBGT) is an environmental index representing temperature, humidity, and radiation

Source: Heat Illness Prevention Information, Ministry of the Environment, Conceptasia, August 2022

Fig.7 Heat Stroke Alerts



Note: https://www.wbgt.env.go.jp/en/

Source: Heat Illness Prevention Information, Ministry of the Environment, Conceptasia, August 2022

References:

1) *Optimal Composition of Fluid-Replacement Beverages*, by Lindsay B. Baker and Asker E. Jeukendrup, 2014
2) *Report of the Task Group on Reference Man*, by W. S. Snyder, M. J. Cook, E.S. Nasset, L. R. Karhausen, G. Parry Howells, and I. H. Tipton, 1975
3) *Nutrition, A Very Short Introduction,* by David A. Bender, 2014
4) *Water, hydration, and health*, by Popkin BM, D'Anci KE, Rosenberg IH. 2010
5) Heat Illness Prevention Information, Japan's Ministry of the Environment: https://www.wbgt.env.go.jp/en/doc_prevention.php