

Trends in General Medicine

Grounding: An Anti-Aging Breakthrough?

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ABSTRACT

Directly touching the earth outside connects our conductive human body to the natural electrical output of the earth, a holistic healing practice known as grounding. This direct contact immediately grounds the entire human body from head to toe, as all of the living cells and tissues and fluids of the body are highly conductive and become grounded to the earth nearly instantaneously. Although in medicine we are very familiar with monitoring the electrical activity of the body to diagnose disease (such as using an electrocardiogram to evaluate heart function or an electroencephalogram to evaluate brain function) much less is known about supporting the conductive health of the body in a preventive, proactive way. Over the past several decades, numerous studies have started to reveal the incredible health benefits from spending time in grounded contact with the earth, and these studies suggest that not only are there immediate health benefits to grounding, but that these benefits accrue over time. That begs the question, if one practices grounding routinely over an entire lifetime, could this healing modality potentially be anti-aging, boosting the resiliency of all the different organ systems it supports and ultimately, extending longevity? This review article examines what we know so far from medical studies on grounding and suggests possible pathways that grounding to the earth may in fact offer long term benefits to the body, including protecting muscle mass, bone density, sleep quality, cognitive function and skin health, which together just might protect against age related health changes, decreasing the development of frailty, and increasing health span.

Keywords

Grounding, Earthing, Sarcopenia, Osteoporosis, Osteopenia, Frailty, Cognition, Brain, Anti-aging, Dementia, Longevity, Inflammation, Muscle mass, Bone density, Sleep quality, Circulation, Collagen.

Introduction

Could touching the earth outside actually be anti-aging? Recent research is revealing just how powerfully healing it is to be conductively connected to the earth, a holistic healing practice known as grounding. Grounding is a relatively new term placed on a very old healing practice of using the earth's natural electrical fields to support the body's function and resiliency. The premise of grounding is that direct conductive contact with the earth's crust allows for electrons to flow freely between the body and the ground, but regardless of the mechanism of action, several decades of research now points to how the human body goes into a healing state when it makes direct contact with the earth outside.

The fact that the human body is an electrically conductive unit is not new, we've been using the premise of the electrical activity of the body to help monitor the body's function as well as diagnose and manage disease in medicine for many years. From using an electrocardiogram (ECG) to monitor the heart's electrical activity to an electroencephalogram (EEG) to monitor the brain's electrical activity to an electromyography (EMG) to monitor the muscle's electrical activity it's clear that the function of body's organ systems relies on direct current (DC) energy to operate. Electrical impulses are used throughout the entire body in many different organ systems, in fact nothing would work without this conductivity, from the blink of an eyelid to the inhale and exhalation of the lungs to the peristalsis of the digestive tract and more it all functions utilizing the same DC energy that our planet emits.

So far in medicine it seems we are comfortable using the electrical properties of the body to monitor functionality and diagnose disease using an EEG to diagnose a seizure disorder, or an ECG

to diagnose a cardiac arrhythmia, or an EMG to help diagnose neuromuscular disease even using defibrillator paddles to help restart a healthy heart pattern so using a conductive pathway to boost wellness and protect healthy function of these organ systems proactively makes sense.

Because the entire human body relies on its ability to conduct DC energy, what might intentional conductive support via the DC energy output of the earth do for our body's ability to sustain optimal function over a lifetime? About three decades of medical research into grounding now suggest it may do quite a lot, and in fact this just might add up to prolonging the body's health span. Here are five different pathways that the current research on grounding suggest it may very well be anti-aging.

Potential Anti-Aging Pathways

Grounding decreases inflammation throughout the body

Inflammation is associated with many of the chronic diseases of aging, implicated with the development of cancer, heart disease, dementia, arthritis and more [1,2]. Now termed "inflammaging," researchers postulate that aging is actually an accumulation of inflammation driven changes that cause fibrosis and decreased organ function over time [3,4]. Decreasing the amount of inflammation in the body decreases cancer risk, heart disease risk, dementia risk, lowers pain, protects joints and slows the aging process down [5-7].

Grounding has been shown in multiple medical studies to decrease whole body inflammation [8]. One grounding study found an almost 60% drop in C-reactive protein, a blood marker of whole body inflammation [9]. Even more impressively, grounding has been specifically found to lower inflammatory cytokines, which actually protects the regenerative capacity of the body. Inflammatory cytokines are thought to be a key component in the damage that inflammation plays [10,11] and particularly damaging to proper immune system function in the elderly [12]. In a double blinded study, researchers found that cytokines such as IP-10, MIP-1 β , and sP-Selectin significantly decreased in grounded subjects, as compared to non-grounded controls. The average drop induced by grounding a patient was a 10 – 20% drop in cytokine concentration [13].

Inflammation is an insidious condition that often goes undetected until there is frank disease. Finding a natural solution to keeping inflammation lowered throughout a lifetime, one that is accessible to everyone living on the planet and can be done before frank disease alerts us to high inflammation levels, is a potential game changer in the medical field and for humanity as a whole.

Grounding Protects the Musculoskeletal System

Age related loss of muscle mass and muscle function (known as sarcopenia) is one of the biggest factors resulting in the development of frailty in the elderly, as decreased muscle mass correlates to a decline in strength, coordination and balance, all of which increase fall risk and threaten independent living in the elderly [14].

Muscle atrophy begins around 40 years old and by 80 years old, the average loss of muscle integrity due to muscle fiber atrophy is 50%. Exercise alone is not enough to protect against these age related changes, even top athletes still exhibit a decline of about 50% in respect to their peak performance by 80 years of age, so other anti-aging modalities beyond sustaining exercise into old age needs to be discovered [15]. Protecting muscle mass and muscle function as the body ages is an important approach to anti-aging [16-21] as muscles are responsible in part for making stem cells in adults, and protecting muscle mass helps to protect the body's capacity for stem cell regeneration [22,23].

Luckily grounding may prove to be one of the ways the human body might naturally retain muscle integrity and importantly, is a passive, easy way to protect musculoskeletal health for those with limited mobility and limited exercise capacity, as often happens in the frail elderly. Grounding immediately reduces muscle tension within milliseconds of the body becoming electrically connected to the earth, one study that used an EMG to measure muscle tension reveal it took less than a single second to measurably decrease muscle tension once test subjects became grounded [24]. In another double-blinded placebo-controlled study comparing grounded participants who fatigued their muscles to muscular exhaustion vs. ungrounded participants who did the same, grounded test subjects recovered faster after the muscle challenge, reported lower pain levels, and even had significantly lower blood cortisol levels (which suggests that the grounded participants were less stressed by the exercise challenge), had significantly lower creatinine kinase levels, reflecting less muscle damage, and lower white blood cell counts than ungrounded subjects [25]. In another study where participants completed an exhaustive 200 deep knee bends, followed by 4 hours of grounding (or sham grounding) afterwards, researchers found that the grounded subjects creatine kinase levels did not increase while, ungrounded subjects had significantly increased creatine kinase levels [26] suggesting grounding even after muscular exhaustion may prevent muscle damage entirely. Another study followed participants who were grounded (vs. sham grounded) during a strenuous yoga challenge that included 10 challenging poses repeated 5 times for an entire hour. The grounded participants had improved blood flow and decreased blood viscosity immediately following the challenge, while ungrounded participants did not [27]. This was followed by another double blinded study that utilized a downhill treadmill challenge to induce muscle soreness after complete muscular exhaustion. Participants then slept grounded or sham grounded afterwards. The grounded participants showed an improved recovery time with respect to creatine kinase... by day 10 the value of creatinine kinase of the grounded subjects was half that of the ungrounded subjects [28].

All in all, the fact that grounding has a near-instantaneous ability to reduce muscle tension, that during muscular challenges grounded subjects have less muscle damage (as indicated by reduced creatine kinase levels,) lowered cortisol levels, a quicker recovery and less soreness afterwards, suggests that grounding might be deeply protective of muscles and allow the human body to have boosted musculoskeletal health as it ages [29].

In addition, grounding may not just protect our muscles but may actually benefit our entire musculoskeletal system as well, including the bones and joints. Osteopenia (age related bone density loss) is a hallmark of aging, and represents one of the biggest risks to independence in an aging population [30]. As bones become less dense, fracture risk increases along with the prevalence of bone pain and bone related injury, both which drastically limit an elderly person's ability to complete routine activities of daily living. The World Health Organization (WHO) estimated in 2022 that the world wide prevalence of osteoporosis is 20% and osteopenia is 40%, making thinning bones an issue for more than 1 out of every 3 people in the world [31].

In one double blinded study on grounding, just a single overnight session of grounding (8 hours sleeping grounding) reduced renal excretion of calcium and phosphorus and significantly lower serum concentrations of both when compared to participants who slept sham grounded (ungrounded). This suggests less leaching of these important minerals from bone, indicating these minerals remain stored in the skeleton while the body is grounded and reducing the primary indicators of osteopenia and osteoporosis after just one night of grounding [32]. Longer term studies are needed to verify or clarify these findings and the effect that routine grounding practices might have on bone health over time.

Grounding's ability to reduce whole body inflammation also includes joint inflammation as well, providing immediate pain relief which over time may translate into decreased joint wear and tear. Anecdotal studies find that grounding reduces joint pain and increases mobility in patients with knee pain on ambulating [33]. A double blinded study following participants who slept grounded for a month found that 74% of grounded subjects reported decreased back and joint pain, while none of the sham grounded subjects reported any decrease in pain [34].

Again, more studies are definitely called for in evaluating the body's long term musculoskeletal health with routine grounding practices, but preliminary data suggests that grounding is protective of multiple different aspects of the musculoskeletal system, with the findings showing grounding to be most robustly protective of muscle integrity so far.

Grounding Improves Sleep Quality

Sleep is one of the most important ways to protect brain function as we age, since sleep quality is directly correlated with cognition and memory [35]. Aging is associated with changes in both sleep structure and sleep quality, and systemic reviews of studies on sleep and aging find that these alterations in sleep quality are associated with both mild cognitive impairment and Alzheimers disease in older adults [36]. Researchers even found that poor sleep quality is associated with not just normal aging but an accelerated rate of aging and these researchers suggest that improving sleep quality may decrease the speed of biological aging [37]. This makes sense because sleep has been found to protect stem cell regeneration, one of the key factors in the long term resiliency of the body [38, 39]. Poor sleep quality is associated with DNA damage in stem cells,

a hallmark of aging and major contributor to age-related tissue decline [40-43].

These findings are supported by a large meta-analysis of the past 50 years of medical literature on sleep and aging found that protecting sleep quality in midlife promotes improved cognitive function and protects against age-related cognitive decline later in life [44]. Grounding may help with this, as researchers found that test subjects who slept grounded had dramatic improvements to their sleep patterns, along with a complete normalization of cortisol, suggesting deep recovery from stress during sleep. The grounded test subjects also reported less subjective stress and less pain [45]. This protective effect from grounding may be important at any age and any cognitive status, not just for prevention of age related change but also to help improve sleep quality once cognitive change has already been initiated. A recent study on grounding in patients with mild cognitive impairment due to Alzheimer disease found that grounding significantly improved PSQI scores compared to the sham-grounding group [46]. Finding that grounding improves sleep quality in both healthy test subjects with straight forward insomnia as well as test subjects who already have brain changes and cognitive decline associated with neuroinflammation in Alzheimers Disease strongly suggests that grounding the brain arguably the body's most sensitive electrical system might be crucial not only in prevention of age related changes but also as a useful treatment option once those changes have begun.

Grounding May Boost Cognitive Function

Beyond protecting sleep quality, grounding may support health brain function by boosting the brain's cognitive function directly, improving memory and mental clarity. There are multiple mechanisms at play in how grounding might boost cognitive function beyond simply decreasing inflammation as addressed above. Neuroinflammation is a cause of age related brain changes, resulting in neuroinflammatory diseases of aging that affect cognition such as Alzheimer's Disease, Parkinson's Disease and Multiple Sclerosis, ALS, Huntingtons' Disease and more [47-49]. Therefore, medications that decrease neuroinflammation have promising applications in preventing and treating these neuroinflammatory disease [50,51]. But what if there was a simple, totally natural, medication free way to reduce inflammation, protect brain function, and possibly decrease age related changes? That would transform everything, and grounding may do just that. New research has found that inflammation lowers dopamine levels in the brain, which may be responsible for the decrease in mood, loss of motivation, and anhedonia that result from neuroinflammation [52,53]. Grounding has been specifically shown to decrease the exact inflammatory cytokines that have a direct impact on our brain dopamine levels. In one important study, researchers found that cytokines such as such as IP-10, MIP-1 β , and sP-Selectin all significantly decreased by 10 - 20% in grounded subjects, compared to non-grounded controls [54]. By decreasing inflammatory cytokines, it's reasonable to suggest that grounding gives a natural dopamine boost to the brain. This is backed up by studies on grounding and mood. One study found that participants

who were grounded had measurable improvements in mood that were significantly higher than the sham-grounded participants [55]. Grounding may have an even more immediate positive impact on our brain beyond decreasing inflammation and boosting dopamine, by directly modulating brain waves nearly instantaneously upon contact with the earth. Grounding has been shown to immediately shift brain wave patterns (as documented on EEG) with boosted alpha brain wave patterns on grounded test subject occurring within just milliseconds of test subjects becoming grounded to the earth [56-58].

In addition to immediately relaxing the brain [59], boosting creativity [60], even potentially reducing depression [61] by increasing alpha brain waves, grounding may also help our brains process memories and make meaningful connections in our short term memory. Using EEG readings and Schumann Resonance frequencies, researchers found a direct coherence between the human brain and the earth's electrical output. They found that electrical activity from the earth synchronizes with our cerebral cortex, showing a real-time coupling between the earth's Schumann resonance and our brain's cerebral activity [62]. They also found that the highest cohesion between the earth's electrical activity and the electrical activity of the human brain is in the parahippocampal gyrus [63], an area of the brain that is responsible for making accurate and meaningful interpretations of our surroundings and with decision making [64-66]. In fact, atrophy in this area of the brain is a highly sensitive early indicator of Alzheimers disease [67,68] marking the start of an individual losing meaningful context, a hallmark of this disease.

If you've ever been stuck mulling over a problem and then went outside and spent time in nature, it's likely that you've already personally experienced what these studies suggest, that the electrical output of the earth helps boost clarity, helps with problem solving, and even boosts a meaningful interpretation of our life events through this electrical coherence of our brain and our planet.

Grounding Promotes Skin Health

When considering aging, many people focus on skin appearance as a direct reflection of age. Although skin is the most visible of the organs to display age related changes, I put this last on the list of ways grounding may be anti-aging, since inflammation, age related changes of the brain, muscle atrophy and bone atrophy are all undoubtedly more important to address first.

Yet, however superficial it seems, addressing the aging of the skin is still important as skin elasticity, skin perfusion, and the skin's lipid bilayer (crucial in maintaining skin integrity) all decline with age as inflammation accrues in the skin [69-73]. These age related changes have implications on decreased rates of wound repair and increased rates of skin related cancers, not just on cosmetic appearance. Topical skin products boost huge anti-aging claims but yield very limited evidence of efficacy [74]. Yet the simple practice of grounding has the ability to positively impact all of these parameters of skin health from the inside out, boosting

circulation to the skin, improving skin integrity, and as we will see, accelerating skin repair [75].

Multiple studies show clear evidence of dramatically boosted circulation throughout the body during grounding. In fact, grounding through the soles of the feet boosted blood circulation all the way up in facial skin tissues nearly instantaneously, suggesting the positive effects of increased circulation are available even in distant sites of the body that are far away from the grounding point of contact [76-80]. One of the mechanisms of action that helps to boost blood perfusion throughout the body, including the skin, appears to come from an electrically decreased tendency for red blood cells to clump together, which improves blood velocity. Grounding for only 2 hours significantly decreased the zeta potential on red blood cells and helped them flow through the circulatory system more smoothly. On average, the zeta potential of the red blood cells were boosted by 270%, which then increased blood velocity by an average of 260% [81,82].

Boosted blood flow and circulation should mean that skin has more oxygen and nutrients flowing to it, which would translate into improved skin integrity and a boosted capacity to heal, which is exactly what researchers have found. Multiple test subject have shown dramatically improved wound healing with grounding [83], and this has been backed up by a recent study where researchers applied exogenous DC electrical current to the skin. Applying a DC current to the skin not only improved the rate of wound healing, but it specifically improved the closure of keratinocytes and the rate of keratinocyte repair so dramatically that wounds healed three times faster with the DC electrical support [84].

In addition, the sleep benefits described earlier in this article means that collagen repair is enhanced, suggesting that beauty sleep is real. High quality, restorative sleep protects collagen integrity, which is no small thing as collagen is the most abundant protein in the human body, found throughout all tissues and particularly crucial to skin structure. Researchers found that poor sleep actually causes an increase in collagen misalignment and a decrease in collagen integrity as a whole [85]. This disordered collagen makes skin weaker, less elastic, and may contribute to accelerated visible skin aging. Conversely, by connecting to the earth's DC energy through grounding we improve sleep, which may provide anti-aging benefits by boosting collagen integrity, in addition to boosting circulation to the skin and improving the rate of skin repair.

Conclusion

Taken all together, it's hard to deny the potential anti-aging benefits of grounding [86]. From decreasing whole body inflammation, protecting muscle mass and bone density, improving sleep quality and brain function, and even boosted skin health, few things can address so many different aspects inherent to the aging process as grounding to the earth can [87].

Why is this important to even talk about? Just a few hundred years ago human beings were much more likely to spend at least some

time daily grounded to the earth, by touching the earth with their hands, working directly on the earth, walking barefoot on the earth, or wearing conductive clothing made from natural fibers or semi-conductive natural materials. But now we have non-conductive, synthetic rubber soled shoes and synthetic fibers pervasive in our clothing, cars that travel up off the earth on rubber tires, insulated flooring in our homes, schools and offices, asphalt coating our roadways, and virtually no contact directly with the earth unless it is intentionally initiated.

Most people spend day after day after day, year after year after year, without ever actually grounding to the earth at all. Stress, higher cortisol, joint pain, dementia, cancer, age related changes these are all a fall out from life long inflammation accruing while we live disconnected from the earth. So it's important to be absolutely certain we intentionally seek out grounding to the earth, regularly.

Now that we are starting to understand that the human body is an exquisitely designed electrical machine that functions best when it is connected to our beautifully electrical planet, it's time to turn towards maintaining the conductive health of our body and prolonging the health span of it through the natural practice of grounding. Therefore it's also important that there be continued research into this exciting field of conductive medicine, and I hope that future studies can continue to examine not only the long term benefits of grounding but also tease out the ideal length of time that is needed to invoke each desired benefit as well as the different applications of grounding in both the prevention and treatment of disease.

References

1. Fulop T, Witkowski JM, Olivieri F, et al. The integration of inflammaging in age-related diseases. *Semin Immunol.* 2018; 40: 17-35.
2. Miki C, Kusunoki M, Inoue Y, et al. Remodeling of the immunoinflammatory network system in elderly cancer patients implications of inflamm-aging and tumor-specific hyperinflammation. *Surg Today.* 2008; 38: 873-878.
3. Franceschi C, Campisi J. Chronic inflammation inflammaging and its potential contribution to age associated diseases. *J Gerontol A Biol Sci Med Sci.* 2014; 69: S4-s9.
4. Giunta S, Wei Y, Xu K, et al. Cold inflammaging When a state of homeostatic-imbalance associated with aging precedes the low-grade pro-inflammatory-state inflammaging meaning evolution inflammaging phenotypes. *Clin Exp Pharmacol Physiol.* 2022; 49: 925-934.
5. Claudio Franceschi, Miriam Capri, Daniela Monti, et al. Inflammaging and anti-inflammaging a systemic perspective on aging and longevity emerged from studies in humans. *Mech Ageing Dev.* 2007; 128: 92-105.
6. De Martinis M, Franceschi C, Monti D, et al. Inflamm-aging and lifelong antigenic load as major determinants of ageing rate and longevity. *FEBS Lett.* 2005; 579: 2035-2039.
7. Li X, Li C, Zhang W, et al. Inflammation and aging signaling pathways and intervention therapies. *Signal Transduct Target Ther.* 2023; 8: 239.
8. Stephen T. Sinatra, Drew S. Sinatra, Step, et al. Grounding e The universal anti-inflammatory remedy. *Biomed J.* 2023; 46: 11-16.
9. Oschman J, Chevalier G, Brown R. The effects of grounding earthing on inflammation the immune response wound healing and prevention and treatment of chronic inflammatory and autoimmune diseases. *J Inflamm Res.* 2015; 8: 83-96.
10. Minciullo PL, Catalano A, Mandraffino G, et al. Inflammaging and Anti-Inflammaging The Role of Cytokines in Extreme Longevity. *Arch Immunol Ther Exp Warsz.* 2016; 64: 111-126.
11. Bruunsgaard H, Pedersen M, Pedersen BK. Aging and proinflammatory cytokines. *Curr Opin Hematol.* 2001; 8: 131-136.
12. Rea IM, Gibson DS, McGilligan V, et al. Age and Age-Related Diseases Role of Inflammation Triggers and Cytokines. *Front Immunol.* 2018; 9: 586.
13. Müller Erich, Pröller Patrick, Ferreira-Briza Fatima, et al. Effectiveness of Grounded Sleeping on Recovery After Intensive Eccentric Muscle Loading. *Front Physiol.* 2019; 10: 35.
14. Clegg A, Young J, Iliffe S, et al. Frailty in elderly people. *Lancet.* 2013; 381: 752-762.
15. Faulkner JA, Larkin LM, Claffin DR, et al. Age-related changes in the structure and function of skeletal muscles. *Clin Exp Pharmacol Physiol.* 2007; 34: 1091-1096.
16. Duggal NA, Pollock RD, Lazarus NR, et al. Major features of immunosenescence including reduced thymic output are ameliorated by high levels of physical activity in adulthood. *Aging Cell.* 2018; 17: e12750.
17. Ross D Pollock, Katie A O'Brien, Lorna J Daniels, et al. Properties of the vastus lateralis muscle in relation to age and physiological function in master cyclists aged 55–79 years. *Aging Cell.* 2018; 17: e12735.
18. Chakravarty EF, Hubert HB, Lingala VB, et al. Reduced disability and mortality among aging runners a 21-year longitudinal study. *Arch Intern Med.* 2008; 168: 1638-1646.
19. Steven C. Moore, Alpa V. Patel, Charles E. Matthews, et al. Leisure time physical activity of moderate to vigorous intensity and mortality a large pooled cohort analysis. *PLoS Med.* 2012; 9: e1001335.
20. Xu Zhang, Davis A Englund, Zaira Aversa, et al. Exercise counters the age-related accumulation of senescent cells. *Exerc Sport Sci Rev.* 2022; 50: 213-221.
21. Christian Werner, Tobias Fürster, Thomas Widmann, et al. Physical exercise prevents cellular senescence in circulating leukocytes and in the vessel wall. *Circulation.* 2009; 120: 2438-2447.
22. Usas A, Huard J. Muscle-derived stem cells for tissue engineering and regenerative therapy. *Biomaterials.* 2007; 28: 5401-5406.
23. Bryon A Tompkins, Darcy L DiFede, Aisha Khan, et al. Allogeneic mesenchymal stem cells ameliorate aging frailty a

- Phase II randomized double-blind placebo-controlled clinical trial. *J Gerontol A Biol Sci Med Sci*. 2017; 72: 1513-1522.
24. Gaetan Chevalier, Kazuhito Mori, James L. Oschman. The effect of earthing grounding on human physiology. 2005.
 25. Brown D, Chevalier G, Hill M. Pilot study on the effect of grounding on delayed-onset muscle soreness. *J Altern Complement Med*. 2010; 16: 265-273.
 26. Brown R, Chevalier G, Hill M. Grounding after moderate eccentric contractions reduces muscle damage. *Open Access J Sports Med*. 2015; 6: 305-317.
 27. Brown R, Chevalier G. Grounding the Human Body during Yoga Exercise with a Grounded Yoga Mat Reduces Blood Viscosity. *Open Journal of Preventive Medicine*. 2015; 5: 159-168.
 28. Müller E, Pröller P, Ferreira-Briza F, et al. Effectiveness of Grounded Sleeping on Recovery After Intensive Eccentric Muscle Loading. *Front Physiol*. 2019; 10: 35.
 29. Khalid, Madiha, Jeremy Madvin. Mechanisms Lead towards Improved Health Massage with Earthing. 2021.
 30. Curtis E, Litwic A, Cooper C, et al. Determinants of Muscle and Bone Aging. *J Cell Physiol*. 2015; 230: 2618-2625.
 31. Xiao PL, Cui AY, Hsu CJ, et al. Global regional prevalence and risk factors of osteoporosis according to the World Health Organization diagnostic criteria a systematic review and meta-analysis. *Osteoporos Int*. 2022; 33: 2137-2153.
 32. Sokal K, Sokal P. Earthing the human body influences physiologic processes. *J Altern Complement Med*. 2011; 17: 301-308.
 33. Oschman JL, Chevalier G, Brown R. The effects of grounding earthing on inflammation the immune response wound healing and prevention and treatment of chronic inflammatory and autoimmune diseases. *J Inflamm Res*. 2015; 8: 83-96.
 34. Ober C. Grounding the Human Body to Neutralize Bioelectrical Stress from Static Electricity and EMFs. *ESD Journal*. 2000.
 35. Mander BA, Winer JR, Walker MP. Sleep and Human Aging. *Neuron*. 2017; 94: 19-36.
 36. Casagrande M, Forte G, Favieri F, et al. Sleep Quality and Aging A Systematic Review on Healthy Older People Mild Cognitive Impairment and Alzheimer's Disease. *Int J Environ Res Public Health*. 2022; 19: 8457.
 37. Gao X, Huang N, Guo X, et al. Role of sleep quality in the acceleration of biological aging and its potential for preventive interaction on air pollution insults Findings from the UK Biobank cohort. *Aging Cell*. 2022; 21: e13610.
 38. Rossi DJ, Jamieson CH, Weissman IL. Stems cells and the pathways to aging and cancer. *Cell*. 2008; 132: 681-696.
 39. Garinis G, van der Horst G, Vijg J, et al. DNA damage and ageing new-age ideas for an age-old problem. *Nat Cell Biol*. 2008; 10: 1241-1247.
 40. Micheu MM, Rosca AM, Deleanu OC. Stem/progenitor cells and obstructive sleep apnea syndrome new insights for clinical applications. *World J Stem Cells*. 2016; 8: 332-341.
 41. McAlpine CS, Kiss MG, Zuraikat FM, et al. Sleep exerts lasting effects on hematopoietic stem cell function and diversity. *J Exp Med*. 2022; 219: e20220081.
 42. German Cancer Research Center Deutsches Krebsforschungszentrum DKFZ. A good night's sleep keeps your stem cells young. *ScienceDaily*. ScienceDaily. 2015.
 43. Walter D, Lier A, Geiselhart A, et al. Exit from dormancy provokes DNA-damage induced attrition in haematopoietic stem cells. *Nature*. 2015; 520: 549-552.
 44. Scullin MK, Bliwise DL. Sleep cognition and normal aging integrating a half century of multidisciplinary research. *Perspect Psychol Sci*. 2015; 10: 97-137.
 45. Ghaly M, Teplitz D. The biologic effects of grounding the human body during sleep as measured by cortisol levels and subjective reporting of sleep pain and stress. *J Altern Complement Med*. 2004; 10: 767-776.
 46. Lin CH, Tseng ST, Chuang YC, et al. Grounding the Body Improves Sleep Quality in Patients with Mild Alzheimer's Disease A Pilot Study. *Healthcare Basel*. 2022; 10: 581.
 47. Zhang W, Xiao D, Mao Q, et al. Role of neuroinflammation in neurodegeneration development. *Signal Transduct Target Ther*. 2023; 8: 267.
 48. Zhang W, Sun HS, Wang X, et al. Cellular senescence DNA damage and neuroinflammation in the aging brain. *Trends Neurosci*. 2024; 47: 461-474.
 49. Thadathil N, Nicklas EH, Mohammed S, et al. Necroptosis increases with age in the brain and contributes to age-related neuroinflammation. *Geroscience*. 2021; 43: 2345-2361.
 50. Köhler O, Benros ME, Nordentoft M, et al. Effect of anti-inflammatory treatment on depression depressive symptoms and adverse effects A systematic review and meta-analysis of randomized clinical trials. *JAMA Psychiatry*. 2014; 71: 1381-1391.
 51. Kohler O, Krogh J, Mors O, et al. Inflammation in depression and the potential for anti-inflammatory treatment. *Curr Neuropharmacol*. 2016; 4: 732-742.
 52. Miller AH, Raison CL. The role of inflammation in depression from evolutionary imperative to modern treatment target. *Nat Rev Immunol*. 2016; 16: 22-34.
 53. Lee CH, Giuliani F. The role of inflammation in depression and fatigue. *Front Immunol*. 2019; 10: 1696.
 54. Müller E, Pröller P, Ferreira-Briza F, et al. Effectiveness of grounded sleeping on recovery after intensive eccentric muscle loading. *Front Physiol*. 2019; 10: 35.
 55. Chevalier G. The effect of grounding the human body on mood. *Psychol Rep*. 2015; 116: 534-542.
 56. Zahari ZL, Mustafa M, Rahman NAB, et al. An effectiveness of EEG signal based on body earthing application. *Int J Adv Sci Eng Inform Technol*. 2023; 12: 2322-2326.
 57. Sokal P, Sokal K. The neuromodulative role of earthing. *Med Hypotheses*. 2011; 77: 824-826.
 58. Laura Koniver. Cerebrospinal Fluid and Brain Health Optimized By Grounding. *American J Neurol Res*. 2023; 2: 1-4.

59. Hou Y, Zhang S, Li N, et al. Neurofeedback training improves anxiety trait and depressive symptom in GAD. *Brain Behav.* 2021; 11: e02024.
60. Caroline Lustenberger, Michael R. Boyle, Alban Foulser A, et al. Functional role of frontal alpha oscillations in creativity. *Cortex.* 2015; 67: 74-82.
61. Alexander ML, Alagapan S, Lugo CE, et al. Double-blind randomized pilot clinical trial targeting alpha oscillations with transcranial alternating current stimulation tACS for the treatment of major depressive disorder MDD. *Transl Psychiatry.* 2019; 9: 106.
62. Cherry NJ. Human intelligence The brain an electromagnetic system synchronized by the Schumann resonance signal. *Med Hypotheses.* 2003; 60: 843-844.
63. Michael P, Saroka KS. Human quantitative electroencephalographic and schumann resonance exhibit real-time coherence of spectral power densities Implications for interactive information processing. *J Signal Inform Process.* 2015; 06: 153-164.
64. Bohbot VD, Allen JJB, DagherA, et al. Role of the parahippocampal cortex in memory for the configuration but not the identity of objects Converging evidence from patients with selective thermal lesions and fMRI. *Front Human Neurosci.* 2015; 9: 431.
65. Li M, Lu S, Zhong N. The parahippocampal cortex mediates contextual associative memory Evidence from an fMRI study. *BioMed Res Int.* 2016; 2016: 9860604.
66. Aminoff EM, Kveraga K, Bar M. The role of the parahippocampal cortex in cognition. *Trends Cogn Sci.* 2013; 17: 379-390.
67. Hoesen GWV, Augustinack JC, Dierking J, et al. The parahippocampal gyrus in Alzheimer's disease. *Clinical and preclinical neuroanatomical correlates.* *Ann N Y Acad Sci.* 2000; 911: 254-274.
68. Echávarri C, Aalten P, Uylings HBM, et al. Atrophy in the parahippocampal gyrus as an early biomarker of Alzheimer's disease. *Brain Struct Funct.* 2011; 215: 265-271.
69. Fore J. A review of skin and the effects of aging on skin structure and function. *Ostomy Wound Manage.* 2006; 52: 24-35.
70. Lee YI, Choi S, Roh WS, et al. Cellular Senescence and Inflammation in the Skin Microenvironment. *Int J Mol Sci.* 2021; 22: 3849.
71. Quan T. Molecular insights of human skin epidermal and dermal aging. *J Dermatol Sci.* 2023; 112: 48-53.
72. Rorteau J, Chevalier FP, Fromy B, et al. Vieillesse et intégrité de la peau - De la biologie cutanée aux stratégies anti-âge Functional integrity of aging skin from cutaneous biology to anti-aging strategies. *Med Sci Paris.* 2020; 36: 1155-1162.
73. Gruber F, Marchetti-Deschmann M, Kremslehner C, et al. The Skin Epilipidome in Stress Aging and Inflammation. *Front Endocrinol Lausanne.* 2021; 11: 607076.
74. Zargaran D, Zoller F, Zargaran A, et al. Facial skin ageing Key concepts and overview of processes. *Int J Cosmet Sci.* 2022; 44: 414-420.
75. Koniver L. Grounding and Skin Repair the Power of DC Energy. *Curr Res Cmpl Alt Med.* 2023; 7: 197.
76. Chevalier G. Grounding the Human Body Improves Facial Blood Flow Regulation Results of a Randomized Placebo Controlled Pilot Study. *Journal of Cosmetics Dermatological Sciences and Applications.* 2014; 4: 293-308.
77. Chevalier G, Sinatra ST. Emotional Stress Heart Rate Variability Grounding and Improved Autonomic Tone Clinical Applications. *Integrative Medicine A Clinician's Journal.* 2011; 10: 16-21.
78. Chevalier G, Melvin G, Barsotti T. One-Hour Contact with the Earth's Surface Grounding Improves Inflammation and Blood Flow A Randomized Double-Blind Pilot Study. *Health.* 2015; 7: 1022-1059.
79. Brown R, Chevalier G. Grounding the Human Body during Yoga Exercise with a Grounded Yoga Mat Reduces Blood Viscosity. *Open Journal of Preventive Medicine.* 2015; 5: 159-166.
80. Gaétan Chevalier, Sheila Patel, Lizabeth Weiss, et al. Effects of Grounding Earthing on Massage Therapists An Exploratory Study. *Health.* 2018; 10: 228-250.
81. Elkin HK, Winter A. Grounding Patients with Hypertension Improves Blood Pressure A Case History Series Study. *Altern Ther Health Med.* 2018; 24: 46-50.
82. Chevalier G, Sinatra ST, Oschman JL, et al. Earthing grounding the human body reduces blood viscosity-a major factor in cardiovascular disease. *J Altern Complement Med.* 2013; 19: 102-110.
83. Oschman J, Chevalier G, Brown R. The effects of grounding earthing on inflammation the immune response wound healing and prevention and treatment of chronic inflammatory and autoimmune diseases. *J Inflamm Res.* 2015; 8: 83-96.
84. Shaner S, Savelyeva A, Kvartuh A, et al. Bioelectronic microfluidic wound healing a platform for investigating direct current stimulation of injured cell collectives. *Lab Chip.* 2023; 23: 1531-1546.
85. Chang J, Garva R, Pickard A, et al. Circadian control of the secretory pathway maintains collagen homeostasis. *Nat Cell Biol.* 2020; 22: 74-86.
86. Chevalier G, Sinatra ST, Oschman JL, et al. Earthing health implications of reconnecting the human body to the Earth's surface electrons. *J Environ Public Health.* 2012; 2012: 291541.
87. Menigoz W, Latz TT, Ely RA, et al. Integrative and lifestyle medicine strategies should include Earthing Grounding Review of research evidence and clinical observations. *Explore NY.* 2020; 16: 152-160.