The Influence of Weather and Climate on Urinary Volume, pH, 17-Ketosteroids, Hexosamines, Cl, K, Na and Urea*

by

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PURPOSE OF STUDY

The present study was carried out for a number of reasons:

(1) It was already known from climatic chamber and high altitude studies (1962b) that thermal and hypoxic stresses may seriously affect the daily urine volume, pH of urine, and the excretion of 17-ketosteroids, chloride, potassium, etc. in urine of man. However, these studies have been carried out for short periods (at most a few months in succession) with students, soldiers and other extremely fit human beings, who cannot be considered to be representative of the general population. The meteorological conditions in climate or low pressure chambers are also not natural and therefore the effects of other natural meteorological factors are easily overlooked. Another problem, in most of the previous experiments, is, that the daily psychological stress conditions (pleasant or unpleasant) of the subjects tested are usually insufficiently known. For these various reasons it was considered to be of great value to study daily the effect of the natural meteorological environment on normal, working, healthy men for a period of 4 years. Of the people selected, a great number of daily stress conditions (such as difficulties in work or at home, illness, etc.) were known and could be included in the graphs.

(2) One is often inclined to forget that, despite the homeostasis of the human body, for short periods considerable fluctuations in the laboratory data may occur which can exceed considerably the range of fluctuations which in clinical work are considered to be normal and which usually do not take into consideration the meteorologically induced fluctuations. As a result an erroneous diagnosis may be made in the case of subjects with biological values normally lying at the edge of the normal spreading of these values, because under certain weather conditions these border values may exceed considerably the normal range.

(3) As urine volume, the daily production of 17-ketosteroids and the excretion of electrolytes in the urine of man are controlled to a considerable extent by hormonal processes in the body, the perpetual daily interaction between the meteorological environment and the physiological processes of the body cannot be demonstrated in a better way than by comparing daily the meteorological factors and a series of easily measurable substances excreted by the body.

METHODS OF STUDY

A. SUBJECTS USED:

Three adult males and two females were used during the initial studies in 1959. After it was found that similar results were obtained in these different subjects, in view of the long-term project a selection had to be made because very few people are

willing and are able to collect daily their urine for a period of 4 years (yearly holidays excluded). So the majority of the 4 years daily observations were based on one adult person of 50 years of age. During those four years for shorter periods his daily curves were compared with similar curves of the four subjects (2 males and 2 females) mentioned above, in order to establish whether the subject used still had the same physiological pattern as in 1959*.

Originally 24-hour urine was collected. However, for the working subjects used it was usually extremely difficult to collect urine between 8 a.m. and 2 p.m. Therefore, for a certain time, the 24-hour urine values were compared with values of urine collected during the period 2 p.m. - 8 a.m. Although the total values differed, the daily fluctuations were the same. This made us decide to use only the 18-hour value (2 p.m. - 8 a.m.) for this 4-year study. Every day at 2 p.m. the subject emptied his bladder and from then onwards all urine was collected in one large bottle, usually at 6 p.m., after he returned home from his work, and during the evening at home. If the subject had to go out for several hours he took a bottle with him in his car.

The subject lived a regular life, i.e. his daily food habits did not change; his daily fluid consumption was practically the same (about 650 - 750 ml), i.e. number of cups (each about 50 ml) of coffee (1 - 2/day) and cups of tea (7 - 8/day, 3 in the afternoon, 5 in the evening). On days that this routine was changed both food and fluid consumption were noted. Although sudden drastic changes in food and fluid consumption affect the daily curves it was found that the really high peaks and low depressions were so characteristic and exceeded the usual daily fluctuations and increased fluid consumption to such an extent that the consumption of one or more glasses of fluid on a particular day could be neglected. This facilitated our work considerably, because in the first period of our work daily the accurate amount of fluid consumption was measured. However, later on, for daily comparison such an accuracy was not considered to be necessary.

Daily both pleasant and unpleasant stress conditions of the subject were recorded. All this information together with the clinical data were plotted in our daily biometeorological weather log (Tromp, 1962b).

B. CHEMICAL DETERMINATIONS

Daily the following 8 parameters were determined: Total urine volume (from 2 p.m. in the afternoon till 8 a.m. the next morning), the pH of the fresh urine (at 6 p.m. in the afternoon) and the excretion of 17-ketosteroids, hexosamines, chloride, potassium, sodium and urea in urine (2 p.m. till 8 a.m. the next morning).

The various analyses**, together with the meteorological data (recorded in my own meteorological station at the University Medical Centre at Leiden), were compiled in large biometeorological logs for the period 1959-1963. In Figures 1-8 small parts of these curves have been reproduced.

*) The daily fluctuation curves in the five subjects during short periods in 1960, 1961 and 1962 were similar. Unless we assume that all 5 subjects changed in the same way during those years, it seems more logical to believe that the basic functions of the main subject remained more or less the same during the whole period of study.

**) All chemical analyses, except the 17-ketosteroid determinations, were carried out in the Clinical Lab. of the Dept. of Internal Diseases, Univ. Medical Centre, Leiden, The Netherlands (Read Dr. W. van der Slik). The 17-ketosteroids were determined in the Clinical Lab. of the Endocrinological Dept. of the Univ. Medical Centre, Leiden (Read Prof. A.A.H. Kassenaar). All measurements of the daily amount of urine and the sampling for chemical analyses were carried out by the author personally. All analyses were carried out by the same technician Miss Elizabeth P. J. Kooy. The various compounds (17-ketosteroids, etc.) can be analyzed several days after the sampling of the urine without affecting the observed values. The samples were always kept in a cool environment. I wish to avail myself of this opportunity of thanking Prof. Kassenaar and Dr. W. van der Slik for their hospitality and most valuable assistance and guidance during the past few years, and Miss E. F. J. Kooy for her excellent analytical work.