THE ROLE OF ULTRAVIOLET RADIATION ON CARDIOCIRCULATORY REGULATION AND ON CARDIOVASCULAR RISK

Rolfdieter Krause¹, Jeanette Dobberke¹, Malte Buehring¹, Werner Hopfenmueller², Heinrich Kaase³, Tai C. Chen⁴, Michael F. Holick⁴
1: Department of Natural Medicine & 2: Institute of Medical Statistics, Benjamin Franklin Medical Center, Free University of Berlin, and 3: Institute of Lighting Technics, Technical University of Berlin, Germany; 4: Vitamin D, Skin, and Bone Research Laboratory, Boston University Medical Center, Boston, MA, USA.

I. Historical aspects of sunlight and cardiocirculatory regulation

The benefit of the exposure to sunlight as a treatment for cardiocirculatory and cardiovascular disorders has been reported for more than 6,000 years, since the times of the Egyptian emperors Ramses and Nofretete. The medical use of natural heliotherapy has also been reported from Hippokrates ("Corpus Hippocraticum"), from health care habits of ancient Rome and from the physicians of the Islamic culture in ancient Iran [29]. A renaissance of heliotherapy took place in the last decades of the nineteenth and in the beginning of the twentieth century. All over Europe, especially in rural areas and at middle and high altitudes (500 – 2000 m above sea level) the exposure to natural sunlight for preventing or treating resistant infectious diseases (e.g. tuberculosis), bone health as well as treating cardiocirculatory disorders was developed [14].

In Germany, natural heliotherapy became an established measure of curative treatment against cardiocirculatory disorders, arrhythmias, and hypertension at the beginning of the twentieth century [9]. Moreover, between 1940 and 1950 reports were published from Sweden about children and adolescents who were artificially UV-irradiated in wintertime to prevent recurrent viral infections [36] and from Germany about miners who were irradiated with artificial ultraviolet light for the compensation of the lack of sunlight while working in the mines and for rehabilitating their physical condition [28]. Through these experiences it became evident for the first time that serial irradiation with (artificial) sunlight had cardiocirculatory effects similar to those after endurance training.
II. UVB and cardiocirculatory and blood pressure regulation

Bühring [7] conducted serial whole body irradiations of healthy young people and demonstrated that only a UV-irradiation lamp with a sun simulating UV-output (that contained UVB radiation; $\lambda=290-320\text{nm}$) showed beneficial effects on the cardiovascular system, whereas in the UVA-irradiated (320-400nm) or non-irradiated controls showed no effect. Schuh et al. [40] demonstrated the same effects after full-daytime exposure at a high altitude (2000 m above sea level); both groups showed that there was a reduction of heart rate at rest and during ergometric exercise and also a reduction of the accumulation of lactic acid at submaximal and maximal ergometric work load. These empirical observations were supported by epidemiological observations over the last four decades that there was a seasonal variation in blood pressure in normotensive as well as in untreated and treated hypertensive persons, with a decrease of blood pressure during summer and an increase during winter [3, 37]. Rostand [38] reported, using a meta-analysis of the data of the INTERSALT-study, that there was a lower level of blood pressure in normal people and a lower prevalence of hypertension the nearer people lived to the equator. The prevalence of hypertension rose with the distance from the equator both to northern and to southern latitudes. Data from the WHO-MONICA-project showed that the incidence of myocardial infarction and the death rate from myocardial infarction as well as sudden death is statistically significantly higher in countries of northern latitudes all over the world [48].

A relationship between latitude and cardiovascular disease mortality was discussed by Gardner [11] from data of England and Wales, from other parts of Europe by Smith [46], and by Fabsitz [10] from the United States. Scragg et al. [42, 43, 44] first focussed on a possible relationship between ultraviolet irradiation and the seasonality of cardiovascular disease mortality. In a community-based study he found that the incidence of myocardial infarction is inversely associated with the serum level of 25-hydroxyvitamin D₃.

III. Vitamin D and cardiocirculatory system and blood pressure regulation

An association between the elevation of blood pressure and the serum concentration of 25-hydroxyvitamin D₃ was observed in patients with essential hypertension [15] and in animals (Dahl salt-sensitive rats) [47]. Moreover, Kristal-Boneh et al. [25] found a correlation between 1,25-dihydroxyvitamin D₃ and the height of blood pressure.