TECHNICAL DISCUSSIONS

SOLAR RADIATION AND ITS RELATED HEAT EFFECTS ON THE HUMAN ORGANISM

RESEARCH ON VARIOUS ASPECTS

Summaries of Papers

by

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The Meteorological and Physiological Significance of the Cumulative Discomfort Index (Cum.D.I.) by Ezra Sohar, Jacob Tennenbaum and Dov Yaski.

A modification of the Discomfort Index of E.C. Thom, transferring the index to the centigrade scale, was used as a means of assessing the feeling of discomfort due to heat. By this modification the Discomfort Index (D.I.) is equal to the arithmetical mean of the dry bulb temperature (D.B.) and the wet bulb temperature (W.B.).

\[ DI = \frac{DB + WB}{2} \]

In order to measure the total heat load on various days or during different periods of time we developed the Cumulative Discomfort Index (Cum.D.I.), which is obtained as the sum of D.I. points above twenty-four for each hour of the corresponding period of time.

During an experimental march from Eilat to Metulah in August 1959 D.I. and the Effective Temperature (E.T.) were measured each hour of the day and night and a good correlation was found between these two scales.

In view of the fact that under conditions prevailing in Israel the two scales correlate well, and that the measurement of the D.I. is a much simpler and a more rapid procedure than measuring the E.T., we recommend the use of the D.I. as more suitable for everyday use.
Various physiological reactions to heat - pulse rate, rectal temperature and excretion of sweat - were measured during the march on ten young men. Of these, only the excretion of sweat was found to be dependent upon heat load and relatively uninfluenced by other factors. A good correlation was obtained between the Cumulative Discomfort Index and the volumes of sweat for twenty-four hours and, separately, for the period of the march.

This gives the Cum.D.I. a physiological significance as a measure of environmental heat load.

Voluntary Sodium Intake during Effort in Hot Environments by Ezra Sohar, Raphael Adar, and Abraham Hershco.

The amount of salt added by ten young men as condiment to their food was measured during an experimental march from Eilat to Metulah. The voluntary salt intake contributes an average of only 4.7% of the total daily sodium intake in an ordinary Western-type diet.

No correlation was found between voluntary sodium intake and the total sodium intake, urinary sodium excretion or environmental heat load.

Voluntary salt intake is determined mainly by personal food habits, and may be modified to some extent by external factors such as the taste of the food or persuasion. Salt appetite is not to be equated with salt requirement.

Dehydration and Urinary pH by Raphael Adar, Jacob Tennenbaum, Reuven Lens and Ezra Sohar.

Changes in urinary pH were measured during an experimental march by ten men from Eilat to Metulah during August 1959. Only minor fluctuations were noted in the urinary pH and these were in no way correlated with the varying degrees of dehydration (up to 6% of body weight) which occurred during the period of effort. There were only small differences in the state of hydration from day to day, and these were not related to the minimal changes in the average pH of the morning urine on the respective days.

No correlation was found between changes in urinary pH and between the volume of urine excreted, the concentration of sodium, potassium and chloride in the urine, the volume of sweat excreted, changes in rectal temperature, and the varying external heat load.

These results tend to discredit the theory that the increased occurrence of uric acid stones which is reported in Israel is due to decrease in urinary pH caused by dehydration.
The Physiological Significance of the Cumulative Discomfort Index (Cum.D.I.)
by Jacob Tennenbaum, Ezra Solar, Raphael Adar and Tuvia Gilat, and Dov Yaski,
Biological Research Institute, Nes-Ziona.

During an experimental march from Eilat to Metulah a good correlation was
noted between the Cumulative Discomfort Index (Cum.D.I.) for four hours, and
the Cum.D.I. during effort on the one hand, and the volumes of sweat secreted
during the respective periods, on the other hand. This fact establishes the
physiological significance of the Cum.D.I. as an index of environment heat
load, because the rate of sweating may be considered as the best indicator of
physiological response to the total heat load of the environment.

From the data gathered a nomogram was drawn from which the expected loss
of fluid can be derived for a given effort and varying heat loads as expressed
by the Cumulative Discomfort Index.

Intake and Urinary Excretion of Sodium Chloride under Varying Conditions of
Effort and Environment Heat by Ezra Zohar, Raphael Adar, Jacob Tennenbaum and
Moshe Kesten

The sodium intake and the urinary excretion were recorded in an experimental
march from Eilat to Metulah during August 1959 by ten young men and in ten
naturopaths living near Safad in August 1960. Sodium excretion was determined
also in workmen in Eilat and in men working in the engine rooms of a ship at
sea.

During the experimental march the men were free to take water, food and
salt as they pleased, and their diet was similar to the average normal diet of
the population. No clinical or laboratory signs of salt depletion were
observed though the men perspired at the rate of 5.5-10.3 litres per twenty-
four hours.

The average intake was 6.0 gm. sodium (equivalent to 15 gm., sodium
chloride) per day, and the average daily urinary excretion was 4 gm. sodium
(10 gm. sodium chloride). The difference between intake and urinary excretion
is accounted for by losses of sodium in the sweat and by changes in the volume
of the extracellular fluid which are caused by fluctuations of the environ-
mental heat load. On the average 82.9% of the total intake of sodium was
derived from the food, 12.4% from water and other beverages, and only 4.7%
from the salt added as condiment to the food.

No correlation was found between sodium intake and the external heat
load or the volume of sweat secreted.
Thirty-five workmen who were engaged in hard physical labor under climatic conditions that prevail in Eilat in August, and who ate average diets, excreted an average of 3.19 gm. sodium (8 gm. sodium chloride) per twenty-four hours.

Nine men working in shifts in the engine-rooms of a ship at sea, also ate average diets, and were doing work that was not so strenuous. They were subjected, however, to extreme external heat loads - the cumulative discomfort index for twenty-four hours was twice that of a hot summer day in Eilat. Their average urinary excretion was 2.35 gm. sodium (6 gm. sodium chloride) per day.

Ten naturopaths living in a small village near Safed, enjoyed comfortable weather (cumulative discomfort index about 1/3-1/4 of that in Eilat), and did light to moderate work. Because of their food habits their average sodium intake was as low as 0.8 gm. per day, and half of this, on the average, was excreted in the urine each day.

No clinical signs or symptoms, that could have been interpreted as being caused by salt deficiency, were noted in any of these groups. The various combinations of work, heat load, and sodium intake observed in the four groups may be taken as representative of the population in this country. It may be concluded that for a population living on a normal diet no danger of salt depletion exists during the summer in Israel. On the other hand, when fluid is restricted, acute hypernatremia may develop after losing large amounts of sweat. The addition of salt to the daily diet as sodium chloride tablets or saline is superfluous and may be harmful.