SUNLIGHT EXPOSURE AS A MAJOR PREVENTATIVE FACTOR IN THE DEVELOPMENT OF HYPERTENSION AND OTHER DISEASES

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Abstract.

Background. An independent observation study of the effects of sunshine on the reduction of blood pressure, done on the Caribbean island of St. Lucia. Sunlight is known to convert cholesterol to vitamin D-3; insoluble unconjugated bilirubin (direct) to soluble, excretable conjugated bilirubin (indirect); induce sweating; and convert aldosterone and other steroids to less active or inactive metabolites. Additionally, sunlight affects the pineal gland and melatonin secretion through its network of receptors. Melatonin secretion is greater in the dark and it inhibits the secretion of leutinizing hormone. Consequently a decrease in melatonin secretion will cause a subsequent rise in sexual steroids, which are convertible to vitamin d-like compounds. Most of these affects of sunlight have the effect of reducing blood volume or reducing sodium levels in the blood and interstitium. Would sunlight exposure have a measurable affect on blood pressure by reduction in blood volume? If there was a measurable difference in blood pressure levels, would that difference be therapeutic?

Methods. A brief history was taken from each of the 186 subjects and their blood pressure was measured.

Results. The overall average blood pressure was found to be 135/79 mm Hg, and the overall average pulse of 71, with an average daily sunlight exposure of 4 hours and 4 minutes. The average blood pressure of people with 1 hour per day of sunlight exposure was 141/85 mm Hg. The average blood pressure for 2 hours per day exposure to sunlight was 145/83 mm Hg. The average blood pressure of people with 7 hours per day was 121/72 mm Hg. The nine hour result was 121/77 mm Hg. Altogether, the statistical power for the systolic data was 0.0021. The statistical power for the diastolic data was <.00001, Both values are considered highly statistically significant.

Conclusions. Sunlight exposure of three (3) hours per day or more is a major preventative factor in the development of hypertension in the general population. The optimum daily exposure to sunlight is seven (7) hours to prevent hypertension.

BACKGROUND

Hypertension is an insidious disease the may effect up to 25% of the American population. Black Americans have a much higher incidence of hypertension than their white neighbors. Black Londoners have a significantly higher incidence of hypertension than Urban Zulu in South Africa. Urban Zulu's have a higher incidence of hypertension than their rural brethren. However, hypertension in Kalahari bushmen is virtually unknown, even at advanced age. These facts lead one to conjecture that the development of hypertension may be due to an environmental factor.

The most obvious of environmental factors different from London to Africa is the difference in temperature. In Africa, the temperature is tropical at all times of the year, with few exceptions. Temperature differences alone do not satisfactorily explain the higher incidence of hypertension in urban Zulu's versus rural Zulu's. This leaves us with sunlight exposure as the most likely environmental factor which could explain these diverse ranges of blood pressure throughout the world.
Kalahari bush people are constantly exposed to the sun’s intensity without relief from dawn to dusk. Outside of their abodes they are relentlessly bombarded by the sunlight directly and reflectively. More developed cultures in the same region take advantage of houses and buildings which do not allow the penetration of sunlight through the periphery and, additionally, may be cooled by air conditioning. Air conditioning will reduce sweating. The Kalahari are so acclimated to sunlight exposure that sunburn is not a significant problem. Sunburn is the complex skin reaction to the wavelength of 290 nm to 320 nm of UV radiation, the same wavelengths that breakdown cholesterol and ionize bilirubin.

The quantity of the ultraviolet sunburn radiation that reaches the earth's surface is dependent on the quantity of atmosphere it passes through, its attenuation by the absorption in the ozone layer, and scattering by atmospheric turbidity. The intensity of light is a function of the latitude, season, and time of day. As expected, there is an increase and accompanying decrease of intensity of sunlight on the earth as one moves from one pole to the other. The intensity of sunlight is highest at the equator.

If sunlight exposure over a lifetime was beneficial, it would reduce the body's retention of electrolytes, cholesterol, sodium and water retention, reduced bilirubin levels, and consequently lower blood pressure.

METHODS

During the spring and summer of 1993 I conducted a survey of the residents of Vieux Fort, St. Lucia for the purpose determining if per diem levels of sunlight exposure results in differences of blood pressure. On Saturday mornings, I placed myself and my assistants on the corners of streets next to the market place where most residents of the town went to buy their fish, vegetables, fruits and ground provisions. These locations promised the best mix of all social, business, and trade classes in the region because most families needed to buy these provisions for themselves. Also, the farmers who did not live in the town would come in town to sell. My assistants and I queried the subjects about the name; age; residency; work history; exercise; alcohol consumption; meals per day; smoking; hours/day in shade, sunlight, indoors, outdoors; sweating history; existing maladies, and a brief biographic history. Then I measured and recorded each subject's blood pressure and pulse.

At no time were any subjects told what the study was about. Patients returning for repeat check-ups were not recorded. Only the initial blood pressure measurement were used in the study.

RESULTS

The number of people in the study was 186. The average systolic blood pressure was 135.22 mm Hg with a standard deviation of 20.81 mm Hg. The average diastolic blood pressure was 79.13 mm Hg with a standard deviation of 15.51 mm Hg. The average pulse was 71.
Table I. Daily Sunlight Exposure and Blood Pressure Measurements.

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<th>Systolic BP (mm Hg)</th>
<th>Diastolic BP (mm Hg)</th>
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<th>Calculated Z of Diastolic BP</th>
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Summary

4 hours 4 min 135.22 79.13 186 -2.872 -5.625

Statistical Power 0.0021 Highly Statistically Significant < 0.00001 Highly Statistically Significant

Blood Pressure vs Sunlight Exposure
DISCUSSION

It is believed that hypertension in blacks and other dark-skinned ethnic groups is caused by sodium retention. If such was the case, ACE inhibitors and beta-blocker drugs such as labetalol, propranolol, etc., would be an effective medical treatment for these ethnic groups. Such is not the case. Clinically speaking, diuretics and calcium channel blocks produce much better results in these ethnic groups. Hypertension in these groups may be due to a more complex combination of mechanisms of which sunlight exposure may interfere with those pathological processes.

Human skin adjustments to repeated UV exposition is so familiar it is frequently modeled as a simple acclimatization. The quantity of melanin pigmentation in the human skin determines the tolerance to UV radiation. This is certain at the racial level, at the individual genetic level, and in terms of the personal adjustment. Melanin pigmentation increases with exposure to sunlight. In an study a group of men were exposed to the summer sunlight in Idaho, a series of 40 minutes exposure was given to them. After the third exposure, two weeks after the first exposure, the melanin pigmentation had reached a plateau and with continued 40 minutes exposures the skin stayed acclimated with the same degree of pigmentation. In the contrast, it was seen that with growing expositions of 60, 80, and 100 the minutes pigmentation increases progressively. This is analogous to the man in the poor physical condition who runs a slow 400 meters, developing an improved capacity to run 400 and who eventually reaches a plateau. If he then starts to run 1600 meters, he starts with the improved acclimatization earned while running 400 meters, but he has to develop additional adjustment increases for the more vigorous effort. This is characteristic of many sorts of adjustment to the ambient environment.

Nearly everyone enjoys the trip to the beach on a sunny day unless he acquires a sunburn. However, the good feeling associated with the sun exposition is not yet explained in metabolic or biochemical terms. There are, however, six known prominent benefits of solar irradiation on normal human skin.

1. The production of vitamin D from the cholesterol.
2. The conversion of bilirubin to a soluble non-toxic form.
3. Sweating, which decreases the level of sodium in the serum.
4. Regulates the release of melatonin from the pineal body which affects the body's internal clock.
5. The conversion of corticoids and minerosteroids, such as aldosterone, to metabolic by-products without reduce or no metabolic activity.
6. Increased melanin production.
THE VITAMIN D AND CALCIUM

Until the 1920s, rickets was a serious medical problem in the United States and Europe. Rickets involves a defect of calcium absorption and as a result the bones form poorly during growth, and the child grows up with inclined legs and other skeletal disfigurements. Women with rickets have deformed pelvises that can prevent normal delivery. Thus an environmental factor can have the same effect as a fatal mutation. The anthropologists believe that the bandy and short stature bones of the Neanderthal man resulted from rickets. Rickets deformities complicates the birth of a child. Additionally, dark-skinned children are much more susceptible to the rickets than light-skinned children because of their skin's increase melanin content which absorbs UV radiation at the cholesterol breaking wavelengths. Melanin protects dark skinned people from dangerous consequences of UV exposure in tropical environments.

Photochemical and biochemical studies show that 7-dehydrocholesterol in the animal skin is converted to the vitamin D3 by the same wavelength of UV radiation that causes sunburn. The action mechanism of vitamin D is as follows: In the liver the vitamin D is converted to 25-hydrocholecalciferol, which enters the circulation and it is confined, consequently, to the granules of the intestinal epithelium cells. Here it attaches directly on the nuclear DNA, causing the DNA to copy the information and the RNA, at the same time, copy the message to form the enzyme needed for transportation of calcium from the gut lumen in the circulation. Thus UV light from the sun or other sources produces vitamin D, that, through a biochemical chain of events regulates calcium absorption and make internal calcification possible. Due to the constant monitoring of blood osmolarity, calcium and other electrolytes are balanced. Increases in calcium concentrations decrease the concentrations of other electrolytes, particularly sodium. Exposure to sunlight is essential for all human because more 90% of the vitamin D necessary for the life it is produced in the skin from the exposition at UV illuminates from the sun. Additionally, every molecule of vitamin D created from cholesterol in the skin's bloodstream as a result of photochemical breakdown is one less molecule of cholesterol to cause artheropathologies.

BILIRUBIN

Bilirubin it is a yellow degradation product of the hemoglobin released when the red cells of blood die. It is gravely toxic for human beings only during the first few life days. An increase in the concentration of bilirubin in the blood causes the exposed skin to change to the characteristic yellows of jaundice; thus hyperbilirubinemia occurs because bilirubin being formed faster than the it is removed from the body. This process, begun by the liver, is delayed abnormally, in these children. A hazardous form of hyperbilirubinemia occurs very frequently in neonates and premature infants whose liver are immature biochemically. It also happens in those children whose red blood cells are destroyed in the pathological conflict of Rh of incompatibility. The lipid soluble bilirubin becomes concentrated in certain parts of the brain, where it can destroy the neurons and produce a clinical syndrome called kernicterus ("yellow brain"). The resulting cerebral damage is irreversible and causes various degrees of motor and mental delay leading to focal cerebral paralysis and eventually death.

Like rodopsin, bilirubin is polarized by white light. Unlike rodopsin, bilirubin's photodecomposition it is not reversed by darkness. The mechanism of the photochemical polarization of bilirubin is as follows: UV light breaks a bond on the surface of the bilirubin molecule resulting in an ionized form. This reaction is the equivalent of a phase 1 metabolic reaction by the liver on drugs, pharmacology. The liver makes a phase 2 reaction with a glucuronyl transfer to produce a soluble form. The excreted conjugates are stable. UV, blue light, has been found to be very effective in the decomposition of bilirubin. It is
not known if increases in bilirubin levels cause increases in blood volume. However, it can be speculated that increases in bilirubin concentrations may lead to corresponding increases in water volume in the blood stream in the bodies continuous efforts to maintain its osmolarity.

Again, the need to decompose bilirubin does not end with childhood. Adults need this decomposition processes for their life processes. Photodecomposition reduces the quantity of phase I reactions by the liver and reduces the biochemical load. Bilirubin is decomposed by several processes.

Bile acids are synthesized from cholesterol at the rate of 0.5 g/day. Before they are secreted they are conjugated with amino acids glycine or taurine. These bile acids are reused by the body over and over again. About 0.5 g/day are lost in the gastrointestinal tract as a result of the digestive process.

The recycling of bile acids occurs in stages. Intestinal bacteria deconjugate bile salts into bile acids which are the absorbed in the small intestine. Bile acids travel to the liver via the enterohepatic circulation (portal system). The liver reconverts these reabsorbed acids back into bile salts and secretes them along with newly synthesized bile acids.

SWEATING

Sweating is the body’s most efficient mechanism of excreting sodium. It is extremely rare for athletes to have hypertension, even in cold climates, because they sweat tremendous quantities of electrolytes and water. The predominant electrolyte of sweat is sodium. With consistent exercise there is a reduction of interstitial sodium concentrations, a reduction in the amount of circulating water (balance osmolarity), and consequently a reduction in blood pressure. Even people who are not athletes benefit from sweating. For example, in a sauna, the sweating has the same benefits in reduction of interstitial sodium concentrations. However, sauna use does not have one added benefit of exercise: increased capillary formation, which is another reason why athletes traditionally have lower blood pressures. Clinical evidence of the effectiveness of sweating in reducing blood pressure is easily demonstrated by two well know pathologies:


Heat Exhaustion:
The direct load of solar radiation is a factor that increases body heat. If the solar load on the human body exceeds the capacity of the body to cool by the radiation, convection, and sweat evaporation, then cardiovascular insufficiency, dehydration, electrolyte deficiencies, vomiting, low grade fever, and fainting occurs. This condition is known as heat exhaustion. The rest, fluid replacement, and protection from additional exposure to heat may all that it is necessary.

Heat Stroke:
If the thermal regulation fails to find the thermal tension in a subject exposed to a high environmental temperature, a high load of radiant heat, or other heats extremes, a condition characterized by high body temperature (hyperthermia), irritability, prostration, delirium, the skin feels dry and hot, reduced or the absent sweat, hyperventilation, and coma may occur, causing temporary or permanent damage to the thermal regulatory system and eventually death. This condition is much more serious than heat exhaustion and is called heat stroke.
SUNLIGHT, THE PINEAL BODY AND MELATONIN

The quantity of time all living creatures are exposed to light varies with two hemispheric skies, from a 24 hour light obscured sky, to an annually varying annual sky with a changing length of day and night, absent only at the equator. Motor activity, sleep, water consumption, body temperature, and the quantity in which many glands secrete their hormones all vary in pace with periods of approximately 24 hours. For example, the concentration of cortisol in the blood of human varies with a characteristic 24 hour cycle. It is maximum in the hours of morning and minimal at night. When people choose to reverse their activity schedules (e.g. working during the dark hours and sleeping during the daylight), their plasma cortisol level require on 5 to 10 days to adapt to the new environmental conditions.

Experiments have supplied evidence that the nervous impulses that reach the pineal body by means of sympathetic nerves determine the amount melatonin synthesized. These impulses vary inversely with the quantity of visible light that strikes the retina, that is, the more light exposure, the less melatonin. Additionally, the mammalian pineal gland also synthesizes and secretes two compounds with biologic activity 5-methoxytryptophol, a methoxy indole like melatonin, whose pineal levels exhibit similar daily rhythms; and arginine-vasotocin, an octapeptide, similar in structure to oxytocin and vasopressin (ADH).

These impulses are carried through the brain, the spinal cord, and sympathetic nervous system by a circular route, that defers from the visual path. The administration of melatonin affects the brain and secretion by various endocrine organs that act on the neuroectocrine centers that control the brain. In the brain, melatonin induces sleep, modifies the electroencephalogram, and increases the levels of the neurotransmitter serotonin. Melatonin blocks the cyclical leutinizing release hormone, the hormone responsible for ovulation, from the pituitary gland and increases prolactin secretion. Immature females exposed to insufficient sunlight became sexually mature at an earlier age than females kept on a 24 hour, light-dark cycle. This effect is the thought to have been mediated by photo inhibition of melatonin secretion. It may be possible that excess sunlight exposure may interfere with the aging process by inhibition of melanin secretion.

PHOTOCONVERSION OF CHOLESTEROL BASED COMPOUNDS

Not much is known about the details of photoconversion of cholesterol based compounds. What is known is that they are converted at about the same rate as cholesterol. The metabolic activity of many of these compounds are unknown. They are for the most part excreted in the urine. More research needs to be done in this subject.

However, because sunlight’s UV radiation breaks down the structure of cholesterol, many speculations can be made:

1. The body’s concentration of cholesterol, including HDL and LDL cholesterol, are diminished, vitamin D is increased as well as total body calcification.
2. Diminished blood pressure due to the total effects of sunlight on the human body.
3. Due to the breakdown of testosterone and testosterone by-products by sunlight, patients with increase exposure to sunlight, male subjects will have lower incidences of prostate cancer and other cancers known to be receptive to testosterone derived metabolites.
4. Due to the breakdown of estrogen and estrogen by-products by sunlight, patients with increase exposure to sunlight, female subjects will have lower incidences of breast cancer and other cancers known to be receptive to estrogen derived metabolites.
MELANIN

Melanin is a brown or black pigment found in many animals. Melanin is very chemically resistant. It has an absorption spectrum relatively flat throughout the ultraviolet, visible, and near infrared spectra. Melanin is not only an good absorber of light, granular melanin (about 1 micrometer in diameter) also scatters light very well. Melanin granules tend to locate as a shell on the nucleus of keratinocytes. This location provides protection from UV light to nuclear DNA, which contains the genetic information for the maintenance of the epithelium throughout life. The degree of melanization may be the factor that determines human skin tolerance for ultraviolet radiation. The dark races differ from light races in the amount of formed melanin, though the number of melanocytes are approximately the same. Blacks form larger granules of melanin than Caucasians, and above that, in Blacks, the melanin granules transcribed in the keratinocytes are packed individual. In Caucasians, two or more smaller melanin granules are found in each lisosome. Blacks, presumable, achieve greater pigmentation dispersion by this means, and the granules stays intact in the stratum corneum, and are better able to stay intact than the smaller fragments as made in the skin of Caucasians. Oriental skin appears to behave similarly to Caucasian skin. The skin of the Australian aborigine is similar to the African Black. There is no difference in stratum corneum thickness among the races.

The importance of racial differences is not understood entirely, and their adjustments to different environments is the topic of much speculation. The banner explanation is that the dark races skinned are protected from aging, carcinogens, and other damaging effects of ultraviolet radiation by their high melanin content. The light skin of the European, Caucasian, Orientals is considered an adaptive adjustment to low ultraviolet radiation levels.

CONCLUSIONS

The most obvious conclusion of this study is that sunlight exposure greater than three hours per day is a major factor in the prevention of hypertension particularly for dark-skinned people. The optimum exposure for prevention of hypertension is seven hours per day.

Additionally, it may also be postulated that sunlight exposure over similar duration may also have the following consequences:

1. Reduce the incidence of prostate cancer and other testosterone sensitive cancers in males.
2. Reduce the incidence of breast cancer and other estrogen sensitive cancers in females.
3. Sunlight exposure may interfere with the aging process by inhibition of melanin secretion and delaying the biological clock.

Now, let us begin to explore the physiological, behavioral, physiological, and biochemical effects of environmental factors that up until now we may have taken for granted.
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