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Earthing Enhances Wellness and Human Performance

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ABSTRACT

Extensive feedback from around the world and some 25 years of research published in peer-reviewed scientific journals have documented that the simple and virtually effortless act of making skin contact with the surface of the Earth (grounding or earthing) can prevent and relieve hundreds of different wellness issues. This includes reducing and even eliminating symptoms of countless costly and pesky health problems, as well as scores of major life-threatening inflammatory diseases. Hence there is much interest in finding logical scientific explanations of how such an unusually broad range of benefits are produced simply by earthing or grounding the human body.

Earthing or grounding research has established effects on virtually every kind of inflammation, which has been recognized as being responsible for literally hundreds of different chronic disorders. One crucial biochemical process requiring electrons is the electron transport chain in mitochondria that produces adenosine triphosphate (ATP), the molecule that powers all cellular and physiological processes. Now Giulivi and Kotz (2025) have demonstrated that grounding or earthing isolated and purified mitochondria from mouse liver increases their ATP production and reduces their production of reactive oxygen species (ROS), thereby balancing oxidative metabolism. There are dozens of mitochondrial disorders, providing another group of conditions that can help explain the array of benefits of earthing or grounding. This report considers mitochondrial effects in view of previous work on earthing or grounding. It has been suggested that mobile electrons from the earth, and/or from the recognized electron stores within the body can neutralize the free radicals that perpetuate chronic inflammation. Consequently, an inflammation hypothesis can account for earthing effects on scores of different inflammatory conditions and the chronic diseases linked to them. We can now consider adding to this list the various non-genetic mitochondrial disorders that also appear to benefit from earthing or grounding.

There is evidence that the connective tissues and fascia of individuals who rarely make skin contact with the electron-rich surface of the earth can become electron deficient. Connecting with the earth is virtually effortless and can be accomplished simply by either removing one's shoes and socks and walking barefoot on grass or on a wet beach, or by using conductive devices that bring the benefits of earth contact into home, office, or vehicle. Sleeping grounded supports better rest and waking with electron stores fully charged.

Now Giulivi & Kotz (2025) have demonstrated that grounding or earthing isolated and purified mitochondria from mouse liver increases their ATP production and reduces their production of reactive oxygen species (ROS), thereby balancing oxidative metabolism. Hence, we can now discuss the effects of earthing on inflammation, ATP production, and ROS production and how they may interact to bring relief for hundreds of health issues and energize the bodies of athletes and other performers who must push themselves to the limits in terms of strength, flexibility and endurance.

Keywords
Earthing, Grounding, Inflammation, Mitochondrial function, Adenosine triphosphate (ATP).

Introduction

Grounding or earthing refers to direct skin contact of humans or animals with the Earth's surface. This occurs through bare feet, bare hands (as in gardening), or swimming (especially in sea water), or by using grounding devices that bring the benefits of earthing into home, office or vehicle. Several studies have shown that people can begin to experience the benefits of Earthing in about 30 minutes of Earth contact.

Modern reports on the health benefits of Earthing were published by Clinton Ober in 2000 [1], and by two Polish physicians, Karol Sokal MD PhD and Pawel Sokal MD PhD in 2012 [2]. Some early European work dates to the German naturopaths [3] and the pioneers of biophysics [4]. Adolf Just (1859-1936) was convinced of the "great curative effect" of barefoot contact with the Earth. Mattheo Tavera (1907-1971), a French scientist, studied crops and soil and hypothesized that all life requires "natural electricity" from the surface of the Earth. Experiments on plants confirming Tavera's hypothesis have been replicated many times (e.g. Figure 1) [6,7].

Figure 1: A placebo effect? No! Vegetation cannot lie! Left, the benefits of connecting sunflowers to the Earth were confirmed during the spring of 2010. The experiment began by placing two identical sunflowers into vases filled with tap water. A prototype Earth & Grow device was inserted into the vase on the left. The photo speaks for itself. After ten days the benefits of connecting the sunflower to the Earth were clearly visible. This innovative green technology enhances the growth and health of all types of potted and greenhouse plants including orchids, veggies, herbs, ornamental trees and shrubs, succulents, fruit trees, and other tropical species [6]. Right, a similar experiment done in Alaska, from The Grounded Documentary Film, 2015 [7].

In 2010, Ober, Sinatra and Zucker published *a* book entitled *Earthing*: *The Most Important Health Discovery Ever* [8]. The book has been translated into many languages, exposing Earthing to millions of people around the world. Research and unsolicited enthusiastic feedback from thousands of people confirms that contact with the Earth is indeed having profound significance for health and longevity.

The feedback has revealed that Earthing provides dramatic relief from more than 180 different uncomfortable or debilitating conditions [9]. This growing list of ailments includes many of the widespread and clinically challenging auto-immune-mediated inflammatory diseases, estimated to affect roughly 5% of the population in westernized countries [10]. According to the US National Institutes of Health, up to 23.5 million Americans (more than seven percent of the population) suffer from autoimmune diseases – and the prevalence is rising. Autoimmune diseases mainly affect women and are a leading cause of death and disability [11].

Earthing research is also providing us with new insights into how our physiology depends on the balance of electron availability and oxidative metabolism, and how our immediate environment can disturb or restore balance in physiological systems. The focus of the research continues to explain how such a simple and virtually effortless method (contacting the surface of our planet) can relieve such a variety of wellness issues. The following is a discussion of three major hypotheses: the inflammation hypothesis, the mitochondrial effects, and the ways these phenomena may interact.

Earthing, Inflammation and Silent Inflammation

In 2000, Clinton Ober published his first report on the benefits of Earthing [1]. This was the same year that Paul Ridker MD and his colleagues at Harvard Medical School reported the development of an important and sensitive test for inflammation called hsCRP [12]. The research was based on study of 28,263 apparently healthy postmenopausal women over a mean follow-up period of three years. CRP or c-reactive protein is an annular (ring-shaped) pentameric protein found in blood plasma (Figure 2). The compound is produced by the liver and is rapidly released into the bloodstream in response to infection or inflammation. CRP binds to molecules on the surfaces of dead or dying cells and on some types of bacteria to activate the complement cascade that helps clear microbes and damaged cells from a site of injury or infection [13].

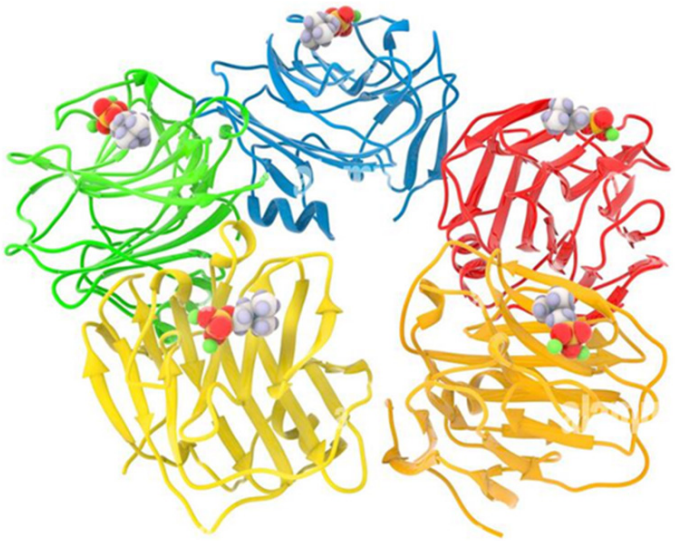

Figure 2: C-reactive protein (CRP) is an annular (ring-shaped) pentameric protein found in blood plasma. The circulating concentration of CRP rises rapidly in response to inflammation. The molecules are secreted by the liver following interleukin-6 secretion by macrophages and T cells. CRP binds to molecules expressed on the surfaces of dead or dying cells and on some types of bacteria, in order to activate the complement cascade that helps clear microbes and damaged cells from a site of injury or infection.

The hs-CRP test enabled researchers around the world to establish relationships between chronic inflammation and virtually all chronic diseases, including the most common killer world-wide, heart disease. CRP testing helps doctors detect inflammation and can be used to track the effectiveness of treatments for inflammatory conditions. By 2021 it could be stated that, "A large body of evidence has accumulated supporting the use of high-sensitivity C-reactive protein (hsCRP) as a clinical measure of inflammation. [14]" While both of the discoveries of Ober and Ridker were profound, taken together they began to explain both the cause and prevention of widespread, painful, costly and debilitating chronic inflammatory and autoimmune diseases. A book by Shilpa Ravella, MD, presents the story of medical science's increasing understanding of hidden or silent inflammation:

> *Medical terminology is filled with "itises": arthritis, colitis, hepatitis, myocarditis. "Itis" means inflammation, and all these terms indicate the specific part of the body that are affected: joints, colon, liver, heart. "A Silent Fire: The Story of Inflammation, Diet, and Disease," a book by Shilpa Ravella, MD, presents the story of medical science's increasing understanding of hidden inflammation. Such inflammation is "silent and sinister," and it is tied to many chronic conditions, writes Ravella, a gastroenterologist with expertise in nutrition… Based on research that has accrued to date, for the first time we are able to say that hidden inflammation, which we typically don't test for, truly can be a cause of disease. It can collude with our genes and environment to evoke disease, and it may be a common thread associated with many diseases.* ~Ravella (2024) [15]

Hence, Ravella unveils inflammation as one potential basis for a unifying theory of disease. Earthing research has added another dimension to this concept.

Silent inflammation is a chronic inflammatory process in the body that often goes unnoticed but that can still have serious effects on health, performance, and longevity. This type of inflammation is not always as obvious as acute inflammation, which is readily identified by swelling, redness, pain, and loss of function. One hypothesis is that mobile electrons from the Earth migrate to sites of inflammation in the body where they neutralize reactive oxygen species (free radicals) that are the cause of so-called "silent inflammation" and that may eventually lead to chronic inflammation and then develop into a wide range of ailments and chronic diseases, including the auto immune diseases and virtually all diseases of aging. There are, in fact, over 100 inflammatory disorders.

A 2021 publication by Sears and Saha discusses silent or quiet inflammation in detail [16]. The authors list the following sequence of stages in the development of silent inflammation: an initial, injury-induced inflammatory response caused by tissue damage, sometimes with microbial invasions, physical injuries (internal and external), diet-induced injuries, oxidative stress-induced injuries, surgery-induced injuries, drug-induced (cancer drugs in particular), and sensor-induced injuries (physical, emotional, or environmental).

Sears and Saha identified two distinct phases to the body's responses to any injury: (1) the initiation of inflammation, and (2) its resolution. The cell and molecular biology of the initiation of inflammation are well-understood; however detailed knowledge of the biology of the resolution of inflammation remains an emerging field [17]. The phenomenon of Earthing is providing us with new insights into this topic. Earthing can facilitate the prevention and resolution of inflammation and its consequences. Research on inflammation and earthing are helping us understand the nature of silent inflammation [17]. See Figure 3.

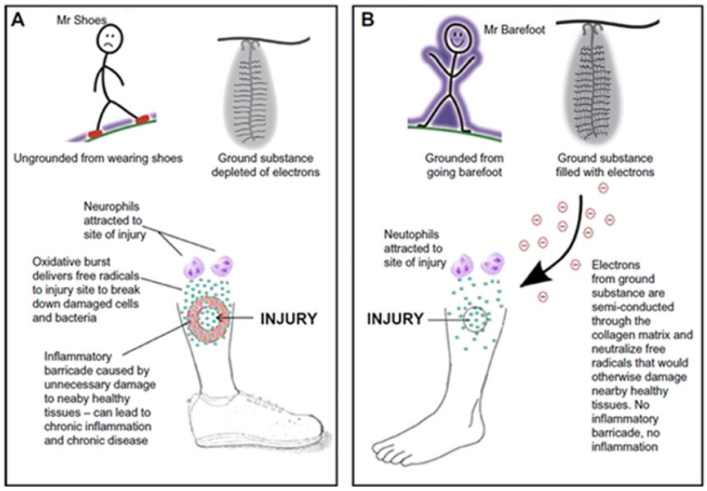

Figure 3: Inflammation hypothesis. Comparison of immune response in ungrounded versus grounded person. (A) After an injury, the ungrounded person (Mr. Shoes) will form an inflammatory barricade around the injury site. (B) After an injury, the grounded person (Mr. Barefoot) will not form an inflammatory barricade, because reactive oxygen species that could damage nearby healthy tissue (collateral damage) are immediately neutralized by electrons semiconducted from the electron-saturated ground substance via the collagen network. From the Journal of Inflammation Research, 2015 [17].

Auto-immune disorders are now regarded as disturbances in the regulation of the production of reactive oxygen species (ROS or free radicals) which are significant contributors to oxidative stress. Dysfunction in these processes is associated with the development of numerous chronic and degenerative diseases. These disorders can be influenced by genetic, environmental, and lifestyle factors. With the exception of thermography, the precise location of these silent inflammations may be difficult to determine. Earthing appears to provide a means to treat these silent and hidden inflammations wherever they are located, without the need to locate their specific foci.

The inflammation hypothesis in relation to earthing has been discussed extensively in a number of publications. Figure 3 is reproduced from the *Journal of Inflammation Research* [18]. The illustration explains how electrons from the Earth in a grounded or

barefoot individual can prevent the formation of an inflammatory barricade around a site of injury. This is probably an early step in the development of silent inflammation. Mobile electrons neutralize free radicals that are thought to produce the barricade.

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The Inflammatory pouch

Detailed information on the inflammatory barricade emerged from the work of Hans Selye, the famous Hungarian/Canadian endocrinologist. Selye developed the concept of stress (see his classic book, *The Stress of Life*. [19] Selye accidentally discovered that he could inject air or saline under the skin of a rat to produce a pouch, which came to be called the Selye or inflammatory or granuloma pouch (Figure 3). By injecting bacteria or hormones into the pouch, Selye was able to establish connections between inflammation and steroid hormones [20]. Histology revealed that the inflammatory barricade is composed of connective tissue.

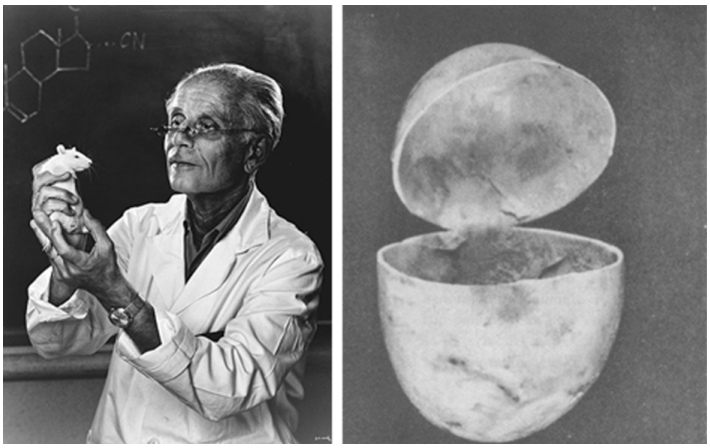

Figure 4: (Left) Hans Selye showing a rat with a pouch produced by injecting air or saline under the skin. These came to be termed Selye or inflammatory or granuloma pouch and have been widely used in the study of inflammation. (Right) the inflammatory pouch could be removed by dissection. Histology showed that the pouch wall was composed of connective tissue.

The Mitochondrial Connection

Mitochondria generate ATP through oxidative phosphorylation while simultaneously producing ROS as byproducts.

Cecilia Giulivi and Richard Kotz [21] have demonstrated that Earthing or grounding mitochondria isolated from mouse liver increased their production of ATP by up to 11% and reduced their production of reactive oxygen species (ROS) by up to 33%.

The findings from study highlight the significant impact of grounding on mitochondrial function, particularly in ROS generation, which consequently affects the coupling of electron transfer to ATP production. Using fluorescence-based assays to evaluate these parameters, we successfully avoided the confounding effects that traditional metal probes introduced by grounding the mitochondrial solution. This methodological approach enabled us to isolate and accurately assess the influence of grounding on mitochondria. Currently, no experimental work has unequivocally demonstrated that grounding alters mitochondrial bioenergetic parameters.

The rates of ATP production and H_2O_2 production were evaluated in mouse liver mitochondria under phosphorylating conditions (State 3) and under the three settings (grounded, sham, and naïve). Significant differences were observed under grounded conditions compared to sham and naïve. Analysis of the variance showed a main effect of grounding on ATP production [$F\ (2,6) = 78.598$, $P < 0.0001$, $P\eta^2 = 0.963$]. Post hoc analyses using Tukey's HSD indicated that the ATP production was 444 ± 2 nmol ATP × (min × mg protein)$^{-1}$ under grounded conditions, significantly higher than that under sham (420 ± 1; $P = 0.002$) and naïve conditions (396 ± 7; $P < 0.0001$). Aligned with the ATP production results, analysis of the variance showed a main effect of grounding on H_2O_2 production rates [$F(2,6) = 10.803$, $P = 0.010$, $p\eta^2 = 0.783$]. Post hoc analyses using Tukey's HSD indicated that the ROS production was not different between sham and naïve conditions [in nmol H_2O_2 × (min × mg protein)$^{-1}$ 0.103 ± 0.009 and 0.12 ± 0.01; $P = 0.213$], but both were higher than that under grounded conditions (0.08 ± 0.01; $P = 0.079$ vs. sham; $P = 0.009$ vs. naïve).

In sum, the ATP production was the highest under grounded conditions, accompanied by the lowest mitochondrial ROS production and the highest coupling of ATP production to oxygen uptake or electron flow through the electron transport chain.

Considering that grounding resulted in a statistically significant increase in ATP production compared to sham and naïve conditions (5 to 11%), but with a more substantial impact on ROS production (decreased by 22 to 33%) than in sham and

naïve conditions, and that research studies indicated that even a modest decrease in membrane potential (<13%) can lead to a 1.2- to 2-fold increase in respiration rate and substantial (by 80%) reduction in H_2O_2 production while exerting minimal effects on State 3 respiration, we evaluated the mitochondrial membrane potential under the three conditions.

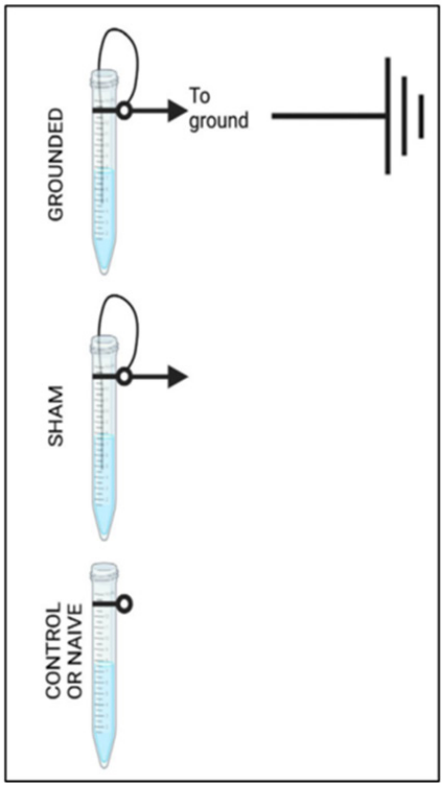

Figure 5: Method of Giulivi and Kotz demonstrating that grounding of mitochondria isolated from mouse liver increased their production of ATP and reduced their production of reactive oxygen species (ROS). A schematic representation of the three experimental setups: grounded (top), sham (middle) and naïve (bottom).

The Giulivi and Kotz study has far-reaching implications deserving of further research because mitochondrial dysfunction is associated with the more than 50 chronic and degenerative diseases, including a range of metabolic disorders, neurodegenerative diseases such as Parkinson's and Alzheimer's, and systemic diseases like diabetes and certain types of cancer [22]. Giulivi and Kotz [21] concluded:

Our results support the hypothesis that grounding provides therapeutic potential across various contexts. Decreased levels of ROS reduce oxidative damage, which may slow processes associated with aging and chronic diseases, which are associated with a decline in mitochondrial function.

In conclusion, these findings underscore the significance of grounding in mitochondrial research and suggest potential therapeutic benefits of grounding for managing conditions related to mitochondrial dysfunction and oxidative stress. Future studies should investigate the long-term effects of grounding and its possible applications in preventive and clinical contexts.

While most mitochondrial disorders are considered genetic, and due to mutations in mitochondrial or nuclear DNA, researchers have also documented the existence of "secondary mitochondrial dysfunctions" which are not directly caused by genetic mutations, but rather arise from environmental factors such as toxins, aging, or other diseases, including diabetes, cancer, and multiple sclerosis, meaning they are not considered "genetic" mitochondrial disorders. These are often referred to as "acquired" mitochondrial dysfunctions. Moreover, many of the mitochondrial disorders with clear genetic origins are expressed through alterations of the immune system [23]. Here we explore the possible acquired mitochondrial dysfunction arising from inadequate supply of electrons for the electron transport chain. Lack of grounding is an important environmental factor in mitochondrial disease worthy of further research.

Mitochondria are increasingly recognized as essential centers for various critical cellular processes, such as energy metabolism, immune responses, and signal transduction (for citations, see reference 15). These organelles are responsible for producing adenosine triphosphate (ATP), the primary energy currency of cells, and they also regulate the production of reactive oxygen species (ROS), which are significant contributors to oxidative stress. Dysfunction in these processes is associated with the development of numerous chronic and degenerative diseases, which can be influenced by genetic, environmental, and lifestyle factors.

Mitochondria have central roles in cellular energy production and regulation of oxidative stress. Hence mitochondrial dysfunction can contribute to the onset of a wide range of chronic diseases [16]. Therefore electron deficiency may interfere with mitochondrial ATP production by limiting electron availability for the electron transport chain essential for production of the ATP that powers all cellular activities. There is extensive documentation for associations between mitochondrial dysfunction and countless health disorders. Mitochondria are present in the cells of all organs and tissues, as well as cells of the immune system. Hence anything that compromises mitochondrial functions can create problems in any of those locations.

Mitochondria in Cells of the Immune System

Here we suggest that all of the above explanations, acute, chronic, or silent inflammation and mitochondrial dysfunction, may be involved in the remarkable list of wellness benefits of earthing. Another connection is simple: cells of the immune system (Figure 6) also contain mitochondria. And these cells require the ATP needed to do the work of healing an injury. This work involves the migrations of these cells to sites of injury or inflammation, and the synthesis of enzymes involved in clearing the repair field of cell and pathogen debris and manufacturing replacement tissues. Contact with the Earth also enables the neutralization of "extra" positive charges such as those present on free radicals (ROS) as well as

excessive oxidative stress, influencing the body's physiology.

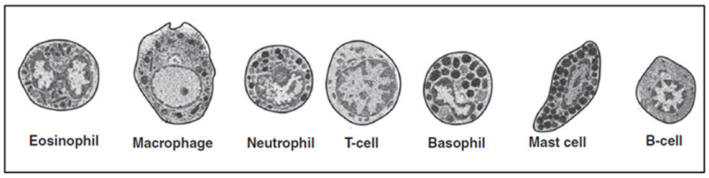

Figure 6: Cells of the immune system require ATP to power their migrations to sites of injury and to synthesize the enzymes need to clear the repair field of cell and pathogen debris.

Earthing is having a significant impact in the world of professional sports

A growing number of professional and amateur performers, including many well-known elite athletes, are using earthing as a pre-performance ritual that has many benefits. For competitors or performers or anyone who must push themselves to the limits in terms of strength, flexibility, and endurance, Earthing provides several sought-after competitive advantages. And post-event earthing helps with inflammation, aches and pains, and fatigue. Earthing leads to quicker recovery from strained muscles as well as from bumps and sprains sustained during a bruising event. For the professionals who travel a lot, earthing provides quick relief from jetlag by quickly resetting their biological clocks to a new location. A growing number of Major League Baseball (MLB) and National Football League (NFL) players use this ritual to manage the physical and mental demands of a stressful season. Hockey and socker players, dancers, musicians, and competitive cyclists have joined in.

Some performers have expressed curiosity about whether there is scientific evidence to explain their positive experiences. There is! Since the year 2000, 42 studies have been published in peer reviewed journals (see the Earthing Institute web page). This research has been done by scientists from 10 countries and at major universities in California, Oregon, Pennsylvania, and California. For example, a 2019 study from the prestigious Olympic Training Center in Rif-Hallen, Austria, published in *Frontiers in Physiology* [24] showed that athletes who slept on grounding mattress pads recovered faster from strenuous downhill running than those who used ungrounded pads. The earthed group had better performance levels and smaller increases in markers of muscle damage.

Feedback from athletes has been featured on the sports pages of newspapers. For example:
Baseball: Adam Ottavino, Boston Red Sox relief pitcher, practiced Earthing by walking barefoot on the grass at Fenway Park before games [25].

Football: Arizona State Associated Press all-American wide receiver Jordyn Tyson used the Earth to "tap into his superpower. [26]"

The research has established that contact with the Earth—whether being outside barefoot or indoors connected to grounded conductive systems—is a simple, natural, and yet profoundly effective strategy against chronic stress, autonomic nervous system dysfunction, inflammation, pain, poor sleep, disturbed heart rate variability, hypercoagulable blood, jetlag, and hundreds of common health disorders, including cardiovascular diseases [27] A recent study [21] has shown that electrons from the earth increase the output of the energy molecule, adenosine triphosphate (ATP), from isolated mitochondria. Mitochondria are found in every cell in the body and the ATP they produce energizes all cell and tissue processes. This explains what Jordyn Tyson refers to as "tapping into his superpower."

Conclusions

The focus of this report is to explain how Earthing or grounding the human body can prevent and relieve a stunning range of health conditions. Unsolicited feedback from thousands of individuals from around the world has led to an estimate of hundreds of different unpleasant or chronic health issues profoundly influenced by Earthing or grounding. There are at least 100 different inflammatory disorders and about 50 mitochondrial diseases. The connection between Earthing and inflammation is well established. And the recent work on mitochondria by Giulivi and Kotz [21] supports a connection between Earthing and many mitochondrial disorders.

Further work is needed to elucidate the precise mechanisms linking mitochondrial dysfunction, immune dysregulation, and pathology. By targeting mitochondrial dysfunction and regulating ROS levels, it appears to be possible to influence the progression of various diseases and improve overall health outcomes.

The studies to date, including those regarding the effects of Earthing on reducing muscle damage [28] without improving the energy cost of running or the physiological responses of elite athletes [29], prompted investigation into the impact of reactive oxygen species (ROS) and adenosine triphosphate (ATP) during grounding on mitochondria.

The effects on ATP production will be of interest to athletes and other performers, for whom energy metabolism is critical to their functioning.

Professional and amateur performers and athletes of all kinds are using "earthing" or "grounding" as a pre-performance ritual that has many benefits. For competitors who must constantly push themselves to the limits in terms of strength, flexibility, and endurance, earthing provides several sought-after competitive advantages. And post-event earthing helps with inflammation, aches and pains, and fatigue, leading to quicker recovery from strained muscles as well as from bumps and sprains sustained during a bruising event. For the professionals who travel a lot, earthing provides quick relief from jetlag by resetting their internal biological clocks. A growing number of Major League Baseball (MLB) and football (NFL) players use this ritual to manage the physical and mental demands of a stressful season. Hockey players and competitive cyclists have joined in.

Some performers have expressed curiosity about whether there is scientific evidence to explain their experiences. There is! 42 studies have been published so far by scientists from around the world since the year 2000 (Earthing Institute web page [9]). The research has been done by scientists from 10 countries. For example, a 2019 study published in *Frontiers in Physiology* showed that athletes who slept on a grounding mattress pad recovered faster from strenuous downhill running than those who used an ungrounded pad [30]. The Earthed group had better performance levels and smaller increases in markers of muscle damage. These results were obtained at the prestigious Olympic Training Center in Rif-Hallen, Austria. Grounded downhill treadmill running caused measurable improvements in parameters related to fatigue that were detectable within 5 minutes. Ungrounded subjects had not fully recovered 10 days after the exercise. In the USA Earthing research has been done at major universities in California, Oregon, Pennsylvania and Connecticut. Feedback from performers has been featured on the sports pages of many newspapers. For example:

Baseball: Adam Ottavino, an accomplished Red Sox relief pitcher, practiced “Earthing" by walking barefoot on the grass at Fenway Park before games (Grossfeld, Boston Globe, July 5, 2021).

Football: Arizona State Associated Press all-American wide receiver Jordyn Tyson used the Earth to “tap into his superpower.” (Nate Mills, Cronkite News, August 30, 2025).

Emerging evidence shows that contact with the Earth—whether being outside barefoot or indoors connected to grounded conductive systems—may be a simple, natural, and yet profoundly effective environmental strategy against chronic stress, autonomic nervous system dysfunction, inflammation, pain, poor sleep, disturbed heart rate variability, hypercoagulable blood, and many common health disorders, including cardiovascular diseases (J Environ Public Health Jan 12; 2012:291541). The most recent study has shown that electrons from the earth increase the output of the energy molecule adenosine triphosphate from mitochondria. These organelles are found in every cell and tissue in the body. The ATP they produce energizes all cell and tissue processes. This probably explains what Jordyn Tyson referred to as “tapping into his superpower.” Research on Earthing is revealing a scientific basis for the “superpower” mentioned by Jordyn Tyson.

Acknowledgments

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