



Cryo Advanced technology

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# CRYOTHERAPY

## SCIENTIFIC STUDIES

# ATHLETIC RECOVERY THROUGH CRYOTHERAPY

Athletes and individuals who engage in physical activities and strenuous routines are prone to develop musculoskeletal sports injuries, which may result from accidents, improper use of equipment and poor training practices including failure to do warm-up and stretching exercises. Some of the most common types of sports injuries are muscle sprains and strains, ligament or tendon tears, joint dislocation and bone fracture that can eventually affect an athlete's performance. In addition, sports injuries can be either acute or chronic. Acute injuries occur suddenly while a person performs an activity. On the contrary, chronic injuries may result from over use of certain areas of the body over a long period of time. Both acute and chronic sports injuries are associated with disabling symptoms such as pain, swelling and limited mobility (National Institute of Arthritis and Musculoskeletal and Skin Diseases, 2016).

The moment a person acquires injury, the body reacts by releasing chemicals from damaged cells. This triggers an inflammatory response wherein the blood vessels of the injured area become dilated to increase blood flow, thereby, carrying nutrients to the damaged tissues. Minor injuries, such as sprains and strains, are initially managed with PRICE (Protection-Rest-Ice-Compression-Elevation) therapy. (National Health Service UK, 2015). However, in severe cases, some sports injuries such as those that can damage the anterior cruciate ligament (ACL) and medial collateral ligament (MCL) of the knees may require reconstruction surgery and rehabilitation to restore normal function and mobility (American Academy of Orthopaedic Surgeons, 2009).

Application of ice or cold pack as the third element of PRICE therapy, is known to decrease inflammation as it helps constrict blood vessels. Hence, cryotherapy, which utilizes cryochambers with temperatures ranging from  $-110^{\circ}\text{C}$  to  $-140^{\circ}\text{C}$ , can potentially facilitate recovery of body parts affected by various types of sports injuries. Such benefit is also brought about by the alteration of serum mediators of inflammation and serum muscle enzymes. In a study conducted to determine the effectiveness of whole body cryotherapy (WBC) in athletic recovery, it was revealed that WBC can increase the levels of anti-inflammatory cytokine interleukin (IL)-10, and decrease the levels of proinflammatory cytokine IL-2 and chemokine IL-8. This process is also supported by a decrease in the intracellular adhesion molecule-1. Furthermore, cold stimulation also improves athletes' recovery by exerting positive effects on muscular enzymes creatine kinase and lactate dehydrogenase (Banfi, Lombardi, Colombini, & Melegati, 2010). On the other hand, high-intensity and high-duration exercises can also induce metabolic stress and increase temperature, which may eventually cause structural damage and muscle soreness. Hence, exposure of the affected area to cold temperature immediately following the exercise, can reduce the energy demand of the muscles and provide temporary analgesic and anti-inflammatory effects (White & Wells, 2013).

On the contrary, in another study focusing on the effects of cryotherapy on muscle recovery and inflammation after muscle damaging exercise, it was revealed that thought cannot significantly

alleviate strength decrement and muscle soreness, a mitigation in plasma chemokine ligand 2 was noted after a 20-minute cryotherapy (Crystal, Townson, Cook, & LaRoche, 2013). In addition, a study by Hubbard and Denegar showed that cryotherapy can be effective in decreasing pain related to soft tissue injury. However, further investigation is still needed to evaluate its effectiveness compared to other rehabilitation techniques (Hubbard & Denegar, 2004). Aside from facilitating athletic recovery, patients with sports injuries who required surgery may also benefit from cryotherapy. In a study conducted in Brazil, patients who underwent cryotherapy combined with an exercise protocol immediately after ACL reconstruction, experienced less pain and an improvement in the range of motion of the affected knee. As a result, decreased intake of pain medications, reduced length of hospital stay and an improvement in the quality of life were noted among postoperative patients (Dambros, Martimbianco, Polachini, Lahoz, Chamlian, & Cohen, 2012).

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# CRYOTHERAPY: AN EMERGING WEIGHT MANAGEMENT OPTION

Obesity is considered to be a serious global health crisis associated with different comorbidities affecting various organ systems as manifested by certain health conditions such as obstructive sleep apnea, malignancies, coronary artery disease and metabolic problems. Hence, wide range of treatment options to manage weight are being utilized to address this issue. These include lifestyle modification, exercise programs and anti-obesity medications (Hamdy, Uwaifo, & Oral, 2016). However, some of these approaches, particularly certain weight-loss products tainted with hidden active ingredients found in prescription drugs, may pose serious health risks such as cardiac problems and stroke (U.S. Food and Drug Administration, 2015). Aside from the risks associated with these treatment options, some of these approaches have poor compliance rates due to the fact that several patients find it difficult to sustain regular exercise and adhere to the prescribed diet regimen.

Cryotherapy, which is defined as the therapeutic use of cold temperature, has been an emerging health trend in weight loss. It uses extremely low temperatures to stimulate skin sensors, activates the central nervous system (CNS) and enhance the release of endorphins which are known to inhibit pain and elevate an individual's mood (US Cryotherapy). There are two mechanisms responsible for achieving weight loss through cryotherapy – shivering and nonshivering thermogenesis. Shivering thermogenesis allows muscles to contract facilitate an increase in energy metabolism. On the other hand, nonshivering thermogenesis involves adaptation to cold exposure to promote fat burning (Patrick, 2016). In 2013, a study conducted by Dr. Rana Gupta, Dr. Philipp Scherer, Dr. Qiong Wang and graduate student Caroline Tao in UT Southwestern Medical Center, revealed that in response to cold temperature, adults have the capability to produce new brown fat cells essential in weight loss and maintenance (University of Texas Southwestern Medical Center, 2013). Compared to white fat cells that store excess calories and are deposited around the abdomen, brown fat acts as a furnace that facilitates burning of calories at a high rate.

In fact, in another study conducted by Swedish researchers, it was found that after exposing their subjects to temperatures between 63 – 66 degrees Fahrenheit and repeatedly submerging their feet in ice cold water for five minutes, brown fat deposits were detected from their subjects' body with a 15-fold increase in its activity. Moreover, brown fat also aids in blood sugar metabolism and reduces insulin resistance (King, 2014). Furthermore, a study conducted in University of Pittsburgh showed that insulin resistance is closely related to thigh adipose tissue distribution or cellulite formation (Goodpaster, Thaete, & Kelley, 2000). Hence, increasing brown fat deposit through exposure to cold temperature, such as cryotherapy, can help prevent these problems. Cryotherapy also offers a wide range of benefits to achieve weight loss. One of these is that it is considered as an effective and safe weight management option as it helps burn 500 – 800 kcal per session, which can increase exponentially depending on the level of physical activity. In fact,

according to a new study, a 15-minute exposure to cold has a metabolic equivalent of one hour of exercise (Berlin, 2014). On the other hand, cryotherapy, also promotes better sleep as it induces a feeling of relaxation, thus, promoting better blood circulation to the brain.

Furthermore, improved sleeping pattern can also be linked to weight loss by boosting the immune system through increased melatonin production and prevention of insulin resistance. Lastly, compared to exercise or workout programs, cryotherapy allows an individual's body to feel re-energized because it stimulates bodily functions without resulting to fatigue and musculoskeletal pain (Cryotherapy Health and Wellness, Inc.).

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# CRYOTHERAPY FOR BEAUTY

Beauty and wellness have been two of the top priorities for the majority of people around the globe. In a survey conducted across 46 countries by the research group AC Nielsen, it was reported that 78 percent of their respondents feel the increasing pressure to look good (Westall, 2007). The desire to be beautiful, which is not limited to women, has led to the discovery of beauty regimens and the emergence of different trends, such as cryotherapy, tailored for both image and health-conscious consumers.

Beauty or physical attractiveness has three determinants namely waist to hip ratio (WHR), body mass index (BMI), and curvaceousness. As an index of fat deposition, WHR can be calculated by obtaining the ratio between the circumference of the waist and the circumference of the hips. Generally, a WHR of approximately 0.7 is considered to be the most attractive. In addition, BMI, which is closely related to WHR, is also one of the reliable measures of body fat. BMI can be calculated by dividing the body weight (in kilograms) by the square of height (in meters). Normal BMI range depends on different factors such as gender and race. On the other hand, curvaceousness, defined as the degree of 'hourglass' shape or the size of the bust relative to the circumference of the hips and waist, is also considered as another marker of physical attractiveness particularly among women (Fisher & Voracek, 2006). Aside from those mentioned above, beauty is also characterized by radiant and glowing skin. Some of the factors that can damage the skin include prolonged exposure to ultraviolet rays leading to the appearance of wrinkles, skin discoloration, freckles and age spots (Gardner, 2015). Furthermore, climate and environmental temperature can also increase the risk of certain skin problems such as acne, which is usually manifested by occluded pores, pustules or pus-filled bumps, and cysts (Cole, 2015). During hot weather, the skin becomes prone to breakouts because warm and humid environment permits colonization by bacteria and fungi (Balato, Ayala, Megna, Balato, & Patrino, 2013).

To achieve physical attractiveness, many people have been trying various methods such as changing lifestyle habits, applying home remedies and undergoing treatments in dermatology clinics. One of the most effective ways to maintain a beautiful, flawless skin is to increase the intake of food rich in antioxidants, including vitamins A, C, and E, and selenium. In fact, in a study published in the *European Journal of Clinical Nutrition*, it was reported that a single dose of either black or green tea would significantly increase the plasma antioxidant potential by ferric-reducing antioxidant power (FRAP) assay (Peng, et al., 2014).

Another method that can help achieve physical attractiveness is through the use of different forms of cryotherapy. One of these is a nonsurgical treatment for fat reduction and body contouring, called cryolipolysis. This promising method competes with liposuction as it offers noninvasive procedure with limited side effects. The mechanism behind cryolipolysis is thought to be related to the effect of vacuum suction with regulated heat extraction in impeding the blood flow to induce crystallization of the targeted adipose tissue. Thus, resulting in apoptosis of the target adipocytes and subsequent removal from the treatment site within the following weeks (Ingargiola, Motakef, Chung, Vasconez, & Sasaki, 2015). In addition, another form of cryotherapy called cryofacial can help reduce pore size, support collagen production, eliminate dark spots

and blemishes, and revitalize the skin. Aside from this, cryotherapy in the form of focused cold therapy (FCT) induces cryoneuromodulation through the application of cold temperature between -20 to -88.5 degrees Celsius. This method reduces wrinkle formation as it inhibits the signaling of the temporal motor branches of the facial nerve in the temple region that induces temporary muscle relaxation without the use of neurotoxins (Wong & Giausseran, 2014).

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# CRYOTHERAPY TO DEFY THE AGEING PROCESS

Ageing is an inevitable reality that entails changes in an individual's physical appearance and overall health status. In fact, according to the Global Health Observatory (GHO) data reported by the World Health Organization (WHO), the average life expectancy of the global population in the year 2015 was 71.4 years (World Health Organization,2016). Moreover, by the year 2030, it is expected that one out of five of the global population will be over 65 years old. Hence, extensive research studies have focused on methods to defy the ageing process, preserve vigor and prolong an individual's lifespan while maintaining a good quality of life in the advancing years (Low, 2013).

To achieve the goal of delaying the onset of diseases or decline in health status related to the ageing process, the National Institute on Ageing (NIA), which is part of the U.S. Federal Government's National Institutes of Health (NIH), exerted its best efforts to increase awareness on various methods that promote longevity and active life expectancy - old age free of disability. One of the methods that is known to defy ageing is through the use of antioxidants, which act by eliminating the by-products of oxygen and food metabolism called 'free radicals'. However, there is no sufficient evidence to support this claim and still needs further investigation. Aside from this, another method that has anti-ageing effect is caloric restriction. In a pilot study on Comprehensive Assessment of Long-term Effects of Reducing Intake of Energy (CALERIE), it was revealed that overweight adults who decreased their caloric intake by 20 to 30 percent showed a lower fasting insulin levels and core body temperature.

These two indicators are linked to improved longevity in animal models. On the other hand, another effect of ageing is the alteration in hormone levels responsible for supporting and maintaining good metabolism,immune function,sexual reproduction,and growth.Hence,some anti-ageing therapies are geared towards regulating the level of hormones that decline in the advancing years. However, some of these off-label use of hormone replacement therapy are associated with several health risks such as endometrial problems and heart diseases in women (National Institute on Ageing, 2016). With the increasing demand for different anti-ageing possibilities, the emergence of cryotherapy has been thought to benefit a greater population. In fact, some of the methods that utilize the technology behind cryotherapy such as cryofacials and hydrafacials which last for 10 – 25 minutes can help remove dead skin cells to revitalize the skin. Furthermore, cryotherapy is also known to facilitate the healing process of damaged tissues, improve blood circulation and metabolism, increase serotonin levels and boost the function of an individual's immune system (Keenan,2015).

Aside from cryo facials and hydrafacials, cryoneuromodulation is another method known to remove one of the most common signs of ageing, which is wrinkles. Before, this procedure is only done through cryosurgery, which was then associated with possible permanent damage to nerve function. With recent studies and advancement in technology, it was found out that same desired effect can be achieved by using moderate temperature. Hence, leading to the

utilization of focused cold therapy (FCT) to reduce dynamic facial wrinkles by inducing temporary muscle relaxation as it blocks the impulse conduction of motor nerves without the use of neurotoxins (Wong & Gausseran, 2014).

In addition, temperature also plays a vital role in maintaining the normal function of a physical system. Several studies show that high temperature can affect metabolic rates and increase the rate of biochemical reactions responsible for the ageing process as it facilitates oxidative and/or DNA damage. In fact, both poikilotherms and homeotherms showed a clear trend for lower temperature being associated with longer lifespans in wild populations and in laboratory conditions wherein even slight changes in temperatures for long periods of time can influence longevity. Hence, cryotherapy, which induces a decrease in body temperature that equates to a decrease in molecular disorder, has the potential to slow down the ageing process and improve life expectancy (Keil, Cummings, & de Magalhães, 2015).

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# THE ROLE OF CRYOTHERAPY IN PREVENTIVE MEDICINE

Various types of cryotherapy have shown a wide range of benefits in managing and treating different health conditions, particularly in reducing inflammation related to rheumatism and sports injuries. Aside from being considered as a curative technique, the results of several scientific studies have also revealed the potential benefits of cryotherapy in preventive medicine, such as in averting migraine attacks, asthma exacerbation, early onset of Alzheimer's disease (AD) and the occurrence of hair loss or alopecia among cancer patients undergoing chemotherapy.

One of the most common applications of cold therapy is in the management of migraine. Its benefits are associated with the cooling of blood passing through the intracranial vessels, which can be achieved by applying two freezable ice packs on the neck targeting the carotid arteries. This method is commonly referred to as targeted neck cooling. In addition, such benefits are also attributed to the effects of cold temperature in minimizing edema by decreasing vascular permeability leading to a reduction in the release of inflammatory mediators (Sprouse-Blum, Gabriel, Brown, & Yee, 2013). Aside from this, cryotherapy has also been used in the prevention of acute asthma exacerbation. In fact, in a study conducted by Yamauchi (1988), it was found out that exposure to intense cold temperature (up to -175 degrees Celsius) for several weeks in Japan improved the lung function of asthmatic patients. This was supported by the study of Engel et. al. (1989), which revealed that such condition can induce a transient bronchodilatory effect (Westerlund, 2009).

Moreover, apart from its influence on the respiratory response, exposure to cold temperature can also decrease the levels of histamine (Wojtecka-Lukasik, et al., 2010). Histamine is an inflammatory mediator associated with the pathology of allergy such as asthma (Dunford & Holgate, 2010). Hence, with these benefits, it can be taken into account that cryotherapy can exert huge benefits as an adjunct intervention in asthma treatment and prevention. On the other hand, it was also postulated that cryotherapy can also exhibit potential benefits in preventing the early onset of AD through vascular and inflammatory response alteration and oxidative stress reduction.

This premise was supported by preliminary experimental studies showing the effects of cryostimulation in increasing the level of anti-inflammatory cytokines, such as IL-6 and IL-10, and in decreasing the production of pro-inflammatory cytokines, including IL-1a, IL-2, and IL-8. Moreover, cryotherapy also showed antioxidant properties as it can support the activities of glutathione peroxidase and glutathione reductase, and increase the concentration of antioxidants, particularly extra erythrocyte hemoglobin and uric acid (Misiak & Kiejna, 2012). In addition, cold application has also shown significant impact in averting hair loss related to chemotherapy. This method is called scalp cooling, which has been practiced for decades in preventing chemotherapy-induced alopecia (CIA). Evidences have shown that the mechanism

behind scalp cooling is related to the effect of cold temperature in inducing vasoconstriction that reduces the supply of blood in the patient's hair follicles in the period of peak plasma concentration of certain chemotherapy agents. Moreover, scalp cooling is also known to reduce the rate of metabolism and biochemical activity which makes the hair follicles less vulnerable to the damage caused by chemotherapy. Some of the most common methods of scalp cooling are the use of ice bags, frozen cryogel packs and caps that can promote an endothermic cooling reaction. However, these methods are associated with frequent and regular cap changes, which demands much effort to ensure effectiveness. With the advancement in cryotherapy technology, the development of continuous cooling machines that use liquid circulation and a one-size-fits all system have shown much potential in promoting a cost-effective intervention to prevent CIA (Breed, an den Hurk, & Peerbooms, 2011).

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# THE USE OF CRYOTHERAPY IN BIOHACKING

For several years, cryotherapy has been utilized to treat sports injuries among athletes and to relieve pain and inflammation among patients with rheumatism. Hence, such intervention was noted to bring a significant impact in improving the quality of life of many patients around the globe. Aside from this, recent advancement in technology has led to the discovery of more complex applications of cryotherapy such as its potential benefit in the emerging trend of biohacking.

Biohacking is a self-driven biological experiment geared towards applying scientific principles to find alternative methods related to DNA sequencing, microbial screening, environmental monitoring, and improving healthcare services and delivery (Seyfried, Pei, & Schmidt, 2014). The concept behind biohacking is comparable to computer hacking. Instead of altering the computer system, biohacking cracks the code of how the human body is programmed to function and to respond to different stimuli. Biohackers tend to experiment on their own bodies to find solutions to certain health problems related to genetic make-up and other circumstances that may have affected their well-being. Moreover, biohacking also aims to conquer the ballooning costs of research and development by producing accessible and cheap laboratory equipment and methods (Loftrup, 2015).

Cryotherapy, which utilizes extremely cold air in a cryochamber or cryosauna, has been used in biohacking to achieve optimum health outcome. Exposure to cold temperature stimulates the sympathetic nervous system as the body perceives a life-threatening situation and activates survival mechanisms. Some of the advantages of cryotherapy that gain attention from biohackers are its benefits on relieving pain and inflammation. Moreover, it also promotes blood circulation that supports cellular processes and reduces damage to organs and tissues (Taylor, 2016).

One of the most famous pioneers of biohacking is David Asprey, an American entrepreneur whose goal is to live until the age of 180 years old through his bulletproof concept. Asprey ventures on experimenting with his own body to determine the response to sleep, light, nutrition and supplementation. As Asprey's ideas turn to an industry, his life becomes an open book that influences the lives of millions of people who listen to his broadcasts, read his blogs and subscribe to his social media pages (Conner, 2016).

To achieve his personal goal, Asprey established a biohacking laboratory in Victoria, British Columbia in Canada. His facility consists of different equipment such as the cryotherapy chamber to promote longevity. This premise can be supported by the results of several research studies which reveal the potential benefits of cryotherapy in regulating various biochemical processes. In a study published in a Polish journal, it was found out that exposure to ten sessions of three-minute whole body cryotherapy with temperatures ranging from -120 degrees Celsius can suppress oxidative stress by increasing the total antioxidative status (TAS) in plasma (Miller,

Mrowicka, Malinowska, Kedziora, & Majsterek, 2011). Aside from this, cryostimulation is also hypothesized to have an immunostimulating effect related to enhanced noradrenaline response and can be connected with paracrine effects. In fact, in a study that aimed to determine the effects of whole body cryotherapy in pro- and anti-inflammatory cytokine levels in healthy men, it was noted that twenty sessions of 3-minute cryostimulations per day can significantly increase the level of anti-inflammatory cytokines IL-6 and IL-10 and decrease the IL-1a cytokine level (Lubkowska, Szygula, Chlubek, & Banfi, 2011).

Oxidative stress, that leads to the production of free radicals, is known to play a major role in the development of a wide variety of illnesses such as cardiovascular diseases, diabetes, cancer and autoimmune diseases. Inflammation, on the other hand, can lead serious damage to tissues and organ systems. Hence, by suppressing oxidative stress and inflammation through cryotherapy, the risk of developing different health problems can be minimized, thereby promoting longevity (Li, Browne, Bonner, Deng, Tian, & Mu, 2014).

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