BIOPHYSICS OF EARTHING THE HUMAN BODY

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Reprint from
BIOELECTROMAGNETIC AND SUBTLE ENERGY MEDICINE
SECOND EDITION
edited by Paul J. Rosch, MD

CONTENTS

INTRODUCTION

In medicine, the path to new discovery is often difficult and challenging. When a valuable discovery is made, it can be even more difficult to get it to the people who need it. This is true even for discoveries that could resolve costly and debilitating disorders that affect many people and ruin many national economies, and that, therefore, deserve the highest priority. A discovery of this kind is the topic of this chapter.

In a Classic letter to *Science* entitled *Dionysians and Apolionians,* Albert Szent-Györgyi stated it this way:

> Wilhelm Ostwald[1] divided scientists into the classical and the romantic. One could call them also systematic and intuitive. John R. Platt calls them Apollonian and Dionysian. These classifications reflect extremes of two different attitudes of the mind that can be found equally in art, painting, sculpture, music, or dance. One could probably discover them in other alleys of life. In science the Apollonian tends to develop established lines to perfection, while the Dionysian rather relies on intuition and is more likely to open new, unexpected paths for research. Nobody knows what"intuition" really is. My guess is that it is a sort of subconscious reasoning, only the end result of which becomes conscious.
>
> These are not merely academic problems. They have most important corollaries and consequences. The future of mankind depends on the progress of science, and the progress of science depends on the support it can find. Support mostly takes the form of grants, and the present methods of distributing grants unduly favor the Apollonian. Applying for a grant begins with writing a project. The Apollonian clearly sees the future lines of his research and has no difficulty writing a clear project. Not so the Dionysian, who knows only the direction in which he wants to go out into the unknown; he has no idea what he is going to find there and how he is going to find it.[2]

The book you are holding in your hands can be extremely valuable to any scientist or therapist entering unknown territory. Here you will find scientific concepts that are mostly outside of the mainstream, therefore, they can act as fertile new ground for contemplation, synthesis, and new discov- ery. The human body is always unknown territory, for when we think we understand one aspect, several other mysteries pop up.

INFLAMMATION

We now know that many, if not all, of the most common, debilitating, and costly health disorders and diseases are partly or entirely energetic in nature, and are therefore, difficult to prevent, treat, or even comprehend when energy is left out of the discussion. Moreover, cures for the most serious health problems will remain elusive until medical researchers consider energetics. This does not mean textbook biochemical or molecular energetics, it means the energetics as described by the steadily maturing sciences of physics, biophysics, and quantum physics. This fact is documented by one of the most significant advances in biomedicine that has taken place in recent times. Specifically, the study of inflammation has become one of the most active areas of biomedical research, with over 400,000 peer reviewed studies completed during the period 1967–2013 (see Figure 38.1).[3] Inflammation is incomprehensible without an energetic perspective.

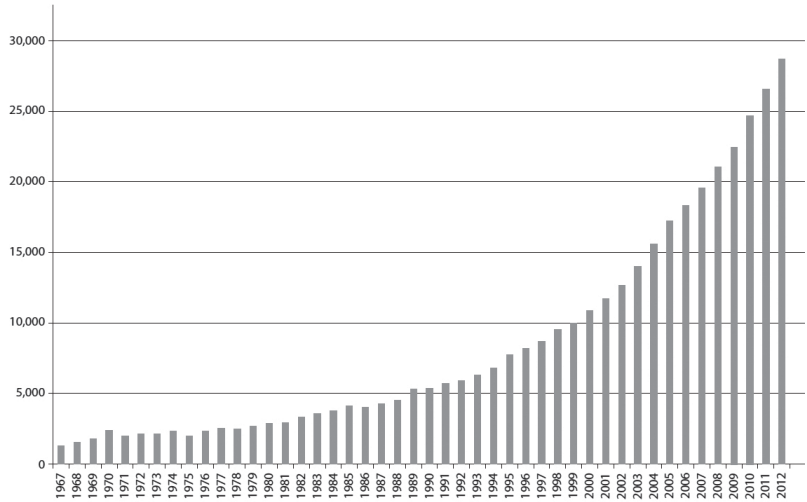

FIGURE 38.1 Growth in number of peer reviewed studies of inflammation, 1967–2012, data from the National Library of Medicine database, PubMed (as of January 20, 2013).

Chronic disease is the number one cause of death and disability worldwide. Treating patients with chronic diseases accounts for 75% of U.S. health care spending, which surpassed $2.3 trillion in 2008. The most common and costly chronic diseases are heart disease, cancer, stroke, chronic obstructive pulmonary disease, osteoporosis, and diabetes.[4] Other significant inflammatory conditions include Alzheimer disease, asthma, bowel disorders, cirrhosis of the liver, cystic fibrosis, lupus, meningitis, multiple sclerosis, psoriasis, and arthritis. Tragically, many patients suffer from several of these problems simultaneously.

The public has been informed about the inflammation connection in articles published in major news sources (e.g., The Secret Killer, *Time* Magazine, 2004).[5] While abundant research has documented a relationship between chronic inflammation and virtually all chronic diseases, including all of the diseases of aging, profoundly important questions are unanswered. In fact, they are rarely discussed:

- What causes chronic inflammation?
- Precisely why is inflammation associated with so many different chronic diseases, just exactly what is the connection?
- Why have these chronic diseases reached epidemic proportions in recent times?
- What can an individual do about it?
- When an energetic approach is effective for a chronic issue, what is this telling us about human biology that could help us stay healthy and recover from disease should it arise?

This chapter relates to all of these questions. It concerns a natural approach to inflammation and chronic disease that is"of the earth" and that has been recognized since ancient times. Unfortunately, modern biomedicine rarely looks at traditional wisdom, focusing instead on the latest pharmacology and high-tech devices. We begin with the benefits of direct physical contact with the surface of the earth, as with bare feet or hands. This is termed "grounding" or "Earthing." In the process of studying why Earthing is so beneficial, scientists have uncovered some of the missing pieces of the inflammatory response, developed new information on how the immune system works, and described natural methods anyone can use to support their immune system.

BAREFOOT

People who work barefoot in the garden or walk barefoot along the beach often experience a special sense of wellbeing, just from being in direct physical contact with the earth. Some teachers of ancient practices such as Yoga and *Qigong* recommend that all exercises be done while barefoot on the earth. There is no comparison between walking, running, or practicing any form of movement therapy or martial arts indoors and doing the same activities with bare feet in direct contact with the earth. Why should this be the case? The significance of barefoot contact with the earth has been known since ancient times. Native American elders have discussed this in their traditional story telling:

> It was good for the skin to touch the bare earth, and the old people liked to remove their moccasins and walk with their bare feet on the sacred Earth…they sat on the ground with the feeling of being close to a mothering power…the soil was soothing, strengthening, cleansing and healing.
>
> **—Luther Standing Bear (1868–1939)** *Sioux Tribal Leader*[6]

In the late nineteenth century, a back-to-nature movement in Germany claimed many health benefits from being barefoot outdoors, even in cold weather.[7] In the 1920s, George Starr White, MD, investigated the practice of sleeping grounded after being informed by some individuals that they could not sleep properly, "unless they were on the ground or connected to the ground in some way," such as with copper wires attached to grounded-to-Earth water, gas, or radiator pipes. White reported that sleep improved with these techniques.[8] However, these ideas never caught on in mainstream society.

A modern Yoga teacher says that the benefits of walking barefoot on the earth include:

- A better balance in our nervous systems
- Improved circulation
- Reduction in inflammation in our bodies
- It is the ultimate antioxidant!

—Samantha Fox Olson[9]

Recent research confirms each of these points.

Throughout history, humans mostly walked barefoot or with footwear made of animal skins (moccasins). They slept on the ground or on animal hides. We shall see that recent research confirms the health advantages they achieved by this lifestyle and explains why this happens. Through direct contact or through perspiration-dampened and electrically conductive animal skins used as footwear or sleeping pads, the ground's abundant free electrons were able to enter their bodies, which are electrically conductive. Through this mechanism, every part of the body can equilibrate with the electrical potential of the earth, thereby stabilizing the electrical environment of all organs, tissues, cells and molecules, and providing a key ingredient needed for the operation of the immune system.

MODERN LIFESTYLE AND DIABETES

Modern lifestyle has increasingly separated humans from contact with earth's electrical field and free electrons. For example, since the 1960s, we have increasingly worn shoes with insulating rubber or plastic or composite soles, instead of the traditional leather soles fashioned from animal hides. Some have lamented that the use of insulating materials in post-World War II shoes has separated us from the Earth's energy field.[10] Obviously, we no longer sleep and walk directly on the ground as we did in times past. Moreover, our houses have floors made of wood or acrylic that are also insulating. Even carpets are made from synthetic materials that are nonconductive, and that can cause build-up of harmful static electrical charges on our bodies.

During recent decades, stress related chronic illness, immune disorders, and inflammatory diseases have increased dramatically, and some researchers have suggested that environmental factors are the likely cause. However, the possibility of modern disconnection with the earth's surface as a cause of chronic disease has not been considered by modern biomedicine. The research summarized in this chapter points in that direction.

For example, we are experiencing a global epidemic of diabetes, and there are compelling reasons to look at the possibility that this may in part be related to our loss of contact with the surface of the earth. Figure 38.2 graphs the escalating incidence of diabetes along with the growth of sales of athletic shoes, virtually all of which have insulating rubber or plastic soles. In the early 1950s, some 95% of shoes had leather soles. Leather is a material that will conduct electrons if it is moist, as from the inevitable perspiration from sweat glands on the bottoms of the feet. Fifty years later, 95% of shoes had insulating soles, mostly made of synthetic or composite materials, electrical insulators that completely disconnect the wearer from the earth. Other lifestyle changes over the same time period included the introduction of fast-food, computers, and cellular telephones. People moved indoors to watch television. Skin contact with the surface of the earth became rare.

Diabetes accounts for 10% of all health care dollars spent.[11]

> The world is losing the battle against diabetes as the number of people estimated to be living with the disease soars to a new record of 382 million this year, medical experts said on Thursday. The vast majority have type 2 diabetes—the kind linked to obesity and lack of exercise—and the epidemic is spreading as more people in the developing world adopt Western, urban lifestyles. The latest estimate from the International Diabetes Federation is equivalent to a global prevalence rate of 8.4% of the adult population and compares to 371 million cases in 2012.[12]

A recent news headline:

> *Diabetes Ailing 114 Million Chinese Risks Ravaging Budget:* Diabetes may consume $22 billion, or more than half of China's annual health budget, if all those afflicted with the condition get routine, state-funded care. The disease is putting an "overwhelming burden" on the country, according to the International Diabetes Federation, which says China spent $17 billion, or about $194 a patient, on diabetes last year. A study released last week found China has 114 million diabetics or 21.6 million more than the Brussels-based federation estimated in November. Extending average care to the enlarged population of diabetes sufferers would wipe out all of China's additional investment in health. The government budgeted spending 260.25 billion yuan ($42.5 billion) this year, a 27% increase, on basic medical services and subsidies for a state-run health insurance program. China's diabetes costs will balloon, with almost 500 million Chinese at risk of developing the disease. "It's very scary," said T.H. Lam, a professor of public health at the University of Hong Kong. "This only represents the beginning of the diabetic epidemic. The worst is yet to come." Diabetes costs an average of $1270 per patient globally and $8478 in the U.S., according to the International Diabetes Federation. Treatment for the metabolic condition and its associated ailments is expensive because patients with poor blood-sugar control can develop complications ranging from heart disease and stroke to gangrenous foot ulcers, blindness and kidney failure.
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> **—Bloomberg News, September 12, 2013**

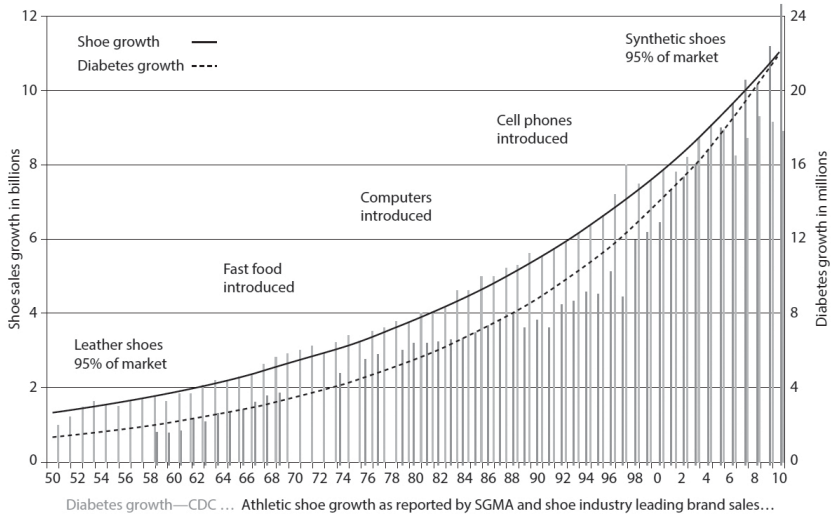

FIGURE 38.2 Sixty years of synthetic soled shoe sales growth correlates with last sixty years of diabetes growth.

At the end of the last century, experiments initiated independently by Ober in the USA,[13] and cardiologist and neurosurgeon father and son on the medical staff of a military clinic in Poland, Karol and Pawel Sokal,[14] revealed distinct physiological and health benefits with the use of conductive bed pads, mats, EKG- and TENS-type electrode patches, and plates connected the earth outside. These physiological changes included effects on blood glucose regulation.

REDUCTION OF PRIMARY INDICATORS OF OSTEOPOROSIS, IMPROVEMENT OF GLUCOSE REGULATION, AND IMMUNE RESPONSE

The Sokals were seeking regulating factors that are universal in nature and that might be disturbed in the modern environment. Their hypothesis was that interactions between living organisms and the electrical properties of the earth, either by direct contact with the earth's electrically charged surface and/or by field interactions with the earth's electrical field, could be involved in physiological regulatory processes. They mentioned theories about the origin of life involving electrical phenomena that triggered the combining of the elements in the primordial aqueous environment to form stable biomolecules that could reproduce themselves. Perhaps in modern times such electrical phenomena continue to be important forstabilizing various essential regulatory processes.

Their study was designed to answer the question: Does the contact with the earth affect calcium–phosphate homeostasis, concentration of electrolytes, glucose metabolism, proteins, and thyroid function? They conducted a series of experiments to determine whether contact with the earth via a copper conductor can affect physiological processes. The results related to diabetes, osteoporosis, and thyroid function.

> Earthing had a direct, statistically significant and beneficial effect on the regulation of blood glucose in patients with noninsulin-dependent diabetes mellitus. This was demonstrated by the decrease in fasting glucose concentrations (means ± standard error of the mean) from 10.6 ± 1.2 to 7.4 ± 0.8 mmol/L, $p < 0.05$.

Double-blind experiments were conducted on groups ranging from 12 to 84 subjects who followed similar physical activity, diet, and fluid intake during the trial periods. Grounding was achieved with copper plates (30 × 80 mm) placed on the lower part of the leg, attached with a strip so that it would not come off during the night. The plates were connected by a conductive wire to a larger plate (60 × 250 mm) placed in contact with the earth outside.

Earthing continually during rest and physical activity over a 72 h period decreased fasting glucose among patients with noninsulin-dependent diabetes mellitus (NIDDM). Patients had been well controlled with glibenclamide,* an antidiabetic drug, for about 6 months, but at the time of study had unsatisfactory glycemic control despite dietary and exercise advice and glibenclamide doses of 10 mg/day.

In another experiment with nonmedicated subjects, grounding during a single night of sleep resulted in statistically significant changes in concentrations of minerals and electrolytes in the blood serum: iron, ionized calcium, inorganic phosphorus, sodium, potassium, and magnesium. Renal excretion of both calcium and phosphorus was reduced significantly. These reductions in blood and urinary calcium and phosphorus directly relate to osteoporosis. The results suggest that earthing for only a single night reduces the primary indicators of osteoporosis. This is a remarkable finding that needs a follow-up study by those interested in public health and the high costs of medical care.

The Sokals drew blood samples from six male and six female adults with no history of thyroid disease. A single night of grounding produced a significant decrease of free tri-iodothyronine and an increase of free thyroxin and thyroid-stimulating hormone. The significance of these results is unclear, but the logical explanation is that earthing influences hepatic, hypothalamic, and pituitary relationships via adjusting thyroid function.

Many individuals on thyroid medication reported symptoms of hyperthyroid, such as heart palpitations, after starting grounding.[15] Such symptoms typically vanish after medication is adjusted downward under medical supervision. Through a series of feedback regulations, thyroid hormones affect almost every physiological process in the body, including growth and development, metabolism, body temperature, and heart rate. Further study of Earthing effects on thyroid function will obviously be valuable.

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*Glibenclamide, also known as glyburide is an anti-diabetic drug in a class of medications known as sulfonylureas, closely related to sulfa drugs. It is sold under the trade names Diabeta, Glynase and Micronase in the United States and Daonil, Semi-Daonil and Euglucon in the UK, and Delmide in India. It is also sold in combination with metformin under the trade names Glucovance, Benimet and Glibomet. The drug works by binding to and activating the sulfonylurea receptor 1, the regulatory subunit of the ATP-sensitive potassium channels in pancreatic beta cells. This inhibition causes cell membrane depolarization, opening the voltage-dependent calcium channel. This results in an increase in intracellular calcium in the beta cell and subsequent stimulation of insulin release.

The Sokals concludedthatearthing the humanbody influences humanphysiological processes, including increasing the activity of catabolic processes and may be "the primary factor regulating endocrine and nervous systems." They also concluded that grounding the human body represents a"universal regulating factor in Nature" that strongly influences bioelectrical, bioenergetic,and biochemical processes and appears to offer a significant modulating effect on the chronic illnesses they encounter daily in their clinical practices.

In another experiment done by the Sokals, the effect of grounding on the classic immune response following vaccination was examined. Earthing accelerated the immune response, as demonstrated by increases in gamma globulin concentration. This result confirms an association between earthing and the immune response, as was suggested in a study of delayed onset muscular soreness (DOMS) to be discussed below.[16] The reason for this association will also be discussed below.

The Sokals also found that earthing patients with NIDDM continuously during rest and physical activity over a 72 h period decreased their fasting glucose levels. This is another profoundly important result. It supports the idea that disconnecting from the earth affects blood glucose and this could be a significant factor in diabetes. Could it be that the simple change in lifestyle from leather soled shoes to electrically insulating plastics and rubber was a major contributor to our epidemics of diabetes and other chronic diseases? Given the scope of the suffering and the financial significance of the global diabetes problem, this idea deserves serious attention from the biomedical research and public health communities, especially in the regions where diabetes is epidemic.

EARTHING, SLEEP AND CORTISOL PROFILES

A modern understanding of the value of contact with the earth began with the discovery that a simple grounding system placed on a mattress enabled a person to sleep better.[12,17,18,] The grounded sleep system (Figure 38.3) consists of a bed sheet with conductive carbon or silver threads woven into it. The threads connect to a wire that goes out the bedroom window or through the wall to a metal rod inserted into the earth, preferably near a healthy plant. Sleeping on this system connects the body to the earth's electrons and to its electrical field (Figure 38.3). It is an extremely simple change in life-style that can have a huge impact on one's health, as we shall see below.

The grounding or"earthing" story is summarized by the cartoon in Figure 38.4. There is a continuous flow of electrons from the sun to the ionosphere via the solar wind, and thence to the earth's surface via lightning strikes. Lightening keeps the

FIGURE 38.3 The grounded sleep system consists of a cotton sheet with conductive carbon or silver threads woven into it. The threads connect to a wire that goes out the bedroom window or through the wall to a metal rod inserted into the earth near a healthy plant. Sleeping on this system connects the body to the earth. A repeated report from people using this system is that sleeping grounded improves the quality of sleep.

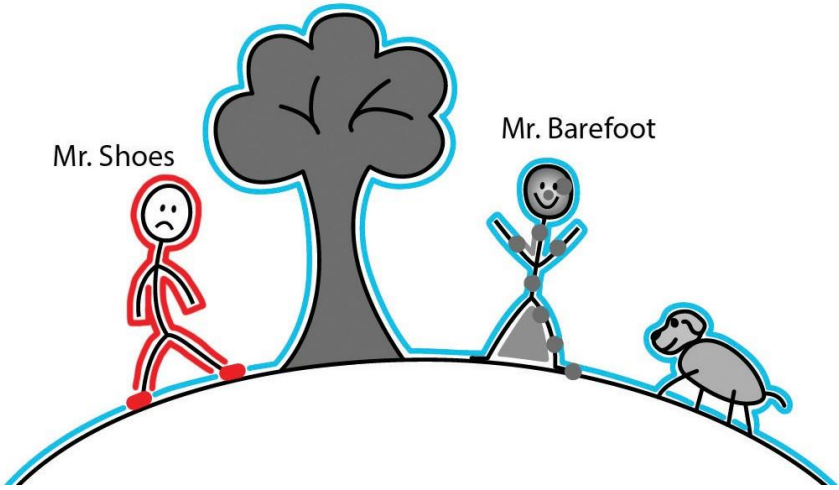


FIGURE 38.4 A continuous flow of electrons from the sun to the ionosphere and to the earth via lightning strikes keeps the surface of the earth electrically charged. Electrostatics teaches that when two conductive objects with different electrical potential touch each other, there is a virtually instantaneous transfer of charge so that the two objects equilibrate to the same electrical potential. The human body is a conductor of electricity and so is the earth. "Grounded" or "earthed" means that our bodies are connected to the surface of the earth and its abundant supply of electrons. This is a natural condition in which earth's electrons spread over and into our bodies, stabilizing our internal electrical environment.

conductive surface of the earth electrically charged.[19] At any given time there are probably about 2000 thunderstorms around the world producing about 44 flashes of lightning each second. About 78% of those flashes occur in the tropics, between 30N and 30S latitude.[20]

Electrostatics is the branch of physics that teaches that when two conductive objects with different electrical potential touch each other, there is a virtually instantaneous transfer of charge so that the two objects equilibrate to the same electrical potential.[21] The human body is a conductor of electricity and so is the earth."Grounded" or "earthed" means that our bodies are conductively coupled or electrically coupled with the surface of the earth and its abundantsupply of electrons. This is a natural condition in which earth's free or mobile electrons spread over and into our bodies, stabilizing our internal electrical environment. At the same time, it appears that an earth connection allows rhythms in the earth's electric field to entrain the body's biological clocks. This is the most likely explanation for the fact that a brief (e.g., 15 min)period of standing barefoot on the earth eliminates the effects of jet-lag, most likely by shifting a person's biological clocks to the rhythms present at their new location.

A repeated report from people using this system is that sleeping while grounded to the earth improves the quality of sleep. Insomnia is a serious problem for approximately half of the people in the USA. The problem is so severe that news and business media take notice.[22,23] Poor sleep is thought to lead to many automobile, industrial, and other types of accidents, and costs U.S. businesses nearly $150 billion annually in absenteeism and lost productivity.[24]Therefore, further investigations of grounded sleep seem worthwhile.

A pilot study showed that improved sleep was associated with normalization of the day-night rhythm of the "stress hormone," cortisol (Figure 38.5).[25] Cortisol is a stress hormone that is associated with both psychological and physical stress, inflammation, and sleep dysfunction in humans. Chronic elevation of cortisol can result in disruption of circadian rhythms, which, in turn, contributes to a multitude ofadverse health conditions, including sleep disorders, hypertension and cardiovascular disease, stroke, decreased bone density, decreased immune response, mood disturbances, autoimmune diseases, and abnormal glucose levels.[26]

> Cortisol rhythms have broad impact on most if not all systems in the body. Cortisol is both a mediator and a marker of the stress response. The finding that grounding or earthing the body during sleep normalizes the day-night cortisol rhythm, while improving subjective reports of sleep, pain and stress24 is indicative of a deep significance to natural contact with the surface of the earth. The convergence of endocrine measures with subjective behavioral data make a strong case for the conclusions reached.

Neurologic effects of chronic elevated cortisol secretion include chronic activation of the sympathetic nervous system (flight-or-fight response) leading to hypertension and cardiovascular disease. The hypothalamic-pituitary-adrenal (HPA) axis and the sympathetic nervous system have been utilized as objective markers of stress reactions.[27] Previous research has established relationships between cortisol levels and sleep dysfunction, stress, pain, anxiety, depression, irritability, inflammation, circadian rhythms, the immune response, and various chronic diseases. These relationships are real; they have been the topic of literally

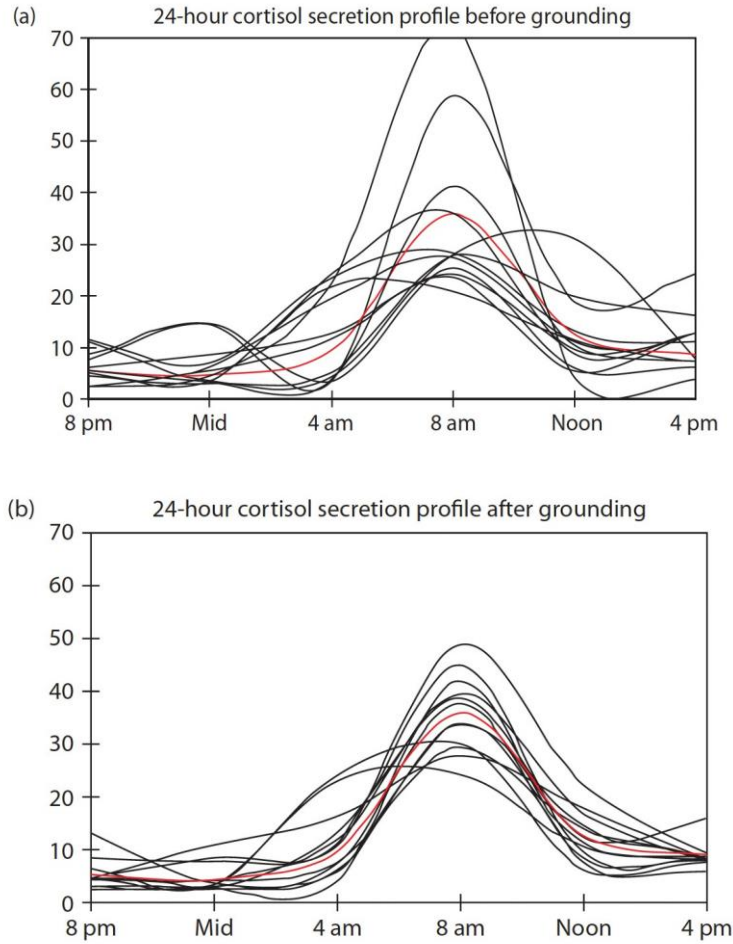


FIGURE 38.5 Cortisol levels before and after grounding. In unstressed individuals, the normal 24 h cortisol secretion profile follows a predictable pattern: lowest around midnight and highest around 8 a.m. Graph (a) illustrates the wide variation of patterns among study participants prior to grounding, while (b) shows a realignment and normalization trend of patterns after six weeks of sleeping grounded. (From Ghaly M, Teplitz D. J Alternat ComplMed 2004;10:767–76.)

thousands of scientific studies. For example, a search of the National Library of Medicine database, PubMed, lists nearly 13,000 studies with key words "cortisol" and "stress" and 1900 studies with key words "cortisol" and "sleep." A scholarly summary of this science can be found in Measuring Stress.[28] See, in particular, Chapter 8, on measuring stress hormones.[29] Cortisol is widely studied because it is a central, readily measured and an easy-to-interpret factor.

Cortisol-releasing mechanisms seem to be involved in the regulation of sleep.[30] Twenty-four-hour hyper-secretion of cortisol has been linked to chronic insomnia.[31] Evening and nocturnal cortisol levels were significantly increased in patients with severe chronic primary insomnia.[32] Power frequency 50–60 Hz extra-low frequency electromagnetic fields and pulsed radiofrequency fields are reported to affect sleep. Sleep disruption has been reported in human populations with nighttime exposure to elevated 50–60 Hz electromagnetic fields.[33,34] Weak, pulsed radiofrequency radiation at 20 μW/crn2 has been reported to alter the HPA axis with a slight elevation in cortisol serum level.[35] Significantly suppressed sleep electroencephalographic (EEG) and disruption of rapid eye movement (REM) sleep are reported after exposure to pulsed radiofrequencies.[33,36–38] Pulsed radiofrequency exposure is reported to alter cerebral blood flow, and sleep and waking EEGs.[35] Mann and colleagues reported significant sleep differences after exposure to weak pulsed radiofrequency radiation, with a predominance of the parasympathetic over sympathetic tone in the autonomic nervous system.[33] Together, these studies indicated that weak exposures to electromagnetic fields can disrupt normal sleep patterns as measured by various parameters, including direct measurement of hormones, sleep quality, duration of sleep, sleep EEG, REM sleep patterns, parasympathetic/sympathetic autonomic nervous system balance, and disruption of normal sleep spectral-power density ranges. Disregulation of circadian cortisol profiles is also associated with pain.[39]

A book on earthing presents two decades of accumulated anecdotal cases of people with many types of health challenges whose conditions have improved because of earthing. 15 For example, from the evidence presented here, it is not surprising that there are reports that a vast number of autoimmune disorders are partly, or completely, ameliorated by earthing.

PAIN AND STRESS

Many who had improved sleep with earthing also reported reduction in pain from new or old injuries or from conditions such as arthritis. As more feedback was gathered, it appeared that many other uncomfortable or debilitating conditions were partly, or completely, mitigated by grounding the body during sleep.

When any method seems to have a broad spectrum of benefits, as often happens with sleeping grounded, one can look for a common underlying mechanism. One mechanism is obvious: extensive scientific research from around the world has already shown that lack of sleep stresses the body and has many detrimental health consequences. The cortisol study (Figure 38.5) strengthened the argument that grounding the body reduces stress so that people can sleep better. A procedure that improves sleep could therefore provide relief from a host of disorders related to adrenal exhaustion, stress and the resulting anxiety.

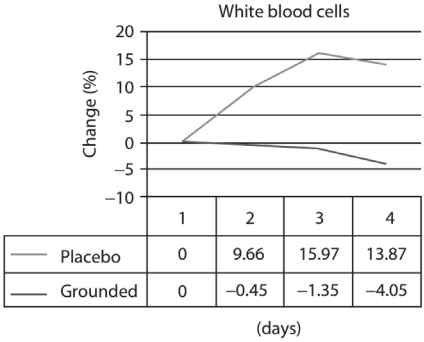
Melatonin is the most important of the pineal hormones. In a previously unpublished study, it was found that melatonin increased in 66% of subject after sleeping grounded for 6 weeks (Figure 38.6). Increases ranged between 2% and 16%. Melatonin decreased by 6% in only one of the subjects. The other three remained the same. Melatonin increases are important because melatonin is a hormone that supports the immune system, promotes deep and restful sleep, slows cell damage and aging, improves energy, and may even inhibit the growth of cancer cells.[40]

Sleeping grounded is the first intervention ever discovered that speeds recovery from the pain of delayed onset muscle soreness.

Looking further, we know that lack of sleep is often the result of pain—people simply cannot sleep well when they are in pain. Hence, reduction of pain might lead to improved sleep, reduction in stress to the body, and relief from a wide variety of unpleasant and debilitating conditions. Many who started sleeping on a grounding pad reported less pain and discomfort, not only during the night, but on the following day.

Pain reduction from sleeping grounded has been well documented in a controlled study of delayed onset muscle soreness (DOMS). This is a well-known result of excessive, unfamiliar, or intensive exercise. Muscle cell breakdown and inflammation occur along the muscle Z-lines (the regions where tension developed within the muscle cell is conducted to the myofascial system and bones, to produce movements[41]) and muscle cell membranes become leaky. Muscle soreness begins 24–48 h after the exercise and can last well over 96 h. DOMS is an excellent experimental model for the study of acute inflammation. The excessive exercise can be standardized and it does not produce any permanent injury to the subject. In all measurements after the initiation of the trauma, ungrounded subjects expressed the perception of greater pain. Related to the pain finding was evidence of a muted white blood cell response indicating that a grounded body experiences less inflammation (Figure 38.7). Subjects were also tested with a blood pressure cuff on the calf of the injured leg. Subjects that had slept grounded consistently, at every

measurement taken, could withstand greater pressure than controls. Sleeping grounded is the first intervention ever discovered that speeds recovery from the pain of DOMS.[16]



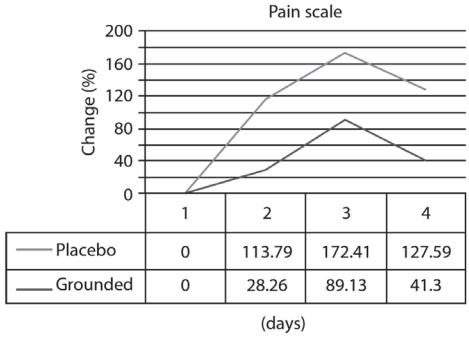


FIGURE 38.7 Delayed onset muscle soreness and grounding. In all measurements, ungrounded subjects expressed the perception of greater pain. Related to the pain finding was evidence of a muted white blood cell response indicating that a grounded body experiences less inflammation. (From Brown R, Chevalier G, Hill M. *J Alternat Compl Med* 2010;16(3):265–73.)

ELECTRICAL FIELDS

One of the documented causes of sleep disturbance is the environmental electric field from home wiring and appliances. The wires to a lamp or clock radio on a table next to the bed induce measurable voltages on the body, as do wires concealed behind walls. The electric field is present even when the lamp is turned off. These induced voltages were measured by an electrical engineer, Roger Applewhite, who is expert in the design of electrostatic discharge grounding systems for the electronics industry.[42] Measurements were taken while ungrounded and then grounded using a conductive patch or conductive bed pad. Applewhite measured the induced fields at three positions: left breast, abdomen, and left thigh. Each method (patch and sheet) immediately reduced the common alternating current (AC) 60 Hz ambient voltage induced on the body by a highly significant factor of about 70 on average. Figure 38.8 shows this dramatic effect.

	Left breast	Abdomen	Left thigh
Baseline	1.24	1.3	1.32
Bed pad	0.01	0.012	0.009

FIGURE 38.8 Effect of grounding with bed pad on 60 Hz induced body voltage. (From Applewhite R *Euro Biol Bioelectromagn* 2005;1:23–40.)

The Applewhite study showed that when the body is grounded, its electrical potential becomes equalized with the Earth's electrical potential through a transfer of electrons from the earth to the body. This, in turn, prevents the 60 Hz field from producing an AC electric potential at the surface of the body and from producing perturbations or oscillations of charged molecules inside the body. The study confirms the "umbrella" effect of earthing the body explained by Nobel Prize winner Richard Feynman in his famous Berkeley lectures on physics.[43] Feynman said that when the body potential is the same as that of the earth (grounded), the body becomes an extension of the earth's gigantic electric system. The earth's potential thus becomes the "working agent that cancels, reduces, or pushes away electric fields from the body."

As pointed out above, the surface of the earth has an abundance of electrons that give it a negative electrical charge. If you are standing outside on a clear day, wearing shoes or standing on an insulating surface (like a wood or vinyl floor), there is an electrical charge of some 200 volts between the earth and the top of your head (Figure 38.9).

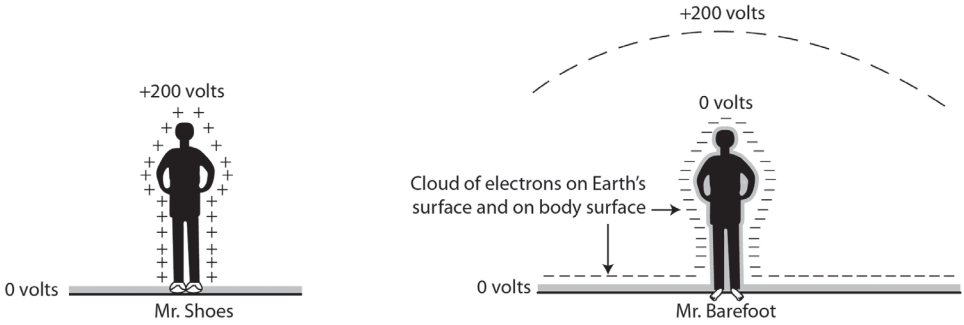


FIGURE 38.9 The surface of the earth has an abundance of electrons that give it a negative electrical charge. Left, if you are standing outside on a clear day, wearing shoes or standing on an insulating surface like a wood or vinyl floor or asphalt, there is an electrical charge of some 200 volts between the Earth and the top of your head. Right, if you are standing outside in your bare feet, your whole body is in electrical contact with the Earth's surface. Your body is a relatively good conductor. Your skin and the Earth's surface make a continuous charged surface with the same electrical potential. Also, notice in the diagram on the right that the charged area is pushed up and away from your head if you are grounded. Any object in direct contact with the earth—a person, a dog, a tree—creates this shielding effect (see also Figure 38.4). The object is essentially residing within the protective "umbrella" of earth's natural electric field. This protective phenomenon also occurs inside your house or office if you are connected to the earth with an earthing device, such as a grounding wrist pad or a foot pad. Adapted from Richard Feynman's famous Berkeley Lectures on Physics. (From Ober C, Sinatra ST, Zucker M. Earthing: The Most Important Health Discovery Ever? Laguna Beach, CA: Basic Health Publications; Second Edition, 2014, p. 76.)

Applewhite documented changes in the voltages induced on the body by monitoring the voltage drop across a resistor. The results confirmed the "umbrella effect" described above.

The electrons in the body of the grounded person are not perturbed by environmental electrical systems.

You might ask, "If there really is a voltage difference of 200 volts from head to toe why don't I get a shock when I go outside?"

The answer is that to experience a shock there has to be a current flow through your body. The air is a relatively poor conductor, and therefore, allows virtually no electrical current flow from the atmosphere, through your head, through your body, and to the surface of the earth. If you are standing outside in your bare feet

(the right side of Figure 38.9), you are earthed: your whole body is in electrical contact with the earth's surface. Your body is a relatively good conductor. Your skin, respiratory and digestive tracts, and the earth's surface make a continuous charged surface with the same electrical potential. In a later section, we will see that earth's surface charge reaches the surfaces the red blood cells, where it has important effects by reducing blood viscosity.

Stated simply, one of the best things a person can do to lessen the likelihood of developing a chronic disease is to spend at least part of their day connected to the earth. Going outside barefoot is one way to do this. Another is to place a grounding sheet on one's bed (Figure 38.3) and a third way is to have a grounding mat under one's feet if they are sitting at a desk. These are exceedingly simple, virtually trivial alterations in one's lifestyle that can have profound health implications.

Also notice to the right in Figure 38.9 that the charged area is pushed up and away from your head if you are grounded. Any object that is in direct contact with the earth—a person, a dog, a tree—creates this shielding effect (see also Figure 38.4). The object is essentially residing within the protective "umbrella" of earth's natural electric field. This protective phenomenon also occurs inside your home or office, if you are connected to the earth with an earthing system such as a bed or foot pad.

HEALTH ON THE 10TH FLOOR

Chevalier has discussed evidence that living in high-rise buildings can have adverse health effects.[44] Specifically, in 2009, Wolinsky and colleagues, using data from a large, nationally representative sample of older people (>70 years) on Medicare, showed that significant stroke risks are associated with living in multi-story residential dwellings versus single-story residential homes. They also reported that in 2005 about 150,000 Americans died from their strokes, placing stroke as the third leading cause of death in the U.S.[45]

Stated simply, one of the best things a person can do to lessen the likelihood of developing a chronic disease is to spend at least part of their day connected to the earth in one way or another. Going outside barefoot is one method that many find enjoyable. Another is to place a grounding sheet and/or pillow on one's bed (Figure 38.3). A third way is to have a grounding mat under bare feet while sitting at a desk. These are exceedingly simple, virtually trivial lifestyle changes that have profound, implications for health and longevity.

In presenting this information, Chevalier suggested that being disconnected from the ground, that is, from the earth's surface, for prolonged periods of time, supports low key inflammatory processes that take years to develop into chronic diseases. These inflammatory processes are aggravated by the distance from the ground: the higher above the ground a person lives, and the longer they stay there, the more hazardous it is for their health. Grounding appears to eliminate one of the major contributors to these inflammatory processes and remediates many chronic diseases once they have begun. Stated simply, one of the best things a person can do to lessen the likelihood of developing a chronic disease is to spend at least part of their day connected to the earth. To repeat, going outside barefoot is one way to do this. Another is to place a grounding sheet on one's bed (Figure 38.3) and a third way is to have a grounding mat under their feet if they are sitting at a desk. These exceedingly simple, virtually trivial lifestyle changes can have profound health implications.

Wollinsky and co-workers suggested that the increased stroke risk in multi-story residential dwellings reflects the greater physical, social, and psychological burdens faced by older adults in those settings. Chevalier discussed this and other possible explanations for elevated stroke and chronic disease incidence. On balance, Chevalier's hypothesis seems the most logical explanation. He notes the sum total of the benefits from earthing summarized in this chapter: better sleep, less pain, normalization of daily cortisol levels and circadian rhythms, decrease in inflammation, reduction in stress, normalization of the function of the autonomic nervous system, decreased blood viscosity, faster recovery after injury or from disease, reduction of primary indicators of osteoporosis, improvement of glucose regulation, and more efficient immune responses to trauma. All of these factors are significant for the health of every person, and are especially important for the aging adult. Higher blood viscosity is often correlated with stroke and virtually all of the other cardiovascular issues that are often considered the consequences of aging. Hence, the reduction in blood viscosity found with earthing may have a significant cardiovascular protective effect on older people living in multi-story buildings. Earthing appears to be one of the simplest and yet most profound interventions for helping reduce cardiovascular risk and cardiovascular events.

Consider, for example, a 6 foot tall person standing on the second floor of a multi-story building. Assuming an average of 10 feet per floor and using the typical value of 150 V/m, this person's body will be about 732 V at the top of their head and 457 V at the bottom of their feet. Furthermore, this voltage will increase by 457 V for every floor above the second floor. It is understandable that such a large electric potential the higher one is from ground level could interfere with the functioning of the electrical aspects of the cardiovascular and immune systems.

Take as an example a 6-foot tall person standing on the second floor of a multi-story building. Assuming an average of 10 feet per floor and using the typical value of 150 V/m, this person's body will be at 732 V at the top of the head and 457 V at the bottom of the feet. Furthermore, this voltage will increase by 457 V for every floor above that floor. It is understandable that such a large electric potential the higher one is from ground level could interfere with the functioning of the electrical aspects of the immune system. The constant recharging of the body by positive charges in the atmosphere will neutralize many of the negative charges needed to neutralize reactive oxygen species (free radicals) generated by the oxidative burst—the body's response to injury (discussed in more detail below).

Jamieson and colleagues asked whether the failure to appropriately ground humans is a factor contributing to the potential consequences of electro-pollution in offices.[46] Considerable debate exists on whether electromagnetic fields in our environment pose a risk to health.[47] But there is no question that the body reacts to the presence of environmental electric fields. Applewhite's study unambiguously demonstrated that grounding essentially eliminates the ambient voltage induced on the body from common electricity power sources. We strongly suspect, from the evidence we have gathered, that this has beneficial health consequences.

> What has a splinter in your finger or a wound on the foot to do with the risk of developing Alzheimer's disease, a heart attack, or contracting cancer of the colon? More than most people think! As we learn more and more about the causes of these and many other serious diseases, it becomes increasingly clear, that there is a link to our old defense mechanism; inflammation—the same biological process that causes tissue around a splinter to turn red and an injured foot to swell. The evidence is piling up and begins to radically change the perception of why we get chronic diseases.
>
> **—Dorthe Krogsgaard and Peter Lund Frandsen**[48]

INFLAMMATION AND IMMUNE RESPONSE

Going one-step further, there is good evidence that painful conditions that prevent restful sleep are often the result of various kinds of acute or chronic inflammation—conditions caused in part by highly reactive molecules known as reactive oxygen species (sometimes referred to as free radicals). These molecules are generated by normal metabolism and by the immune system as part of the response to injury or trauma. They are thought to be the immediate cause of the characteristic features or "pillars" of inflammation that have been recognized since ancient times: pain, redness, heat, swelling, and loss of function.

Krogsgaard and Lund Frandsen from Denmark have stated (perhaps overstated) an example of how a simple injury can lead to serious problems many years later (see box).[48] At this point, we do not really know enough to verify or refute this statement, but it does tell a story we suspect may be at least partly correct.

The way a small injury can lead to a chronic medical issue has been concisely summarized, again, by Krogsgaard and Lund Frandsen (see box on page 20).

Inflammation produces heat that can be measured with infrared medical imaging. A study using this approach revealed rapid reductions in inflammation at the same time as pain was reduced (Figure 38.10).

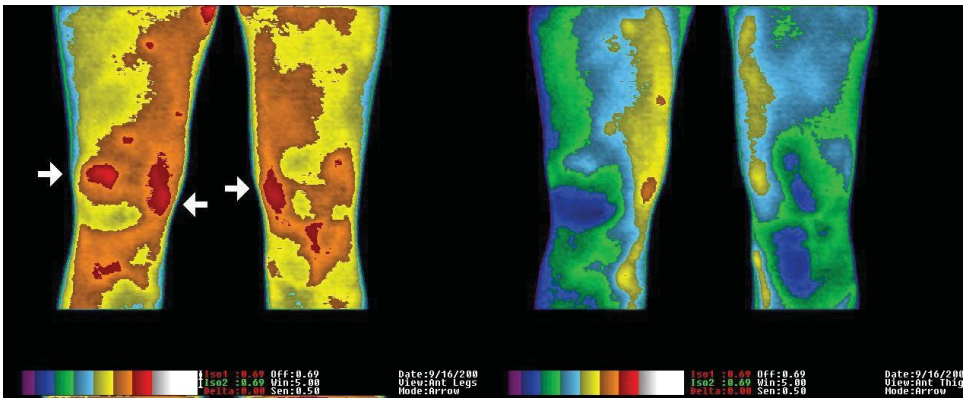


FIGURE 38.10 Inflammation as seen through infrared imaging. Thermal imaging cameras record tiny changes in the temperature of the skin to create a color-coded image map. Because tissue damage causes increased heat, abnormally hot areas indicate inflammation. The infrared photos shown here were taken only thirty minutes apart—before (left) and after grounding (right). They illustrate a rapid resolution of inflammation and help explain the impact of Earthing on chronic pain, stiffness, and a variety of symptoms.

How does grounding the body reduce inflammation? One logical explanation is that grounding the body allows anti-oxidant electrons from the earth to enter the body and neutralize highly charged reactive oxygen species at sites of inflammation. If this hypothesis is correct, one would expect changes in the well-researched profiles in blood chemistry and white blood cell counts associated with inflammation. Such changes have been documented by Brown and colleagues.[15]

Sometimes an inflammation process runs amok and continues much longer than is needed and spreads beyond the originally damaged area. There are several theories about how this happens. Perhaps something goes wrong in the communication between immune cells so that the signal to end the injury response does not arrive. Maybe there are too many free radicals and/or not enough antioxidants or not

enough electrons to neutralize them. Degradation products from the inflammation process may bind to proteins in the connective tissue to form a barrier around the inflammation (the inflammatory barricade). When the process is encapsulated in this way, it is at high risk of becoming chronic, because immune cells and antioxidants don't have free access through the wall of the "inflammatory pouch." Various toxins may leak out from the area and create an irritation that generates further inflammatio−and a vicious cycle is started, which, depending on the person's strong and weak sides, can develop into such seemingly diverse conditions as diabetes, bronchitis, asthma, chronic intestinal disorders, atherosclerosis, Alzheimer's, rheumatoid arthritis, multiple sclerosis, cancer….

—Krogsgaard and Lund Frandsen[48]

PHYSIOLOGICAL EFFECTS OF EARTHING

To follow changes in physiology produced by earthing, the arrangement shown in Figure 38.11a was used. A ground wire was connected to a switch box so that the grounding could be turned on or off during experiments without the subject knowing about whether or not they were grounded. The ground was connected to the subject at the acupoints known as Kidney 1 (Figure 38.11b). Acupuncturists refer to this point as the primary entry point for *Qi*, known in Hawaii as "*mana*" and in Sanskrit as "*prana*." The point is located near the ball of the foot. Gaétan Chevalier and colleagues performed a series of studies using this arrangement that makes it possible to establish a precisely timed earth connection, and to record changes in various physiological parameters before and after the connection is made. Specifically, changes in pulse rate, respiratory rate, blood oxygenation, perfusion index, skin conductance, emotional stress, heart rate variability, and improved autonomic tone have been documented.

STRESS REDUCTION

The effects of earthing on day-night cortisol rhythms indicated changes in blood chemistry related to stress (Figure 38.5). Further study showed rapid shifts in the autonomic nervous system from sympathetic to parasympathetic dominance and normalization of muscle tension (Figure 38.12a), completing the documentation of the cascade of effects of grounding the body on sleep, inflammation, pain, and the debilitating consequences of stress and lack of proper sleep. Some of the effects are nearly instantaneous, as shown in Figure 38.12b, showing the rapid drop in skin resistance, a measure of sympathetic nervous system activity, at the moment of grounding (left arrow), and return at the moment of un-grounding (right arrow).

CARDIOVASCULAR EFFECTS

> Erythrocytes have a strong net negative charge called the zeta potential produced by the scialoglycoprotein coat such that approximately 18 nm is the shortest span between two cells.
>
> **—Wintrobe's Clinical Hematology**[49]

The effects of earthing on the cardiovascular system are profound. A study examined effects of 2 h of grounding on the electrical charge (zeta potential) on red blood cells (RBCs) and the extent of RBC clumping. Ten subjects were grounded with conductive patches on the soles of their feet and palms of their hands. Wires connected the patches to a stainless-steel rod inserted in the earth outdoors. Small fingertip pinprick blood samples were placed on microscope slides and an electric field was applied to them. Zeta potentials were determined using the Smoluchowski equation. RBC aggregation was measured by counting the numbers of clustered cells in each sample (Figure 38.13a). Electrophoretic mobility of the RBCs was determined by measuring terminal velocities of the cells in video recordings taken through a microscope using the system shown in Figure 38.13b. The classic text on zeta potential is *Control of Colloid Stability Through Zeta Potential* (with a closing chapter on its relationship to cardiovascular disease) by T.M. Riddick.[50] The perspectives Riddick developed on cardiovascular disease are important but have not been widely recognized, probably because rheology is a highly specialized and interdisciplinary subject. Moreover, blood is a very complex material, and many variables affect its ability to carry oxygen, nutrients, and metabolic waste products.

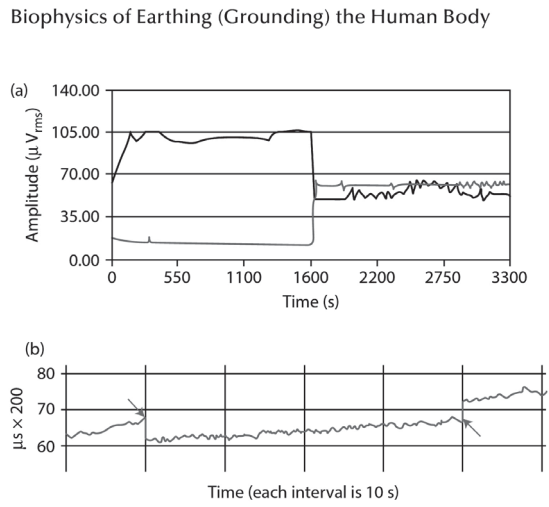


FIGURE 38.12 (a) Virtually instantaneous normalization of muscle tension at the moment of grounding (arrow) measured with electromyography of trapezius muscle. (b) Virtually instantaneous

drop in skin resistance, a measure of sympathetic nervous system activity, at the moment of grounding (left arrow), and return at the moment of un-grounding (right arrow). (From Chevalier G, Mori K, Oschman JL. The effect of earthing (grounding) on human physiology. *Eur Biol Bioelectromagnet* 2006;2(1):600–21.)

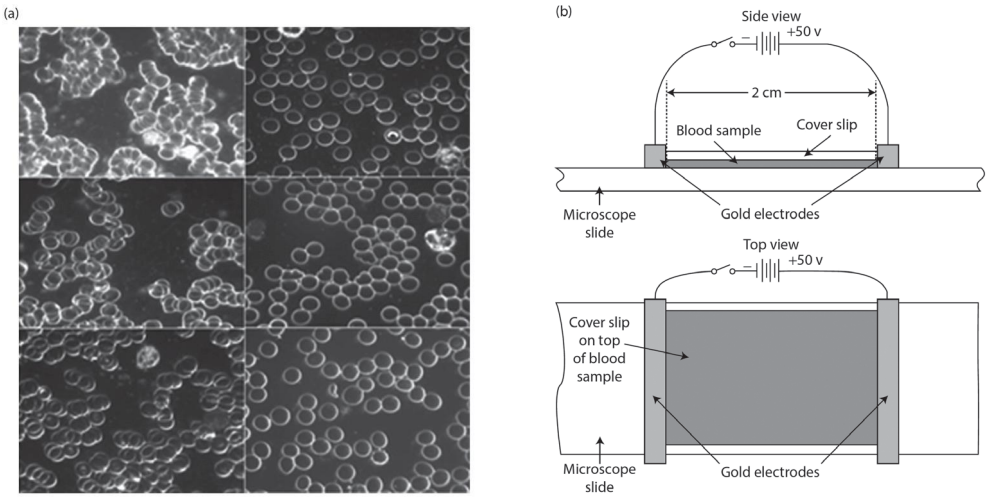
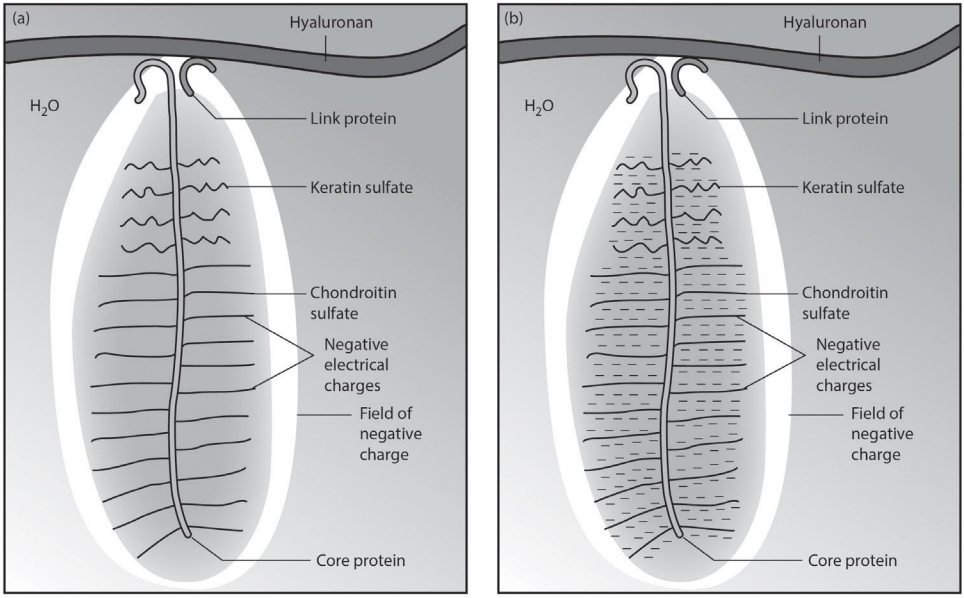


FIGURE 38.13 (a) Reduction in clumping of red cells in three subjects showing before (left) and after 40 min of earthing (right). (b) Apparatus used to measure the electrophoretic mobility (zeta-potential) of red cells before and after earthing.

Earthing or grounding significantly reduced RBC aggregation and increased zeta potentials in all samples by an average factor of 2.70. It was concluded that grounding the body increases the surface charge on RBCs, thereby reducing blood viscosity and clumping. Earthing appears to be one of the simplest and yet most



profound interventions for helping reduce cardiovascular risk and cardiovascular events. Elevated blood viscosity has been implicated in virtually every aspect of cardiovascular disease, such as hypertension, left ventricular hypertrophy, peripheral artery disease, etc. Cardiovascular diseases are the number one cause of death worldwide.

FIGURE 38.14 (a) Ungrounded person: charge reservoirs in the connective tissue ground substance are depleted of electrons. The whole body is "electron depleted." (b) Grounded person: charge reservoirs in the connective tissue ground substance are saturated with electrons. This is referred to as a state of inflammatory preparedness. (Redrawn from Lee RP. Interface. In: Mechanisms of Spirit in Osteopathy. Portland, OR: Stillness Press; 2005. With permission.)

MECHANISM OF IMMUNE RESPONSE

We suggest that the mechanism by which earthing influences the immune response to injury is as follows:

- The polyelectrolyte ground substance (Figure 38.14) extends throughout the body. The charged groups on the glycosaminoglycans have enormous capacity to store electrons. In the ungrounded person, these charge "reservoirs" in the connective tissue ground substance are depleted of electrons (Figure 38.14a). It is thought that electrons in these reservoirs are continually utilized in all the cells and tissues in the body to neutralize reactive oxygen species produced during metabolism and other oxidative processes. Without grounding, the whole body becomes gradually "electron depleted." When the body connects with the earth, the charge reservoirs in the connective tissue ground substance become saturated with electrons (Figure 38.14b). This is referred to as a state of inflammatory preparedness. An injury to any part of the body will have immediate access to stored electrons in nearby ground substance reservoirs, and this will have a protective effect on healthy tissue.
- It is suggested that the way the ungrounded vs. grounded person reacts to an injury is as shown in Figure 38.15.

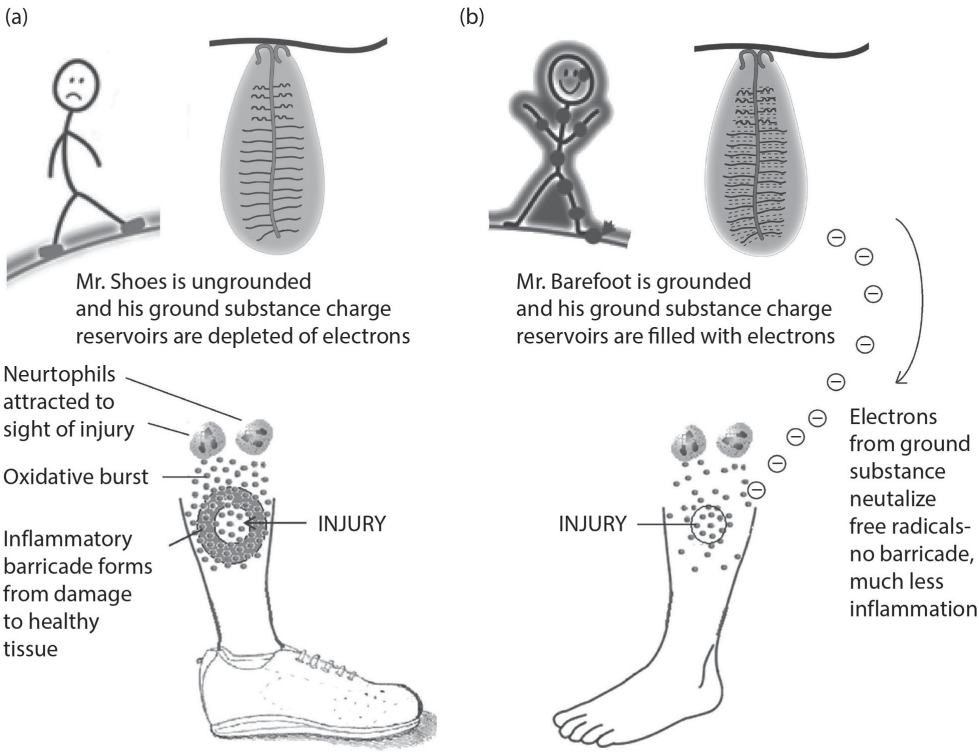


FIGURE 38.15 (a) The ungrounded person will form an inflammatory barricade around the injury site. (b) The grounded person will not form an inflammatory barricade because reactive oxygen species (free radicals) that could damage nearby healthy tissue are immediately neutralized by electrons from the living matrix and from the electron-saturated ground substance.

Neutrophils are the most abundant white blood cells in mammals. They are the first line of defense of the innate immune system. Neutrophils quickly aggregate at a site of injury, attracted by cytokines. These are small cell-signaling protein molecules produced by activated capillary endothelial cells, mast cells, and macrophages. Neutrophils also release cytokines, which in turn amplify the inflammatory reactions by several other cell types.[51] Electromagnetic interactions between the various cytokines may also be involved, as described in the chapter in this book by Oschman and Oschman.[52] These shifts in activity by white blood cells were documented in the DOMS study (e.g., Figure 38.7).

Neutrophils are phagocytes, capable of ingesting microorganisms or other foreign particles. They can internalize and kill many microbes, each phagocytic event resulting in the formation of a phagosome into which reactive oxygen species (ROS) and hydrolytic enzymes are secreted. The consumption of oxygen during

the generation of ROS by various cells of the immune system has been termed the "respiratory burst" or "oxidative burst." The respiratory burst produces large quantities of two very potent oxidative agents: superoxide and hydrogen peroxide. Most researchers are convinced that superoxide and hydrogen peroxide are the primary active agents in the oxidative burst and the killing of pathogens.[53]

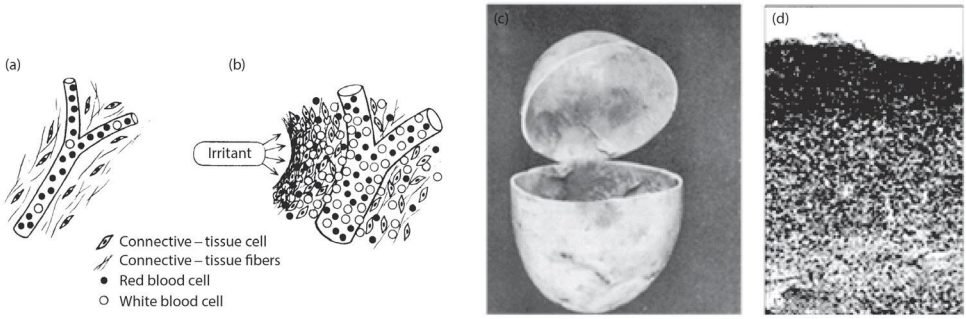


FIGURE 38.16 Formation of the inflammatory barricade, according to Selye.55 (a) Normal connective tissue territory. (b) Same tissue exposed to irritant. Vessel dilates, blood cells migrate toward irritant, connective tissue cells and fibers form a thick impenetrable barricade that prevents the spread of the irritant into the blood, but that also prevents the entry of regenerative cells that could repair the tissue. The result can be a long-lasting pocket of incompletely resolved inflammation that can eventually leak toxins into the system and disturb functioning of an organ or tissue. (c) The inflammatory or Selye or granuloma pouch as described by Selye55 widely used in studies of inflammation. (d) Histology of the inflammatory barricade: facing the chamber is a wall of connective tissue that is impenetrable to dissolved antioxidants and a barrier to cells that can regenerate damaged tissues (Ben Harrison, WFIRM). Electrons are the ultimate anti-oxidants. It is suggested that electrons can be semi-conducted into the inflammatory pouch where they can neutralize reactive oxygen species (free radicals). (From Selye H. J Am Med Assoc 1953;152(13):1207–13.)

The inflammatory or Selye or granuloma pouch as described by Selye (Figure 38.16) has been widely used in studies of inflammation.[54–56] We suggest that the "inflammatory barricade" forming the wall of the pouch is created by damage to healthy tissue in the ungrounded person because of a lack of electrons that would otherwise serve a protective function. If the tissue is healthy and if the ground substance is saturated with electrons as in Figure 38.14b, the tissue matrix will be able to deliver electrons to the healthy tissue surrounding site of injury. In this situation, the inflammatory barricade will not form. This is important because the inflammatory barricade slows or prevents the entry of regenerative cells into the "repair field," a term introduced by W.D. Kessler.[57]

The mechanism for the movements of electrons in tissues has been described as semiconduction.[58] Albert Szent-Györgyi made a distinction between E, or energy stored in chemical bonds, and E*, excited energy that is mobile (Figure 38.17). The basic hypothesis is that the living tissue matrix is a semiconductor network extending throughout the body and is capable of rapidly delivering mobile anti-oxidant electrons, or E* to any point where a free radical appears. If the matrix is in a healthy state, it will be everywhere conductive to E* and the mobile electrons from the ground substance reservoirs will quickly migrate toward any reactive oxygen species that form. If the matrix conduction is blocked, or if electrons are not available (electron depletion; Figure 38.14a), the inflammatory barricade will form. When the matrix is healthy and conductive, and when the ground substance is saturated with electrons, healthy tissue will be protected and free radical damage will be minimized.

Selye and others have obtained evidence that necrotic tissue breakdown products from inflammatory pockets can leak into the blood and lymphatic circulation, producing slow but progressive toxicity or atrophy in various organs at a distance from the original site of trauma. For example, on page 161 of the first edition of *The Stress of Life*, Selye describes how he was able to inject inflammatory pouches in rats with irritants or microbes, producing a syndrome characterized by an inflammation of the heart valves (endocarditis) very similar to that which occurs in children suffering from rheumatic fever. Under some conditions, this was accompanied by inflammation of the kidney (nephritis) and excessive stimulation of the blood-forming organs. This inflammatory pouch concept explains how local pockets of inflammation can trigger a diversity of chronic diseases and disturbances, many of which frustrate the physician because it is difficult to locate the cause. Selye's work tied inflammatory responses with stress, cortisol secretion, and adaptation.

"Silent inflammation" refers to a condition in which the inflamed site is not painful, and may go unnoticed, even though it may be causing problems elsewhere

in the body. The phenomenon was described long ago in dentistry, beginning with 25 years of root canal research by Dr. Weston Price,[59] but currently receives little attention except by "biological" dentists.

The walled off areas as described by Selye may correspond to the dense tissue areas known to practitioners of bodywork, energy, and movement therapies. For example, Ida P. Rolf, in her book, Rolfing®[60] stated that: "In practically all bodies, in one muscle or another, small lumps or thickened nonresilient bands can be felt deep in the tissue. The lumps may be as small as small peas or as large as walnuts." Rolf reproduced Selye's picture of an inflammatory pouch produced by injecting air into fascial sheaths (Figure 38.16b)."Some similarly injurious process no doubt gives rise to the lumpy knottings we have noted." Some of the benefits of Rolfing® (Structural Integration) and other bodywork, energetic, and movement techniques may derive from their ability to reduce or eliminate these pockets of inflammation, and thereby prevent or relieve chronic illnesses. Likewise, a variety of therapeutic technologies introduce or induce electric currents that flow within tissues. Examples include Frequency Specific Microcurrent,[61] Pulsing Electromagnetic Field Therapies,[62] Ondamed®,[63] and perhaps other devices described in this book. It is worthwhile to explore the possibility that successes with these techniques may in part be due to induced semiconduction of mobile electrons across inflammatory barricades.

IMPLICATIONS FOR AGING

The leading theory for the cause of aging is the so-called free radical theory. Simply stated, it has been suggested that aging results from the cumulative damage done to cells and tissues by oxidative stress (reactive oxygen and reactive nitrogen species or "free radicals") produced during normal biochemical processes, such as oxidative metabolism, and during the body's natural responses to injury and pollutants. Because the free radical is a molecule with one or more unpaired electrons, it has charge and magnetic properties that make it highly reactive as well as attractive to free electrons. This is the physics that makes these molecules so destructive, they literally rip electrons from pathogens and damaged cells produced during an injury. Key work of Gershman and Gilbert revealed that elevated oxygen atmospheres in incubators were causing retrolental fibroplasia (now called retinopathy of prematurity).[64] This was one of several clues that led Denham Harman to propose his free radical theory of aging, the most widely studied model of aging.[65]

Today, oxidative stress is being implicated in virtually all of the diseases of aging and in the aging process itself. Recognition of the mobile electron as the ideal

antioxidant has led to an explanation of how earthing, as well as a number of clinical devices, are so effective at reducing inflammation and treating chronic diseases. The ability of charges to migrate through the living matrix is relevant to anti-aging medicine because of the potential antioxidant nature of the mobile electrons. While a great deal of research is being done to correlate inflammation with disease states, there are few theories on the mechanisms involved. The research on earthing has provided a logical and testable theory based on a variety of kinds of evidence. The anti-inflammatory effects of connecting to the earth arise because the earth's surface is an abundant source of excited and mobile electrons.[66]

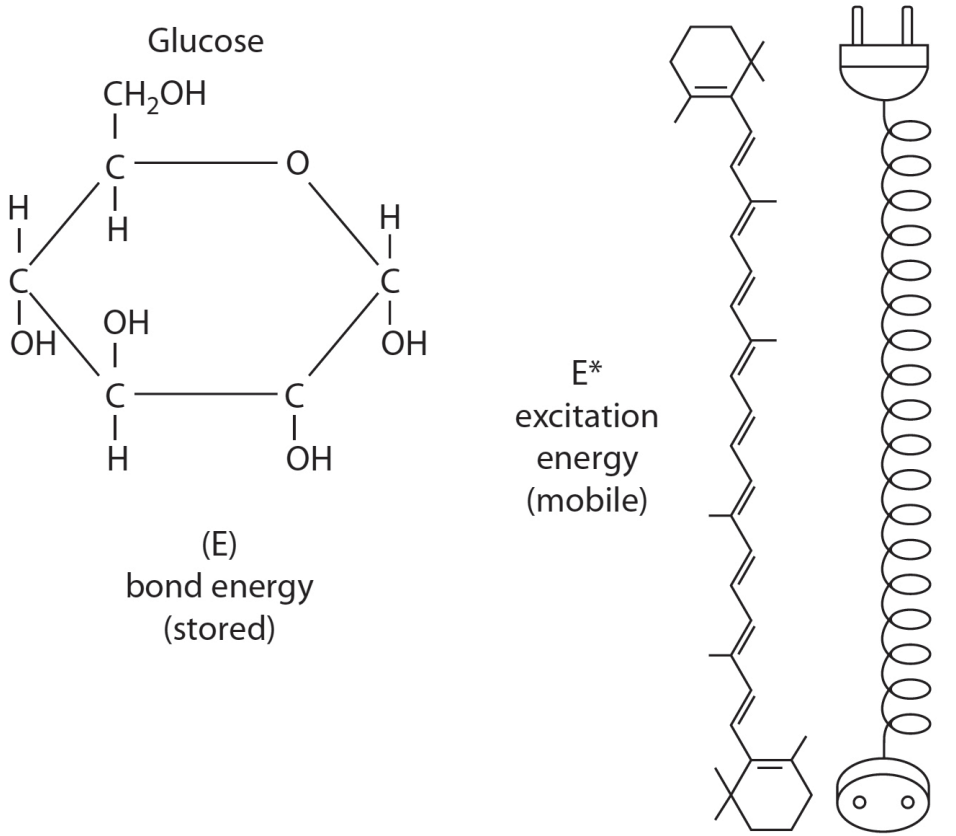


FIGURE 38.17 Albert Szent-Györgyi referred to the immobile electron energy stored in the bonds of the glucose molecule as (E) to distinguish it from mobile excited electrons E*. The carotene molecule on the right contains a series of double bonds, each of which has one electron that is not confined to the bond but is free to move. On the right, he compares the electronically conductive carotene molecule with the power cord for a toaster. The carotene molecule is a semiconductor, whereas the power cord is a conductor. (From Szent-Györgyi A. Bioelectronics. New York: Academic Press; 1968. p. 23, Figure 15.8.)

BRINGING THE EARTH TO YOU

Following on Ober's original discovery13 a number of technologies were developed that could simply and conveniently bring the advantages of connecting with the earth into the home or other building (Figure 38.18). These include conductive grounding sheets for the bed, grounding pads for under the feet or wrists when working at a computer, and bracelets that can be worn around the wrist or ankles or chest. Grounding flip-flops and shoes connect people with the earth during the day as they are walking about (Figure 38.18). These shoes have a conductive plug positioned next to Kidney 1 to allow electrons to enter the body. Users of these products report a variety of benefits ranging from improved sleep to reduction or elimination of cardiac arrhythmias. These reports have been summarized in a book by Ober, Sinatra, and Zucker.[15]

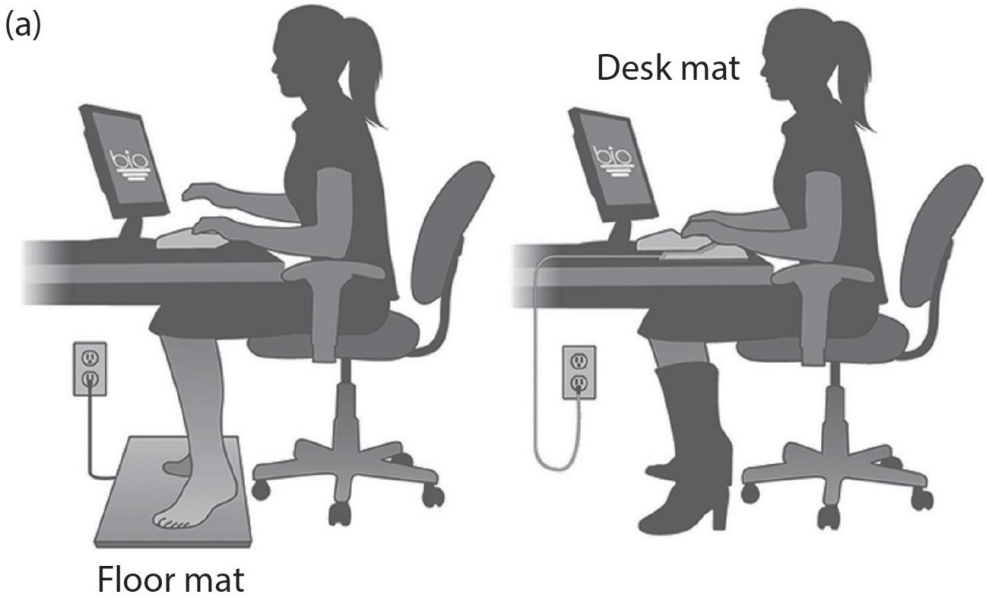


FIGURE 38.18 Methods for bringing earthing into the home or office. Earthing pad for under the feet or wrist in an office.

WHEN IS A RAT A RAT?

The various physiological effects of earthing that have been summarized here bring up the question, "what is a normal organism." The people you see every day vary greatly in their degree of inflammatory preparedness versus electron depletion, depending on how long they have been isolated from the surface of the earth. For

many, the only contact they have with electrons from the earth is when they take a shower, assuming that the water they are using comes to them through metal pipes buried in the earth. An electron-depleted person may look and feel perfectly normal, just like everyone else. The difference between a grounded and ungrounded person probably does not show up until the person has an injury or is recovering from a disease, or until they begin to age. From our observations, we suspect that the grounded person will heal faster and have a lower probability of developing the chronic diseases associated with aging, compared to the less grounded individual. We also predict that the grounded person will sleep better and show fewer of the well-documented effects of stress. These are hypotheses of sufficient importance for public health and medicine to warrant further study.

In 1906, the Wistar Institute in Philadelphia developed and bred the Wistar rat, the first standardized laboratory animal. The Wistar rat became one of the most popular animals for laboratory research. It is estimated that more than half of all laboratory rats in the USA today are descendants of the original Wistar ratline. The Sprague Dawley rat and Long-Evans strains were developed from Wistar rats. As of December 25, 2013, there are 253,226 peer reviewed studies of Sprague Dawley rats listed in PubMed, and 221,446 articles specifically mentioning the use of Wistar rats. This represents an enormous amount of research. Domestic laboratory rats differ from wild rats in many ways. They are calmer and less likely to bite, they can tolerate greater crowding, they breed earlier and produce more offspring, and their brains, livers, kidneys, adrenal glands, and hearts are smaller.

Much modern research on physiology, biochemistry, genetics, diseases, the effects of drugs, and other topics in health and medicine has been done with rat models. Laboratory rats have also proved valuable in psychological studies of learning and memory. The historical importance of this species to scientific research is reflected by the amount of literature on it, roughly 50% more than that on laboratory mice.[67]

When research is done with an animal model, the investigators invariably describe the methods they use, including the strain of the animals. This is done so that others can repeat the studies if they wish. An assumption is that all Wistar rats will be genetically and physiologically similar. However, a 1972 study compared neoplasms in Sprague-Dawley rats from six different commercial suppliers. They found highly significant differences in the incidences of endocrine and mammary tumors. There were also significant variations in the incidences of adrenal medulla tumors among rats from the same source raised in different laboratories. The authorsof the study "stressed the need for extreme caution in evaluation of carcinogenicity studies conducted at different laboratories and/or on rats from different sources."[68]

From our perspective, these findings of great variations in animals are not surprising. Among other things, the physiological status and behavior of animals will differ widely depending on the extent of grounding. Are their cages made of metal, and if they are, is that metal grounded? How close are their cages to wires or conduits carrying 60/50 Hz electricity? From the studies reported here, those factors can make a significant difference. In fact, they represent a "hidden variable" that may have affected the outcomes of countless studies, and could have affected the ability of other investigators to reproduce particular studies.

We know that most, if not all, physiological processes involve electrical activities of one sort or another. When nerves conduct, muscles contract, glands secrete, and sensory organs sense electrical processes are involved. These electrical activities are powered by adenosine triphosphate (ATP) generated by the electron transport chain in mitochondria, a system that requires a continuous supply of electrons.

The conventional view is that all electrical activities in a living system involve ionic currents, but there are good reasons, discussed in the chapter by Oschman and Oschman in this book (Recent Developments in Bioelectromagnetic and Subtle Energy Medicine), and also in reference 53, to consider electron movements as well. We view the acupuncture meridian system as the most likely candidate for distributing electrons from the earth to the system-wide ground substance material, via the point on the ball of the foot known as Kidney 1 (Figure 38.11b).

A consistent observation is that grounding the human body normalizes physiological balances by equilibrating every part of the body with the electrical potential of the earth, thereby stabilizing the electrical environment for all physiological and regulatory processes. The Sokals referred to the earth as a "universal regulating factor in Nature" that strongly influences bioelectrical, bioenergetic, and biochemical processes. Therefore, we are not surprised by the 1972 study comparing neoplasms in rats from different suppliers or animals raised in different laboratories[58].

Often researchers struggle to replicate the results of an important study reported by others. They often assume they are doing something wrong. They may not have considered the electrical environment of their experimental animals. A prediction is that some of the variability in outcomes from one laboratory to another would decrease if experimental animals were provided with a standardized electrical environment. For the animals to be fully healthy and "normal," their cages should be grounded and kept a distance from electrical wiring. This is especially crucial if the study involves measuring recovery from some sort of injury or trauma to the animal being studied. From our experience, the effects of injury or trauma will be very different in grounded versus ungrounded animals.

ELECTRONS VERSUS ANTI-OXIDANTS

Knowing of the potential health effects of reactive oxygen species, commonly called free radicals, and the need to reduce oxidative stress and inflammation to prevent the diseases of aging, it has been easy to convince the public that dietary supplements containing anti-oxidants should keep everyone healthy and prolong lives. An enormous and highly profitable dietary supplement and vitamin business has emerged to meet the resulting demand. Unfortunately, there are fundamental problems with dietary antioxidants.

Dr. David B. Agus is one of the world's leading cancer doctors and a pioneering biomedical researcher. His book, The End of Illness, was number one on the New York Times Bestseller List.[69] After reviewing the literature on anti-oxidants, he made the controversial statement shown in the box. As an expert on the body as a complex system, he speaks with some authority on the fact that we still do not know enough about the regulation of oxidative metabolism to be certain about what dietary antioxidants do to the body's normal balancing act between creating free radicals and neutralizing them.

A second issue arises from Agus' statement that "…once inside the human body, they seem strangely powerless." One reason for this is the impenetrable inflammatory barricade, a wall of connective tissue surrounding a site of injury (Figure 38.16). As collagen is a semiconductor,[70] this barrier is readily traversed by mobile electrons, but not by dissolved anti-oxidants.

> Since the early 1990s scientists have been putting these compounds through their paces, using double-blind randomized controlled trials—the gold standard for medical intervention studies. Time and again, however, the supplements failed to pass the test. True, they knock the wind out of free radicals in a test tube. But once inside the human body, they seem strangely powerless. Not only are they bad at preventing oxidative damage, they can even make things worse. Many scientists are now concluding that, at best, they are a waste of time and money. At worst they could be harmful.

Recent discoveries on the ways water associates with the surfaces of proteins and cell membranes reveals a fundamental and little recognized aspect of how anti-oxidants and other substances move within the body. The usual view is that they are absorbed across the intestinal wall, enter the circulatory system, then diffuse from capillaries into the extracellular spaces, and thence to the cells. Gerald Pollack and his colleagues have determined that the water adjacent to surfaces is in a so-called "fourth phase" that makes it distinctly different from the familiar phases: solid,

liquid, or gas.[71] The water adjacent to hydrophilic surfaces, such as cell membranes, proteins, and many other molecules is highly ordered into a liquid crystalline arrangement that excludes solutes. Pollack refers to this as the "exclusion zone" and to this aqueous phase as exclusion zone or EZ water (Figure 38.19).

There has been a long debate about the nature of water inside of cells (reviewed, for example, by Luby-Phelps)[72] and it now appears that cells contain little water in which molecules can dissolve and diffuse from place to place. The cell is so filled with highly ordered liquid crystalline proteins/water complexes and exclusion zones that there is little room for the diffusion of solutes. On the basis of Pollack's work, it now appears that the same may be true of the extracellular spaces in the body, as they are virtually filled with polyelectrolyte gel or ground substance. Hence, much of the water inside the body is trapped in a gel state.

This raises a new question. Precisely how do antioxidant molecules get from the circulatory system to the places where they are needed to combat inflammation? Exclusion zones may be found throughout the extracellular spaces that were previously viewed as containing "bulk water" through which molecules can diffuse from place to place. Pollack's work shows that the exclusion zone excludes the protein albumin as well as various dyes with molecular weights as low as 100 daltons, only a little larger than common salt molecules. The inflammatory barricade acts as a further barrier to the diffusion of antioxidants into the "repair field" left behind after an injury.

The free or mobile electron does not have this problem. We view the entire healthy fabric of the body as a semiconductor network. Electrons from the earth can enter this network via the point on the ball of the foot known as Kidney 1, and can be rapidly semi-conducted to any point in the body where they are needed to refill charge reservoirs or to neutralize free radicals. A final difficulty with the dietary antioxidant story is the manner by which the scientist/entrepreneur demonstrates the value of antioxidant substances. A typical story:

> Someone picks a perfectly innocent plant, like the blueberry. They chemically extract a molecule from blueberries. Then they put cultured cells in a Petri dish or test tube. These poor cells are under severe oxidative stress, as they are being exposed to an oxygen concentration that is 5–10 times higher than they would ever experience in vivo. Under these stressful conditions, the cells secrete measurable amounts of reactive oxygen species (free radicals) in an effort to survive. To this nonbiological preparation our investigator/entrepreneur adds a bit of their blueberry extract. The levels of reactive oxygen species (free radicals) drop significantly. Voilà! We have

something we can sell. With a combination of this awful science and good advertising, a billion or so dollars' worth of the antioxidant supplement are sold. A lot of perfectly good blueberries are used up in the process, and many unsuspecting people have less money but no less inflammation. We can make a distinction between physical anti-inflammatory methods (earthing) and chemical anti-inflammatory methods (blueberries, cranberry capsules, Green tea extract, effervescent vitamin C, pomegranate concentrate, beta carotene, selenium, grape seed extract, high-dose vitamin E, pine bark extract, bee spit, and the like). The case for this is put forward succinctly in *The Antioxidant Myth: A Medical Fairy Tale.*[73]

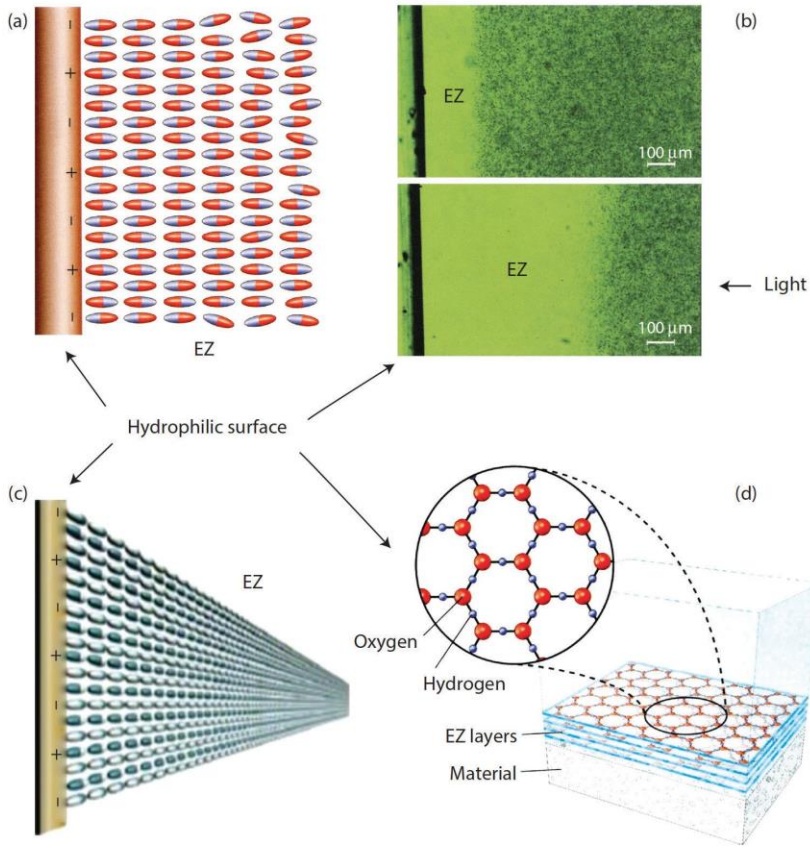


FIGURE 38.19 (See color insert.) (a) Dipolar water molecules (electronegative region shown in red) line up adjacent to a hydrophilic (water-loving) surface. (b) The region close to the surface excludes solutes, demonstrated here with the use of microspheres. The lower picture shows how the exclusion zone is expanded in the presence of light. (c) The exclusion zone is extends far from the hydrophilic surface. (d) The water molecules form honeycomb sheets. (From Pollack G. *The Fourth Phase of Water: Beyond Solid, Liquid and Vapor.* Seattle, WA; Ebner & Sons; 2013.)

The flow of electrons from the earth into the body via Kidney 1, located on the ball of the foot (Figure 38.11), and then throughout the meridian system, can explain how the mobile electron can serve as a natural antioxidant. A working hypothesis is that the body is composed of semiconducting materials that form a network (called the living matrix) that extends throughout the body. It can thereby saturate all of the polyelectrolyte polymers or ground substance matrix with electrons that are then available to participate in any inflammatory process, large or small, taking place in any tissue in the body.

This is not to say that earthing does not affect the chemistry of the body. Most, if not all, biochemical reactions are redox reactions involving transfers of electrons. Paul H. Scudder has published a book on organic chemistry in which all of the organic reactions are described in terms of electron transfers.[74] Scudder breaks down common organic processes into their basic units to explain the electron flow pathways that underlie these processes. The glycosaminoglycan ground substance stores electrons so they will be available where and when needed. This point was confirmed by one of the leading experts on ground substance, Professor Hartmut Heine.[75] It appears that the ground substance can become depleted of electrons when a person has not contacted the earth for a long time.

CONCLUSIONS

The earthing or grounding studies can be summarized with the statement that connecting with the earth is easy and can have many benefits. It is something anyone can do without cost by simply removing their shoes and socks and walking barefoot on the earth. Various methods have been developed to bring an earth connection into the home or office. It has been suggested that this is especially important for those living or working in high-rise buildings. The research on earthing has revealed a new picture of the nature of inflammation and the reason, it can lead to chronic diseases. We can see the inflammatory barricade, which was recognized in ancient times and is still accepted by Western medical science as a common response to injury, does not have to form. Prevention of chronic inflammation is accomplished by having the body's ground substance reservoirs saturated with electrons that can prevent "collateral damage" in healthy tissues, provided that the person is grounded and the living matrix is functioning properly.

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RESEARCH SUMMARY

Ongoing scientific research is exploring the dynamics and details behind the benefits of grounding. The evidence clearly points to a new and exciting frontier in health care. The research indicates that reconnecting to the Earth is a major missing link in the health equation.

Below you will find a summary of the research. The numbers shown in brackets refer to the studies listed at the end of this summary, and in which the evidence was found. The study abstracts are also presented at the end of this summary, and can be accessed in full at the Earthing Institute research page (www.earthinginstitute.net) For additional information on Grounding research, observations from clinicians and patients, and special advisories, please read the Earthing book (available through most book vendors) and visit the Earthing Institute website (at www.earthinginstitute.net)

Reduces and Prevents Inflammation

Chronic inflammation is a causative factor of pain and a causative or aggravating factor of virtually all chronic and aging-related diseases, including cardiovascular diseases, rheumatoid, autoimmune disorders, Alzheimer's, diabetes, and cancer. Grounding reduces or even prevents the cardinal signs of inflammation following injury: redness, heat, swelling, pain, and loss of function.
[Ref: 1, 2, 4, 7, 14, 17, 19]

Eliminates or Substantially Reduces Pain

Most pain, including the most severe, are due to inflammation, and typically respond rapidly to Grounding. Healing-related pains are usually lessened, often significantly, in intensity and duration.
[Ref: 1, 2, 7, 14, 19]

Better Sleep

Twelve subjects slept grounded for 8 weeks. Eleven reported that they fell asleep faster. All reported waking fewer times during the night. Better sleep is one of the most common responses from people after they start Earthing.
[Ref: 1, 19]

Improves Energy

Many people have difficulty waking up in the morning. They have little energy. Studies show that sleeping grounded provides more morning energy as well as vitality throughout the day. In study # 1, 9 (out of 12) subjects reported

improvement in fatigue (more refreshed/less fatigued). Better, deeper sleep is one explanation.
[Ref: 1, 8, 17, 19]

Increases Production of Melatonin

Melatonin is the most important of the pineal gland hormones. It promotes deep and restful sleep, supports the immune system, slows cell damage and aging, improves energy, and may even inhibit the growth of cancer cell.
[Ref: 19]

Exerts a Normalizing Effect on Secretion of the Stress Hormone Cortisol

Cortisol is a mediator and marker of the stress response, associated with both psychological and physiological stress, inflammation, and sleep dysfunction. Chronic elevation of cortisol from stress can result in disruption of the body's circadian rhythms, and contribute to many problems, including sleep disorders, hypertension, cardiovascular disease, decreased bone density, decreased immune response, mood disturbances, autoimmune diseases, and abnormal glucose levels.
[Ref: 1, 19]

Decreases Stress

Both physical stress and psychological stress are aggravating factors for pain and diseases including psychological disorders. Consequently, any natural method for relieving stress has enormous potential to prevent or decrease the negative effects of most diseases.
In multiple studies, Grounding has been documented to have a stress-reducing effect, a result of its systemic impact on the body, including the following:

- a normalizing influence on cortisol, the stress hormone.
- a calming impact on the electrical activity of the brain.
- a normalization of muscle tension.
- a rapid shift from a typically overactive sympathetic nervous system expression, associated with stress, into a parasympathetic, calming mode within the autonomic nervous system (ANS) that regulates heart and respiration rates, digestion, perspiration, urination, and even sexual arousal.
- within the ANS, also an improvement of heart rate variability (HRV) − the miniscule variations in the heart's beat-to-beat interval − that serves as an accurate reflector of stress. Poor HRV is associated with stress-related disorders, cardiovascular disease, diabetes, mental health issues, and reduced lifespan. Grounding improves HRV to a degree far beyond mere relaxation.

[Ref: 1, 3, 6, 9, 19]

Improves Mood

Among 8 female subjects grounded for six weeks, 7 reported improved mood. In another study, 40 participants were randomly divided and either grounded or sham-grounded for 2 hours. Improved mood, according to a questionnaire, was found only for the grounded participants. At a women's wellness conference in 2012, 82 out of the 100 attendees said their mood had improved—by an average of 40%—after grounding during a one-hour lecture.
[Ref: 1, 16]

Reduces Thickness of Blood

Higher blood viscosity (that is, thicker, sludgy blood) often correlates with diabetes and cardiovascular disorders. Two studies were performed to determine grounding effects on blood viscosity. The first involved subjects relaxing for 2 hours with blood viscosity measured using a zeta potential measurement (the greater the zeta potential level, the more spaced the red blood cell are and the lower the blood viscosity). The second study used a commercial blood viscometer to measure viscosity of individuals practicing yoga on a grounded yoga mat. Both studies found that grounding significantly reduces blood viscosity, thus potentially improving red blood cell spacing (thinning them out).
[Ref: 11, 15, 19]

Improves Regulation of Blood Flow in the Torso, Extremities, and Face

Facial blood flow regulation clearly improves among grounded − but not sham-grounded—subjects, and even within one hour, as determined in a study utilizing laser imaging technology. An infrared (thermographic) imaging camera study for the same duration also documented improved circulation of fluids (including blood and lymph) and a decrease in intestinal distension (bloating) throughout the abdomen and torso, which in turn translates into enhanced circulation throughout the body, extremities, and head and face. The results of these innovative studies demonstrate that even one-hour contact with the Earth appears to significantly promote blood regulation and circulation, and provides supportive evidence of grounding's effect on blood viscosity (#10). Added together, these are significant systemic findings, affecting overall and local health, such as healthier facial skin.
[Ref: 2, 13, 17]

Improves Glucose (Blood Sugar) Regulation

Patients with noninsulin-dependent diabetes mellitus were grounded continuously for over 72 hours resulting in a decreased fasting glucose level. This profoundly important outcome suggests that disconnection with the Earth

negatively affects glucose regulation and that grounding may be an overlooked factor in diabetes prevention and treatment.
[Ref: 8, 19]

Prevents Calcium and Bone Density Loss, Reduces Indicators of Osteoporosis and Improves Kidney Function

Non-medicated subjects were grounded for one night. Blood analyses afterward showed a reduction in blood and urinary calcium and phosphorus, and a reduction in renal excretion of both elements. These findings directly relate to bone density and osteoporosis. Earthing for even only one night may reduce primary indicators of osteoporosis.
[Ref: 8, 19]

Gives a Grounding Point to the Body's Bioelectrical Circuits Making them Work Optimally

Your body is a collection of dynamic electric circuits in which trillions of cells constantly transmit and receive energy as they carry out their programmed biochemical reactions. All this activity is regulated by electric fields. From an electric standpoint, both the human body and the Earth's surface are conductors. When two conductors come in contact their respective electric potential (level) equalizes. This is accomplished by sharing electrons. The Earth's surface, being the most negatively charged of the two conductors, gives electrons to the body. Thus, when grounded, a primordial and naturally stabilized electric reference point for all body biological circuits is created. This stabilization is similar to grounding any electronic circuit in order for the circuit to function properly.
[Ref: 10, 19, 20]

Increases Metabolic Rate

Metabolic syndrome refers to the presence of several risk factors − excess abdominal obesity, high triglycerides, blood pressure, and glucose, and low high-density lipoprotein − known to increase the risk of cardiovascular disease and diabetes. These risks factors are often present when a person's metabolic rate decreases substantially and the person starts to gain weight. A study was performed with 28 subjects who were both grounded and sham-grounded in separate 40-minute sessions. Only when they were grounded did the subjects show more efficient processing of energy (a higher basal metabolic rate). In addition, a laboratory study with rats offers support for the findings. Sixty (60) rats were randomly divided into two groups; one group was grounded, the other not grounded. Grounding resulted in a beneficial effect on metabolic syndrome

indicators and body weight (lower) after 20 months. [Ref: 5, 6, 8]

Influences Thyroid Gland Function

Blood samples were drawn from 6 male and 6 female adults with no history of thyroid disease. A single night of grounding produced a significant decrease in tri-iodothyronine (T3) and an increase in free thyroxin (T4) and thyroid-stimulating hormone. The meaning of these results is unclear, other than that grounding affects thyroid metabolism. Over the years we have had feedback from many individuals who were able to reduce their medication for hypothyroidism after starting grounding.
[Ref: 8, 19]

Reduces Muscle Damage, Accelerates Recovery from Delayed Onset Muscle Soreness - DOMS

Delayed onset muscle soreness (DOMS) is what you experience when you overdo it with exercise. Your overtaxed muscles hurt! You are in pain for a few days. In an experiment, 8 healthy young men performed weighted toe raises to create significant muscle soreness (DOMS) in both calves. Each participant was exercised individually on a Monday morning and then monitored for the rest of the week while following a similar eating, sleeping, and living schedule. The group was randomly divided − half being grounded and the other half sham-grounded. Comprehensive testing and measurements revealed reduced muscle damage and accelerated recovery from DOMS among the grounded men compared to the non-grounded men. These results were confirmed in a second DOMS study, which also showed a marked decrease in creatine kinase, a biochemical indicator of muscle damage. In yet another confirming study, researchers found that grounding during cycling exercise significantly reduces the level of blood urea, an indicator of muscle and protein breakdown. The findings represent a major recovery benefit for training athletes.
[Ref: 7, 14, 18, 19]

Speeds Wound Healing

An 84-year-old diabetic woman with an 8-month-old unhealed and painful open wound on the left ankle had undergone various treatments at a specialized wound center with no results. After 2 weeks of grounding daily for a half-hour with an Earthing electrode patch, the wound was healed over and the patient reported being completely pain free. Dramatic examples were reported by Chiropractor Jeff Spencer, who was assigned to promote recovery from exertion and injury among American cyclists during several Tour de France competitions. It is well known that at this extreme level of grueling competition, cyclists tend to experience slow

wound healing after injury, threatening their ability to continue competing. Dr. Spencer found just the opposite with grounding, and observed very rapid healing, along with only minimal classical signs of inflammation: heat, redness, swelling, pain, loss of function. Faster-than-normal wound and surgical healing has been frequently reported over the years. Accelerated wound healing, whether involving injury, surgery, or burn, may result from a combination of reduced inflammation as well as improved circulation carrying healing factors to the site.
[Ref: 2, 7, 14]

Improves Immune System Response to Trauma and Injuries

Significant changes in immune function responses and markers were documented among grounded—and not among non-grounded − subjects in two grounding studies on delayed onset muscle soreness (DOMS). Grounded subjects had less pain, little inflammation, and a shorter recovery time. Another study assessed the effect of grounding on the classic immune response following vaccination. Grounding accelerated the immune response, as demonstrated by increases in gamma globulin concentration. These results indicate an association between Earthing and the immune response.
[Ref: 7, 8, 14, 18, 19]

Normalizes Muscle Tension

As we have noted, the body operates electrically. Example: Nerve impulses stimulate muscle fibers to contract. A study using specialized instrumentation (electromyography, EMG) was set up to measure electrical voltage generated by muscle cells in grounded and non-grounded subjects. Muscle tone refers to the state of tension, that is, the degree of constant steady contraction of a given muscle. Tense muscle cells generate high voltage, while those with low tension generates abnormally low levels of voltage. In our study, grounding increased the tension of muscles with low tone and decreased the tension of tensed muscles allowing for more orderly and efficient function.
[Ref: 3]

Reduces PMS Symptoms and Hot Flashes

Women have frequently reported improved menstrual and menopausal discomfort. In one study, 5 out of 6 female subjects with PMS or hot flashes described a decrease in symptoms within 6 weeks or less.
[Ref: 1]

Anti-aging Effects

The dominant theory of aging emphasizes cumulative damage caused by oxidative stress from free radicals produced during normal metabolism or in response

to pollution, poor diet, stress, or injury. We hypothesize an anti-aging effect of grounding based on electron storage enhancement that readily and abundantly delivers anti-oxidant electrons to sites where tissue integrity might be damaged by free radicals.
[Ref: 19]

Shielding against Low Frequency Electromagnetic Fields (Faraday Cage Effect)

When the body and the Earth's surface come in contact, their potential equalizes. Since the Earth's surface is the most negatively charged of the 2 conductors, electrons are transferred from the Earth's surface to the body. Maintaining the contact between the 2 conductors results in a constant exchange of low frequency electromagnetic fields (EMFs) and electrons that prevent external electromagnetic field to penetrate the body (this is especially true for external low frequency electromagnetic fields, i.e. less than 100,000 Hz) thus maintaining the internal electrical condition of the body into a homeostatic electrical state stabilizing our body's internal electrical environment. This is the Faraday cage effect.

Some critics have absurdly claimed that it is harmful to ground yourself in the presence of EMFs or that the EMFs will interfere with the grounding process. They say that your body will act as an antenna and draw these EMFs into your body. First of all, there is no such evidence for any of this. Quite to the contrary, pretty much all of the grounding studies have been conducted in homes, offices, and facilities where EMFs were present. Two studies (references 20 and 21) show that grounding significantly reduces voltage induced on the body from EMFs. The first, the Applewhite study from 2005, showed a voltage reduction by a factor of at least 70. The Brown study, conducted in 2015, showed that even being close to a monitor, desk lamp, scanner and wireless phone, the AC current generated though the body of a grounded person from their combined EMF emissions is less than 1,800 the minimum perceptible current (1 milliampere) at a distance of 3 feet and less than 380 times while touching the lamp. Such a current is absolutely negligible. Not one of the 50 subjects who participated in the study felt anything. [Ref: 10, 19, 20, 21]

REFERENCES AND ARTICLE ABSTRACTS

1. **M. Ghaly and D. Teplitz, "The biologic effects of grounding the human body during sleep as measured by cortisol levels and subjective reporting of sleep, pain, and stress," Journal of Alternative and Complementary Medicine, vol. 10, no. 5, pp. 767–776, 2004.**

Objectives: Diurnal cortisol secretion levels were measured and circadian cortisol profiles were evaluated in a pilot study conducted to test the hypothesis that grounding the human body to earth during sleep will result in quantifiable changes in cortisol. It was also hypothesized that grounding the human body would result in changes in sleep, pain, and stress (anxiety, depression, irritability), as measured by subjective reporting.

Subjects and Interventions: Twelve subjects with complaints of sleep dysfunction, pain, and stress were grounded to earth during sleep for 8 weeks in their own beds using a conductive mattress pad. Saliva tests were administered to establish pre-grounding baseline cortisol levels. Levels were obtained at 4-hour intervals for a 24-hour period to determine the circadian cortisol profile. Cortisol testing was repeated at week 6. Subjective symptoms of sleep dysfunction, pain, and stress were reported daily throughout the 8-week test period.

Results: Measurable improvements in diurnal cortisol profiles were observed, with cortisol levels significantly reduced during night-time sleep. Subjects' 24-hour circadian cortisol profiles showed a trend toward normalization. Subjectively reported symptoms, including sleep dysfunction, pain, and stress, were reduced or eliminated in nearly all subjects.

Conclusions: Results indicate that grounding the human body to earth ("earthing") during sleep reduces night-time levels of cortisol and resynchronizes cortisol hormone secretion more in alignment with the natural 24-hour circadian rhythm profile. Changes were most apparent in females. Furthermore, subjective reporting indicates that grounding the human body to earth during sleep improves sleep and reduces pain and stress.

2. **W.C. Amalu. Clinical Earthing Application in 20 Case Studies, Medical Thermography, 2005 (Unpublished study)**

   The case studies presented were performed out of an out-patient clinical treatment center in Redwood City, California. The subjects were randomly selected out of the treatment database as they presented for care. Each subject consented to inclusion in the study. Pain levels were assessed and followed using the standardized four point visual analogue pain scale. Thermal imaging of each subject was undertaken utilizing standardized pre-examination preparation protocols and strict image acquisition according to published guidelines. Some of the subjects were supplied with an earthing sleep system consisting of bedding containing conductive fibers, which was placed on top of the subject's mattress and thereafter connected to the earth via a conductive ground cord and an earthed ground rod. Other subjects were given clinical earthing treatments, which entailed the use of conductive electrode adhesive patches that were attached to the skin at specific points and thereafter coupled to the earth via a conductive ground wire that was connected to an earthed ground rod. All of the subjects were followed over time and their results recorded and summarized. Use of high-resolution medical infrared imaging as an objective assessment of both inflammatory and neurophysiologic conditions demonstrated significant immediate changes in both acute and chronic inflammation related conditions. Earthing is showing incredible promise as one of the most significant advances in the treatment of both acute and chronic inflammatory conditions.

3. **G. Chevalier, K. Mori, and J.L. Oschman, "The effect of Earthing (grounding) on human physiology, Part I" European Biology and Bioelectromagnetics, vol. 2, no. 1, pp. 600–621, 2006.**

   Previous research showed that connecting the human body to the earth during sleep normalizes circadian cortisol profiles and reduces or eliminates various subjectively reported symptoms, including sleep dysfunction, pain and stress. We therefore hypothesized that earthing might also influence other aspects of physiology. Fifty-eight healthy adult subjects (30 controls) participated in a double blind pilot study. Earthing was accomplished with a conductive adhesive patch placed on the sole of each foot. An earthing cord led outdoors to a rod driven into the earth. A biofeedback system recorded electrophysiological and physiological

parameters. Upon earthing, about half the experimental subjects showed an abrupt, almost instantaneous change in root mean square (rms) values of electroencephalograms (EEG) from the left hemisphere (but not the right hemisphere) and all of them presented an abrupt change in rms values of surface electromyograms (SEMGs) from right and left upper trapezius muscles. Signal variance in rms muscle potentials also increased significantly. Earthing decreased blood volume pulse (BVP) in 19 of 22 experimental subjects ($p < 0.001$) and in 8 of 30 controls ($p = 0.1$, not significant); heart rate (HR) was not affected. From these results, it appears that earthing the human body has significant effects on electrophysiological properties of the brain and musculature, on the blood volume pulse, and on the noise and stability of electrophysiological recordings. Taken together, the changes in EEG, EMG, and BVP suggest reductions in overall stress levels and tensions, and a shift in autonomic balance upon earthing. The results therefore extend the conclusions of the previous study (Ghaly, Teplitz).

4. G. Chevalier, K. Mori. "The effect of Earthing (grounding) on human physiology, Part II: Electrodermal measurements" Subtle Energies & Energy Medicine, vol. 18, no. 3, pp. 11–34, 2007.

The human body evolved while living in direct electrical contact (electrically grounded) with the earth. The question that arises is: Does loss of electrical contact with the earth affect human physiology? This double-blind study was designed to address this question by measuring several electrophysiological parameters of the body. Subjects were assigned to an experimental group that was grounded to the earth after a 28-minute baseline recording. Grounding the body (earthing) was achieved by placing electrode patches on the soles of the feet and connecting them to a conductive cable that was attached to a metal rod planted in the earth. The total recording time was 56 minutes. The control group was not grounded but "sham grounded." Part 1 of this study presented results from measurements taken with clinical biofeedback equipment. This paper presents results obtained on Jing-Well points using the SSVP (Single Square Voltage Pulse) method. With the SSVP method we were able to corroborate results presented in our first paper with the biofeedback system. The SSVP method results are that grounding the body produces a reduction in tension (relaxation) of the internal organs and a reduction in inflammation. We also postulated that the body was

developed to take advantage of the contact with the earth through the feet by developing a system of distribution of electrons through the kidney meridian at Kidney 1. The present findings are consistent with the results of our previous study which concluded that grounded subjects experienced a reduction in stress and a normalization of the functioning of the autonomic nervous system after earthing.

5. **H. Semple. Earthing effects in female Lewis rats. 2008.** (Unpublished study see EarthingInstitute.net/ Research).

6. **G. Chevalier, "Changes in pulse rate, respiratory rate, blood oxygenation, perfusion index, skin conductance, and their variability induced during and after grounding human subjects for 40 minutes," Journal of Alternative and Complementary Medicine, vol. 16, no. 1, pp. 1–7, 2010.**

   Objectives: Previous studies have shown that grounding produces quantifiable physiologic changes. This study was set up to reproduce and expand earlier electrophysiologic and physiologic parameters measured immediately after grounding with improved methodology and state-of-the-art equipment.

   Design and subjects: A multi-parameter double-blind experiment was conducted with 14 men and 14 women (age range: 18–80) in relatively good health. Subjects were screened for health problems using a commonly used health questionnaire. They were seated in a comfortable recliner and measured during 2-hour grounding sessions, leaving time for signals to stabilize before, during, and after grounding (40 minutes for each period). Sham 2-hour grounding sessions were also recorded with the same subjects as controls.
   Outcome measures: This report presents results for 5 of the 18 parameters measured. The parameters reported here are: skin conductance (SC), blood oxygenation (BO), respiratory rate (RR), pulse rate (PR), and perfusion index (PI).

   Settings/location: This study was performed in a rented facility in Encinitas, California. The facility was chosen in a quiet area for its very low electromagnetic noise.
   Results: For each session, statistical analyses were performed on four 10-minute segments: before and after grounding (sham grounding for

control session) and before and after ungrounding (sham ungrounding). There was an immediate decrease in SC at grounding and an immediate increase at ungrounding on all subjects. RR increased during grounding, and the effect lasted after ungrounding. RR variance increased immediately after grounding then decreased. BO variance decreased during grounding, followed by a dramatic increase after ungrounding. PR and PI variances increased toward the end of the grounding period, and this change persisted after ungrounding.

Conclusions: These results warrant further research to determine how grounding affects the body. Grounding could become important for relaxation, health maintenance and disease prevention.

7. **R. Brown, G. Chevalier, and M. Hill,"Pilot study on the effect of grounding on delayed-onset muscle soreness," Journal of Alternative and Complementary Medicine, vol. 16, no. 3, pp. 265–273, 2010.**

Objectives: The purpose of this pilot study was to determine whether there are markers that can be used to study the effects of grounding on delayed-onset muscle soreness (DOMS).

Design and subjects: Eight healthy subjects were exposed to an eccentric exercise that caused DOMS in gastrocnemius muscles of both legs. Four subjects were grounded with electrode patches and patented conductive sheets connected to the earth. Four (4) control subjects were treated identically, except that the grounding systems were not connected to the earth.

Outcome measures: Complete blood counts, blood chemistry, enzyme chemistry, serum and saliva cortisols, magnetic resonance imaging and spectroscopy and pain levels were taken at the same time of day before the eccentric exercise and 24, 48, and 72 hours afterwards. Parameters consistently differing by 10% or more, normalized to baseline, were considered worthy of further study.

Results: Parameters that differed by these criteria included white blood cell counts, bilirubin, creatine kinase, phosphocreatine=inorganic phosphate ratios, glycerolphosphorylcholine, phosphorylcholine, the

visual analogue pain scale, and pressure measurements on the right gastrocnemius.

Conclusions: In a pilot study, grounding the body to the earth alters measures of immune system activity and pain. Since this is the first intervention that appears to speed recovery from DOMS, the pilot provides a basis for a larger study

8. **K. Sokal and P.Sokal,"Earthing the human body influences physiologic processes," Journal of Alternative and Complementary Medicine, vol. 17, no. 4, pp. 301–308, 2011.**

Objectives: This study was designed to answer the question: Does the contact of the human organism with the Earth via a copper conductor affect physiologic processes?
Subjects and experiments: Five (5) experiments are presented: experiment 1—effect of earthing on calcium–phosphate homeostasis and serum concentrations of iron (N=84 participants); experiment 2—effect of earthing on serum concentrations of electrolytes (N=28); experiment 3—effect of earthing on thyroid function (N=12); experiment 4—effect of earthing on glucose concentration (N=12); experiment 5—effect of earthing on immune response to vaccine (N=32). Subjects were divided into two groups. One (1) group of people was earthed, while the second group remained without contact with the Earth. Blood and urine samples were examined.

Results: Earthing of an electrically insulated human organism during night rest causes lowering of serum concentrations of iron, ionized calcium, inorganic phosphorus, and reduction of renal excretion of calcium and phosphorus. Earthing during night rest decreases free tri-iodothyronine and increases free thyroxine and thyroid-stimulating hormone. The continuous earthing of the human body decreases blood glucose in patients with diabetes. Earthing decreases sodium, potassium, magnesium, iron, total protein, and albumin concentrations while the levels of transferrin, ferritin, and globulins a1, a2, b, and g increase. These results are statistically significant.
Conclusions: Earthing the human body influences human physiologic processes. This influence is observed during night relaxation and

during physical activity. Effect of the earthing on calcium–phosphate homeostasis is the opposite of that which occurs in states of weightlessness. It also increases the activity of catabolic processes. It may be the primary factor regulating endocrine and nervous systems.

9. **G. Chevalier and S. Sinatra, "Emotional stress, heart rate variability, grounding, and improved autonomic tone: clinical applications," Integrative Medicine: A Clinician's Journal, vol. 10, no. 3, 2011.**

   Over the last few years, the utilization of integrative biophysics for medical application has been increasing in popularity. Grounding or earthing is the oldest and most basic form of natural bioelectric potential that supports physiological and electrophysiological changes in the body.

   Since previous investigations have shown that grounding profoundly affects skin conductance within seconds, we hypothesized that grounding may also improve heart rate variability (HRV). In this study of 27 final participants, grounded subjects had improvements in HRV that go beyond basic relaxation ($P<.01$). Since improved HRV has such a positive impact on cardiovascular status, it is suggested that simple grounding techniques be utilized as a ba−sic integrative strategy in supporting the cardiovascular system, especially under situations of heightened autonomic tone (ie, when the sympathetic nervous system is more activated than the parasympathetic nervous system).

10. **K. Sokal and P. Sokal, "Earthing the human body influences bioelectrical processes," Journal of Alternative and Complementary Medicine, vol. 18, no. 3, pp. 229−234, 2012.**

    Objectives: This article describes interaction of the Earth's mass—electrolytic conductor on the electrical environment of human organism—aqueous environment and skeleton. In this environment, bioelectrical and bioenergetical processes take place.

    Methods and subjects: Measurements of electric potential on tongue, teeth, nails, and in venous blood in subjects earthed and unearthed were conducted in Faraday's cage with the use of an electrometer placed outside the cage. Measurements were performed in subjects in lying

position and in movements of standing up and lying down.

Results: In the unearthed human organism in the lying position, electric potential measured in examined points is around 0 mV. Contact of the Earth by a copper conductor with a moistened surface of the human body evokes a rapid decrease of electrostatic potential on the body and in venous blood to the value of approximately - 200 mV. This effect is immediate and general. Interruption of contact with the Earth causes a rapid return of the potential to its initial values in examined points. Changes in electric potential measured in venous blood and on mucosal membrane of the tongue reflect alterations in electric potential of the aqueous, electrical environment.

Up-and-down movement of the insulated human organism causes transient changes in potential in the human electrical environment. During the same movement, values of potential in the electrical environment of an earthed human body remain constant.

Conclusions: These results indicate that up-and-down movement and the elimination of potentials in the electrical environment of the human organism by the Earth's mass may play a fundamental role in regulation of bioelectrical and bioenergetical processes. The Earth's electromagnetohydrodynamic potential is responsible for this phenomenon.

11. G. Chevalier, S. T. Sinatra, J. L. Oschman, and R. M. Delany. "Earthing (grounding) the human body reduces blood viscosity—A major factor in cardiovascular disease," Journal of Alternative and Complementary Medicine, vol. 19, no. 2, pp. 102–110, 2013.

Objectives: Emerging research is revealing that direct physical contact of the human body with the surface of the earth (grounding or earthing) has intriguing effects on human physiology and health, including beneficial effects on various cardiovascular risk factors. This study examined effects of 2 hours of grounding on the electrical charge (zeta potential) on red blood cells (RBCs) and the effects on the extent of RBC clumping.

Design/interventions: Subjects were grounded with conductive patches on the soles of their feet and palms of their hands. Wires connected the

patches to a stainless-steel rod inserted in the earth outdoors. Small fingertip pinprick blood samples were placed on microscope slides and an electric field was applied to them. Electrophoretic mobility of the RBCs was determined by measuring terminal velocities of the cells in video recordings taken through a microscope. RBC aggregation was measured by counting the numbers of clustered cells in each sample.

Settings/location: Each subject sat in a comfortable reclining chair in a soundproof experiment room with the lights dimmed or off.

Subjects: Ten (10) healthy adult subjects were recruited by word-of-mouth.

Results: Earthing or grounding increased zeta potentials in all samples by an average of 2.70 and significantly reduced RBC aggregation.

Conclusions: Grounding increases the surface charge on RBCs and thereby reduces blood viscosity and clumping. Grounding appears to be one of the simplest and yet most profound interventions for helping reduce cardiovascular risk and cardiovascular events.

12. **P. Sokal, Z. Jastrzebski, E. Jaskulska, K. Sokal, M. Jastrzebska, L. Radziminski, R. Dargiewicz, and P. Zielinski. "Differences in blood urea and creatinine concentrations in Earthed and unearthed subjects during cycling exercise and recovery," Evidence-Based Complementary and Alternative Medicine, vol. 2013, 2013.**

    Contact of humans with the earth, either directly (e.g., with bare feet) or using a metal conductor, changes their biochemical parameters. The effects of earthing during physical exercise are unknown. This study was carried out to evaluate selected biochemical parameters in subjects who were earthed during cycling. In a double-blind, crossover study, 42 participants were divided into two groups and earthed during exercise and recovery. One group was earthed in the first week during 30 minutes of cycling exercise and during recovery, and a second group was earthed in the second week. A double-blind technique was applied. Blood samples were obtained before each training session, after 15 and 30 minutes of exercise, and after 40 minutes of recovery. Significantly lower blood urea

levels were observed in subjects earthed during exercise and relaxation. These significant differences were noted in both groups earthed at the beginning of exercise ($P < 0.0001$), after 15 ($P < 0.0001$) and 30 minutes ($P < 0.0001$) of exercise, and after 40 minutes of relaxation ($P < 0.0001$). Creatinine concentrations in earthed subjects during exercise were unchanged.

Conclusions. Earthing during exercise lowers blood urea concentrations and may inhibit hepatic protein catabolism or increase renal urea excretion. Exertion under earthing may result in a positive protein balance.

13. **G. Chevalier."Grounding the human body improves facial blood flow regulation: results of a randomized, placebo controlled pilot study," Journal of Cosmetics, Dermatological Sciences and Applications, vol. 4, no. 6, pp. 293–308, 2014.**

Earthing (grounding) refers to bringing the human body in direct contact with the negative electric charge of the earth's surface by barefoot exposure outdoors or using special conductive indoor systems that are connected to the Earth. To determine if earthing improves facial blood circulation/flow, a double-blind study was designed with forty subjects either grounded or sham-grounded (27 grounded subjects and 13 sham-grounded subjects acting as controls) for at least one hour in a comfortable recliner chair equipped with conductive mat, pillow, and patches. The grounding systems were either grounded or sham-grounded via a wire to the ground port (third hole) of a power outlet. A Laser Speckle Contrast Imaging camera was used to continuously record changes in facial blood flow non-invasively. Facial blood flow regulation clearly improved among grounded—but not sham-grounded—subjects. The results demonstrate, for the first time, that even one-hour contact with the earth restores blood flow regulation to the face suggesting enhanced skin tissue repair and improved facial appearance with possible implications for overall health. Further studies, using larger comparison groups, longer monitoring times, and more measuring methods, are warranted in order to confirm the novel influence of the Earth as a protector of skin health and appearance.

14. **J.L. Oschman, G. Chevalier, and R. Brown.“The effects of grounding (earthing) on inflammation, the immune response, wound healing, and prevention and treatment of chronic inflammatory and immune diseases,” Journal of Inflammation research, vol. 8, pp. 83–96, 2015.**

    Multi-disciplinary research has revealed that electrically conductive contact of the human body with the surface of the Earth (grounding or earthing) produces intriguing effects on physiology and health. Such effects relate to inflammation, immune responses, wound healing, and prevention and treatment of chronic inflammatory and autoimmune diseases. The purpose of this report is two-fold: to 1) inform researchers about what appears to be a new perspective to the study of inflammation, and 2) alert researchers that the length of time and degree (resistance to ground) of grounding of experimental animals is an important but usually overlooked factor that can influence outcomes of studies of inflammation, wound healing, and tumorigenesis. Specifically, grounding an organism produces measurable differences in the concentrations of white blood cells, cytokines, and other molecules involved in the inflammatory response. We present several hypotheses to explain observed effects, based on current research results and our understanding of the electronic aspects of cell and tissue physiology, cell biology, biophysics, and biochemistry. An experimental injury to muscles, known as delayed onset muscle soreness, has been used to monitor the immune response under grounded versus ungrounded conditions. Grounding reduces pain and alters the numbers of circulating neutrophils and lymphocytes, and also affects various circulating chemical factors related to inflammation.

15. **R. Brown, and G. Chevalier.“Grounding the human body during yoga exercise with a grounded yoga mat reduces blood viscosity,” Open Journal of Preventive Medicine, vol. 5, pp. 159–168, 2015.**

    Objective: Research continues to show that being connected to the earth can increase the potential of the body to scavenge free radicals. This study examined the effect of just one hour of grounding on blood viscosity while subjects participated in gentle yoga exercises designed to initiate minor inflammation.

Design: In this double blind model, twenty-eight (28) subjects met at the Bowerman Sports Medicine Clinic on the campus of the University of Oregon and were grounded to the earth via contact with a grounded yoga mat or were sham-grounded. Ten yoga exercises were repeated five times over a one-hour period. Blood was taken pre and post exercise and analyzed for blood viscosity using a scanning capillary viscometer.

Results: Subjects connected to the earth significantly reduced their post exercise systolic blood viscosity ($p = 0.03$) and diastolic blood viscosity ($p = 0.03$).

Conclusion: Grounding has the ability to affect exercise induced inflammation, thereby reducing blood viscosity.

16. **G. Chevalier."The effect of grounding the human body on mood," Psychological Reports, vol. 116, no. 2, pp. 534–542, 2015.**

    Earthing (grounding) refers to bringing the body in contact with the Earth. Health benefits were previously reported, but no study exists about mood. This study was conducted to assess if Earthing improves mood. 40 adult participants were either grounded or sham-grounded (no grounding) for 1 hr. while relaxing in a comfortable recliner chair equipped with a conductive pillow, mat, and patches connecting them to the ground. This pilot project was double-blinded and the Brief Mood Introspection Scale (comprising 4 mood scales) was used. Pleasant and positive moods statistically signifi- cantly improved among grounded—but not sham-grounded—participants. It is concluded that the 1-hr. contact with the Earth improved mood more than expected by relaxation alone. More extensive studies are, therefore, warranted.

17. **G. Chevalier, G. Melvin, T. Barsotti."One-hour contact with the Earth's surface (grounding) improves inflammation and blood flow—A randomized, double-blind, pilot study," Health, vol. 7, pp. 1022-1059, 2015.**

    Earthing (grounding) refers to the human body being in contact with the surface of the Earth by barefoot exposure outdoors or using special indoor systems connected to the Earth. Previous studies have showed multiple beneficial effects as a result of such contact, including better

sleep, normalization of cortisol, reduced inflammation, pain and stress, and better blood flow. To determine if Earthing for one hour improves facial blood circulation, forty middle-aged volunteers were divided into a grounded group and a sham-grounded group according to a double-blind procedure. They were asked to sit in a comfortable recliner chair equipped with a grounding mat, pillow and patches. The grounding systems were either grounded or sham-grounded via a wire to the ground port of a power outlet. An infrared imaging camera was used to measure changes in blood flow and temperature. Thermal imaging showed clearly improved circulation of fluids (including blood) throughout the torso, which in turn, translates into enhanced delivery of blood to the head and improved blood circulation in the face as well. The results of this innovative study demonstrate that even one-hour contact with the Earth appears to promote significantly autonomic nervous system control of body fluids and peripheral blood flow that may improve blood circulation in the torso and face, facial tissue repair, skin health and vitality and optimize facial appearance (face anterior view $p = 0.002$; face lateral views $p = 0.017$; full anterior torso view $p = 0.002$). Further study using larger comparison groups and following subjects for a longer period of time (longitudinal study) is warranted.

18. R. Brown, G. Chevalier, and M. Hill, "Grounding after moderate eccentric contractions reduces muscle damage" Open Access Journal of Sports Medicine, vol. 5, no. 6, pp. 305–317, 2015.

Grounding a human to the earth has resulted in changes in the physiology of the body. A pilot study on grounding and eccentric contractions demonstrated shortened duration of pain, reduced creatine kinase (CK), and differences in blood parameters. This follow-up study was conducted to investigate the effects of grounding after moderate eccentric contractions on pain, CK, and complete blood counts. Thirty-two healthy young men were randomly divided into grounded (n=16) and sham-grounded (n=16) groups. On days 1 through 4, visual analog scale for pain evaluations and blood draws were accomplished. On day 1, the participants performed eccentric contractions of 200 half-knee bends. They were then grounded or sham-grounded to the earth for 4 hours on days 1 and 2. Both groups experienced pain on all posttest days. On day 2, the sham-grounded group experienced significant CK increase (P,0.01) while the CK of the grounded group did not increase significantly; the

between-group difference was significant (P=0.04). There was also an increase in the neutrophils of the grounded group on day 3 (P=0.05) compared to the sham-grounded group. There was a significant increase in platelets in the grounded group on days 2 through 4. Grounding produced changes in CK and complete blood counts that were not shared by the sham-grounded group. Grounding significantly reduced the loss of CK from the injured muscles indicating reduced muscle damage. These results warrant further study on the effects of earthing on delayed onset muscle damage.

19. **J. L. Oschman, G. Chevalier and A.C. Ober."Biophysics of Earthing (Grounding) the Human Body" In: Bioelectromangetic and subtle energy medicine, 2nd Edition, P.J. Rosch Ed.,CRC Press, New York, pp. 427-450, 2015.**

20. **R. Applewhite."The effectiveness of a conductive patch and a conductive bed pad in reducing induced human body voltage via the application of Earth ground," European Biology and Bioelectromagnetics, vol. 1, pp. 23-40, 2005.**

    Voltage induced on a human body by capacitive coupling to the external environment was measured using a high-impedance measurement head. The body was then earth grounded by means of a conductive patch and a conductive bed pad. Each method reduced the coupled 60Hz mains voltage by a factor of at least 70. This result, along with the measurement of the voltage drop across an in-line resistance in the conductive patch provided evidence of a simplified electrical network model of the human body.

    Objectives: To determine if grounding in the presence of electromagnetic fields

21. **R. Brown."The Effects of Grounding on Body Voltage and Current in the Presence of Electromagnetic Fields." the Journal of Alternative and Complementary Medicine.**

    Encountered in a normal housing environment produces harmful currents in the human body.

Design: Test-retest design with duration of five to ten minutes per participant.
Location: Author's residence.
Participants: Fifty participants: 23 males aged 12 - 77 (mean age ± standard deviation, 50.5 ± 19.5) and 27 females aged 13 - 79 (45.9 ± 19.0).

Intervention: Each participant was instructed to touch a lamp on a desk with his or her left hand, then to move the hand away from the lamp (first one foot away and then three feet) while body voltage was measured. Each participant was then grounded and instructed to repeat the same hand movements. Current was also measured during the grounded retest.

Outcome measures: The measured parameters were AC body voltage and current generated from contact or proximity to a lamp and other appliances situated on top of a desk.

Results: AC body voltage was reduced by an average of 58-fold when participants were grounded compared to when they were not grounded. AC currents generated during grounding were several orders of magnitude lower than the accepted minimum level of perception.

Conclusion: Normal levels of electromagnetic fields existing in houses are too low to produce harmful currents when a person is grounded.

For nearly 18 years, Earthing research and feedback from individuals worldwide who have grounded themselves routinely, often while sleeping at night, demonstrate a multitude of benefits. Here is a short list of them:

- Reduced Inflamation
- Reduction of chronic pain
- Deeper sleep
- Increased energy
- Lowered stress
- Improved circulation
- Headache relief
- Lessened hormonal and menstrual symptoms
- Normalization of the body's biological rhythms

For additional information, refer to the Earthing book or visit www.earthinginstitute.net