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Wim Hof Method

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The Wim Hof Method explained

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Introduction

Wim Hof has developed a method characterized by simplicity and effectiveness. The effects and applicability of this method are being investigated by various scientific institutes, including the Radboud University. Initial results have shown that the method appears to affect the autonomous nervous system and the immune system. This means that application of the Wim Hof Method (WHM) may be of particular importance in the fields of public health, sports and at many other levels.

The effectiveness of this method has been known to Wim Hof for years, which is why he wishes to share it with the world. He wants to ensure that this method will be applied on a large scale. To achieve this, his method is being scientifically investigated, he leads training sessions and workshops and gives interviews to local and international media.

This report discusses how the WHM originated, what the method consists of, which physiological effects it has, which scientific results it has yielded and in which fields the method can be applied.

History

Wim Hof has been training his body and spirit in hard natural environments and under conditions of extreme cold. Under these circumstances, breathing and *mindset* become more effective in order to withstand extreme cold. This increase in effectiveness ensures that he is constantly able to explore his physiology in more detail. He has continued to develop and perfect his method over the years by studying his body and mind and by constantly shifting his own goalposts.

His very impressive performance, especially under cold conditions, have earned him fame, along with the nick-name “The Iceman”. In the meantime he has accumulated almost 20 world records, including the longest ice bath, climbing snowy mountain peaks wearing only shorts, running marathons around the polar circle, etc.

In 2007 Wim Hof was examined by the well-known *Feinstein Institute*. The results show that Wim Hof appears to be able to influence his autonomous nervous system. From this moment onwards, Wim Hof made it his goal to share the possibilities offered by his method with the world. He also sought further cooperation with the scientific community to study the possibilities resulting from his method. These findings will be discussed in the present report.

Method

The Wim Hof Method (WHM) will be explained in section. The three components of the method are detailed, with the associated physiological effects on the body.

There are various methods that separately deal with breathing techniques, the training of the *mindset*/concentration or exposure to the cold. As far as we know, there is no method with an interactive basis between these three components. It is the very interaction of these components that appears to provide proof of the positive effect on the body, as shown by several scientific studies. (Hopman et al., 2010; Pickkers et al., 2011; Kamler, 2009). The method consists of three components that reinforce each other and is characterised by simplicity and effectiveness.

The three components of the WHM are as follows:

- **Breathing exercises**
- **Training of *mindset*/concentration**
- **Gradual exposure to the cold**

To explain why the method is so effective and accurate, the abovementioned components will first be separately highlighted, followed by an explanation why the interaction between these three components is so effective.

Breathing exercises

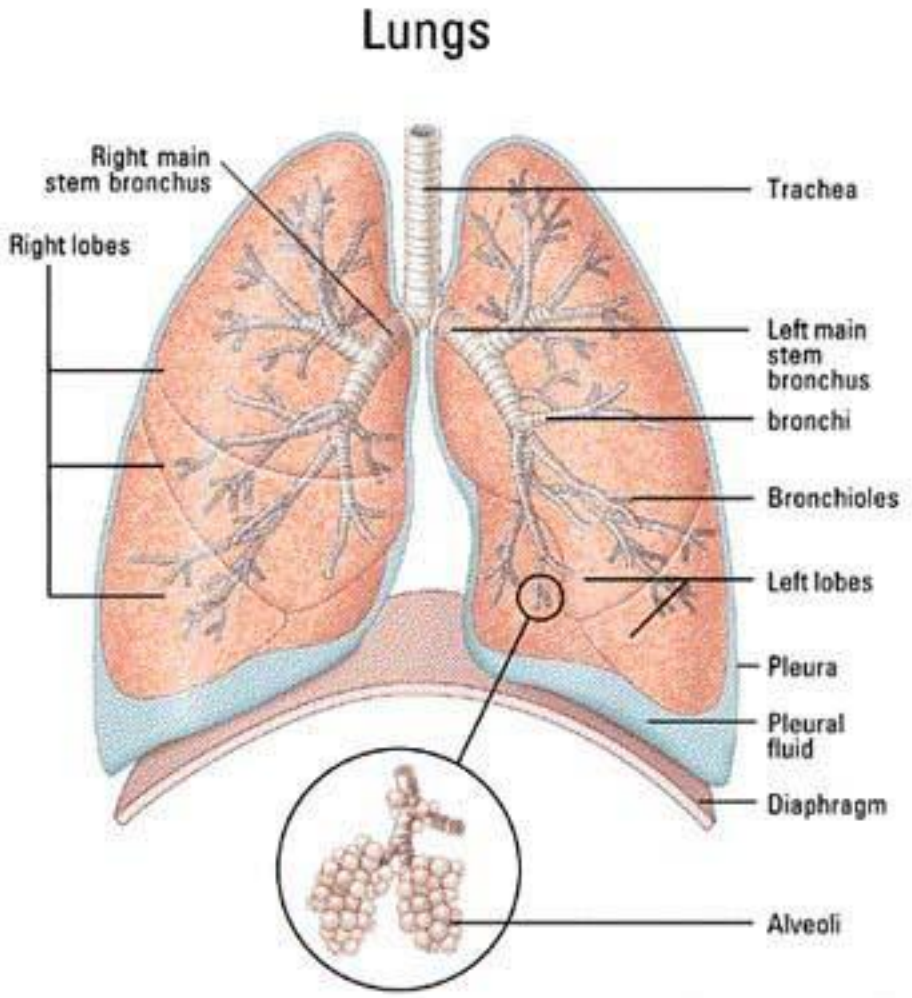
Breathing is a process regulated by the autonomous nervous system and takes place subconsciously. This is fortunate, because otherwise we would have to be aware of it all the time. Breathing has a strong physiological impact; it is the first step in the execution of various chemical processes in the body. The breathing method used also affects the execution of these chemical processes in the body. Furthermore, breathing is the easiest component of the autonomous nervous system to be (partially) influenced.

Over the years, Wim Hof has developed a special breathing technique that helps him keep his body in optimal condition and to keep control under extreme circumstances. The aim of the breathing exercises is to provide the body with more oxygen (O2). By (actively) training the breathing process, once can thus influence various physiological processes in the body. Among other things, this can be used to "purify" the nervous system. To understand why the breathing technique is an important component of the WHM, a more in-depth study will be conducted into the physiological impact of breathing on the body.

Physiology: breathing, body and blood

Breathing is the source of life; each day we breathe in and out about 20,000 times to take up the oxygen we need. Oxygen (O2) is taken in by the lungs and carbon dioxide (CO2), a waste product, is given off.

The lungs have a hierarchical branching structure and consist of two parts (the left and right lung). Oxygen is taken in via the trachea and channelled to the bronchioles (small airways) via the main bronchus. The bronchioles end in pulmonary alveoli. Contact between the oxygen and the blood takes place in these pulmonary alveoli. It is during this exchange that the O2 is taken up into the blood stream and the CO2 is given off. This process is known as "gaseous exchange". Following this exchange, the oxygen-enriched blood flows on to the body cells. The body cells make use of the O2 to release energy resulting from nutrients. The energy released is used to remain alive and healthy (Walker, 2006 p. 50 & 51) and to ensure physical and mental performance. The amount of O2 in the blood stream thus co-determines the amount of energy released. By increasing the amount of O2 in the body, more energy can be released.



Source: http://www.odec.ca/

The alveoli have a large diffusion surface, due to their elasticity. This diffusion surface is the part where the exchange of O2 and CO2 takes place. When breathing normally, this amounts to 70 m2, while during deep breathing it increases to 100 m2 (Mandigers & van Straaten-Huygen, 2004 p. 290 - 316). The breathing technique practised in the WHM results in an even larger surface, allowing more O2 to be taken up. When more O2 is taken up in the blood stream, more CO2 is given off. This serves to "purify" the body. Breathing thus influences the amount of O2 and CO2 in the body.

What happens during the breathing exercises?

The breathing technique is characterized by deep breathing in and unforced breathing out. Hof: "By not breathing out completely, you get to a point at which a residual amount of air remains in the lungs." After this has been done about thirty times, this should be followed by unforced breathing out, but no breathing in, until a need for new oxygen is felt. The entire process then begins again. These cycles are repeated, during which the participant feels light-headed, passive and tingling. The breathing technique results in an increase in the O2 content and a reduction of the CO2 content in the blood. Despite the fact that CO2 is a waste product of the body, the body does require a certain amount of it. These breathing exercises are therefore (partially) intended to take up a sufficient amount of this substance in the body, yet as little as possible. The reduction in the amount of CO2 results in more O2 being released, positively charging the mitochondria (which provide energy to the cell). This makes more energy available to the mitochondria at cell level. The release of this energy is also known as "aerobic dissimilation". This takes place both anaerobically and aerobically (without and with oxygen). Wim Hof: "By releasing more energy, these breathing exercises can clear up a lot of accumulated waste products in the body. This means that control can be achieved at any given moment to provide direct access to this process. This in turn results in enabling a person to influence the chemical activity of the cell."

A scientific study (Pickkers et al., 2011) has shown that, after 30 minutes of using this breathing technique, Hof's blood had a low CO2 content. After a full hour, the CO2 content was significantly lower. Simultaneously, the amount of O2 in the blood increased during the breathing exercises and, after 45 minutes, the amount of O2 had doubled in comparison with that recorded when at rest. Wim Hof: "Concentration is energy. Concentration results in electrical impulses (neurons) and chemical messages (neurotransmitters). The pyruvate that provides energy to the mitochondria is boosted further by focused concentration, with this dissimilation resulting in energy, thus concentration and awareness are essential to this exercise. Increased awareness can be achieved by influencing the mitochondrial activity of the brain cells, thus releasing substances in the hypophysis, epiphysis, third eye and pineapple gland to increase awareness. More energy in the mitochondria of the brain cells thus results in the release of substances that have been hidden in the hypophysis and the pineapple gland."

Training of mindset & meditation/concentration

It is generally known that a strong mindset can be an important weapon when it comes to thinking, doing and achieving. In the WHM, a strong mindset is important to realise your inner strength. Concentration/medication is an important part of this. This concentration is required to achieve what you wish to achieve for certain purposes. If Wim Hof would not concentrate, for example, he would feel just as cold as everyone else. Focus is thus very important.

Autonomous nervous system and concentration techniques

Normally, the autonomous nervous system is independently and subconsciously regulated by the body. The autonomous nervous system regulates functions such as breathing, internal organs, digestion, the dilation and contraction of the blood vessels and the heartbeat. In accordance with current medical opinion, no influence can be exercised over the autonomous nervous system.

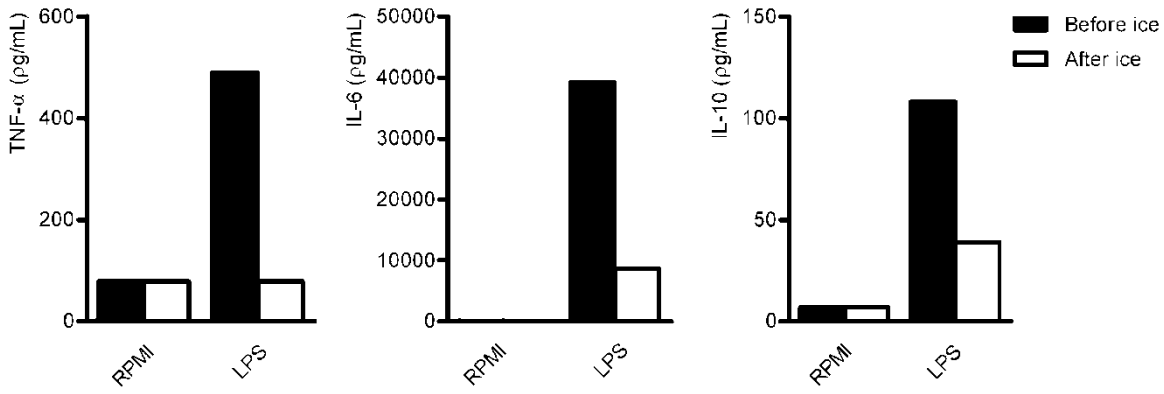
It has emerged from a variety of studies, however, that certain concentration/meditation techniques can result in independent, autonomous activity (Phongsuphap, Pongsupap, Chandanamattha & Lursinsap, 2008; Wu & Lo, 2008; Paul-Labrador et al., 2006). *Mindfulness*-based stress reduction, for example, has resulted in a decrease in activity in the sympathetic nervous system among fibromyalgia patients (Lush, Salmon, Floyd, Studts, Weissbecker & Sephton, 2009). Proof has also been provided that Wim Hof is able to influence his autonomous nervous system by means of his technique (Pickkers et al., 2011). Researchers at Radboud University have investigated the influence of Wim Hof's concentration technique on the activity of his autonomous nervous system and the (natural) immune system. During the course of this experiment, some components of E-coli bacteria are injected into Wim Hof and 200 other trial participants. Administering this substance makes the body think that it is being attacked. Normally this would result in an over-reaction by the immune system, resulting in flu symptoms (headache, fever and muscle pain) for a number of hours. However, Hof only suffered a mild headache at the time when the flu symptoms would normally be at their strongest. The results also showed that Hof only produced half of the number of inflammatory proteins as the average of the other trial participants to whom these bacteria had been administered. Study leader Pickkers declared that Hof was able to produce a controlled response to the bacteria administered by means of his concentration technique. This resulted in a so-called *'fight or flight response'*, which ensured that the body produced more cortisol (the "stress hormone"). This increase resulted in a reduction in the immune response, thus suppressing most of the inflammatory proteins (cytokines) causing the flu symptoms.

The study also showed that the autonomous nervous system can be influenced. The difference between this study and others (Lush et al., 2009; Phongsuphap, Pongsupap, Chandanamattha & Lursinsap, 2008; Wu & Lo, 2008; Paul-Labrador et al. 2006) on the influence of concentration/meditation on the autonomous nervous system is that the body does not relax, but that a '*fight or flight'* response is produced. Meditation/concentration techniques are regarded as reducing stress and cortisol levels in the same way (Lush. et al., 2009; Carlson, Speca, Faris & Patel, 2007). You relax your body, causing the amount of the "stress hormone" cortisol in the body to be reduced. The Wim Hof technique can therefore be differentiated from other meditation/concentration techniques. The Hof technique is not primarily aimed at putting the body into a relaxed state, but rather into an active state. Wim Hof thus has a strong *mindset* and makes use of his (trained) concentration to achieve certain goals, such as influencing the autonomous nervous system in the above case. This results in certain chemical responses that promote his physical condition. The following section discusses the latest component of WHM, i.e. gradual exposure to cold, in more detail.

Gradual exposure to the cold

Exposure to the cold is a less common but very effective technique. When heating systems were first developed in Greek antiquity, cold baths were still thought to have health benefits. In our society we are used to turning up the heating or putting on an extra jersey as it gets colder. We are used to this comfort and there is nothing wrong with this. However, in WHM the cold is an essential force involved in accessing the autonomous nervous system (and the associated immune system). To continue to expand on the study conducted by Pickkers et al. (2011): it appears that the amount of inflammatory protein in Wim Hof's blood stream during exposure to ice (with the aid of the concentration technique) was significantly lower than when the concentration technique was employed on its own. Exposure to ice meant that no inflammatory proteins were found at all. This was because even more cortisol was circulating in the blood than before (see Table 1 for the results), suppressing the amount of inflammatory protein. Another surprising factor was that the results showed that even after six days there was increased metabolic activity in the cells.

Table 1: RPMI and cytokine values[1] before and after exposure to ice



The table above shows that the amount of inflammatory protein TNF-x, IL-6 and IL-10 after exposure to ice was significantly reduced in comparison with the prior situation. The inflammatory protein TNF-α (tumour necrose factor alpha) plays an important role in inflammatory processes and the acute phase reaction. This in turn plays a crucial role in joint diseases such as arthritis and Crohn's disease. An increased inflammatory protein value results in an increase in inflammation, which in turn results in tissue death (necrosis). In addition, this protein is also associated with physical complaints such as fatigue and

[1] The amount of RPMI (*Rosswell Park Memorial Institute medium*) and cytokine response (*stimulation of peripheral blood mononuclear cells with lipopolysaccharide [LPS]*) for the cytokines tumour necrosefactor alpha (TNF-x), Interleukine-6 (IL-6) and Interleukine-10 (IL-10) in Wim Hof's blood stream before and after exposure to the ice.

anaemia. IL-6 (Interleukine-6) is a protein that can cause flu-like reactions in people suffering from auto-immune diseases or infections.

The next question is how it happens that Hof is resistant to long-term exposure to the cold. When exposed to extreme cold for longer periods, most people suffer so-called *freeze damage*. The body automatically closes down the blood supply to less vital body parts such as the legs and arms, thus preserving the vital body parts (heart, lungs, liver and kidneys). The skin starts tingling, with a burning sensation or a complete loss of sensation. Once temperatures have dropped sufficiently, tissue necrosis may begin. When the core body temperature falls below 35°C, under-cooling takes place. In this state, the temperature is so low that the normal metabolism is at risk. In this state the heartbeat, blood pressure and respiration rate will fall and the person will feel faint and weak. This ultimately leads to a loss of consciousness. After about an hour, this situation will result in death. In ice water, undercooling normally takes place after 30 minutes (Stephen, 2009).

However, Hof manages to influence his body to such an extent that he is not yet undercooled after 30 minutes. In fact, by applying his technique, he is able to control his body to such an extent that he can be exposed to ice for more than 1.5 hours. A study (Hopman et al., 2010; Pickkers et al., 2011) showed that, during the 80 minutes in which he was exposed to ice, his body temperature remained at a constant 37 degrees. It was also shown that his heart beat remained low and his blood pressure normal.

How is this physically possible? The study by Hopman et al. (2010) shows that Hof's metabolic rate increased by 300 percent during exposure to ice. This increased metabolic rate resulted in an increase in the heat production of his body. According to Hopman, "Hof is able to turn up his heating system to three times the normal rate. He also does not shake and shiver, which is normally what the body would do to get warm. We don't understand how this is possible." These results are at odds with the generally accepted medical theory that the autonomous nervous system - and thus the temperature - are automatically and autonomously regulated by the body. According to Hopman, Hof appears to be able to influence his autonomous nervous system, while also appearing to regulate his cardiovascular and thermal regulatory systems. Hof's previous claims that he is indeed able to influence his autonomous nervous system have acquired a scientific basis through these studies.

Another study conducted by the Thrombosis Research Institute (ME, CVS, Documentation Centre, 1994) showed that people who took a daily cold shower had significantly more white blood cells in comparison with people who did not. White blood cells are cells that combat diseases. The investigators declared that, by taking a cold shower, the metabolic rate during and after such a shower is increased to keep the body warm. At the same time the immune system is activated, resulting in the release of more white blood cells. This

study indicated that exposure to the cold boosts the immune system.

Brown fat and body temperature

Another study carried out by Maastricht University (van Marken- Lichtenbeld et al., 2011) also showed that Hof was producing a lot of additional heat. The study showed that, at a room temperature of 11°C, Hof produced an average of 35% more body heat than at a normal temperature. This increase in Hof's body temperature even reached 50% during the course of the experiment. At a similar temperature, young adults appear to generate up to 20% more heat. Apart from the fact that Hof manages to influence the generation of body heat through his technique, Marken-Lichtenbeld et al. (2011) state that this may also (partially) be explained by the presence of brown fat in Hof's body. Brown fat is a type of fat tissue that is able to release energy directly (unlike white fat, which stores energy), thus resulting in the production of heat. New-born babies have a relatively high amount of brown fat, so that they can regain any heat lost within a relatively short period. After nine months the amount of brown fat tissue has drastically decreased and continues to decrease over the years. Adults were supposed to have none or hardly any. However, a recent study showed that brown fat is sporadically present and active in adults. Brown fat can be detected by a new measuring method (PET-CT scan) (Nedergaart, Bengtsson & Cannon, 2007). The presence of brown fat in adults has been evidenced in a recent study, according to which brown fat is also present in young adults. It appears that brown fat tissue can also be activated by cold (van Marken-Lichtenbelt et al., 2009). This fat tissue is already activated at 18°C. During this process, fatty acids are removed from the body to provide it with the heat it requires (Carpentier, 2011). Another study indicates that the lower the temperature, the more brown fat tissue is activated to heat the body (Ouellet et al., 2011). The study by van Marken Lichtenbelt et al. (2009) also showed that overweight people had little or no brown fat (WHM and its applications are discussed in more detail here). It was also investigated whether brown fat levels decrease over the years (Ouellet at al., 2011). The study by van Marken Lichtenbelt et al. (2011) involved measuring Hof's brown fat levels at neutral room temperature and in an environment with a temperature of 11°C, wearing only bathing trunks. The results showed that brown fat levels could be detected in Hof at a neutral room temperature. It also appeared, however, that Hof had as much brown fat tissue as the average young adult when measured in the cold. The results imply that brown fat

contributed to heat production. It also indicated that brown fat could be retained by means of low-temperature training, irrespective of a person's age.

Figure 2. Brown fat on PET-CT scans in healthy men

Thermo-neutral temperature *Exposure to cold*

Source: The New England Journal of Medicine

Cold shock

When a person's body temperature drops to below 32.2°C during freezing, the body stops shivering. Shivering is a physical activity that can generate heat. When no external heat is obtained, the body temperature drops in a downward spiral and may ultimately result in a person dying of hypothermia. According to medical opinion, it is crucial for external heating to take place during this process. In 2008, Hof's temperature was measured in the Hypothermia Faculty of the University of Minnesota. Just like Pickkers and Hopman, they noticed that Hof did not shiver as a result of (long-term) exposure to the cold. In addition, Hof's temperature during the course of this experiment dropped below the crucial limit of 32.2°C. According to medical opinion, Hof's temperature could only be increased again by an external source of heat. However, Hof's body temperature increased to 34.4°C without an external source of heat. These results also indicate that this medical theory therefore does not always tally. The team leader, Dr. Kamler, said in this regard: "It's a mystery that we have not yet come close to solving. It tells us that there's enormous potential within the brain that is going untapped. And if we can study him more, and study people like him more, maybe we can unleash that potential for the rest of us.'.

The power of the combination of breathing technique, concentration and (gradual) exposure to the cold

The three basic elements of the WHM will be separately dealt with. This exceptional performance is made possible by an interaction of three elements:

A **strong *mindset*** is essential to achieve the required concentration and focus, so that the techniques are correctly executed even in extreme situations. Among other things, the **breathing exercises** ensure that O2 levels in the body increase, while CO2 levels decrease. Ultimately, on **exposure to cold** (such as ice), the physiological effects are even stronger.

In simple terms, the breathing exercises help to get your body into the state required to gain access to your autonomous nervous system and to resist the cold. Before Hof exposes himself to cold, he prepares himself by engaging in breathing exercises. He needs to have a strong *mindset* to achieve his goals. A strong *mindset* results in concentration and endurance. Cold is used to boost the physiological effects. Where an untrained person wishes to apply the WHM, all three of these components are important. The aim of the breathing exercises is to provide the body with more oxygen and to trigger various physiological reactions, including the release of more energy to strengthen the body. The *mindset* is important at all times. This provides you with the mental and also physical strength you need. This *mindset* can be reinforced by gradual exposure to the cold (by taking brief cold showers).

Science

In 2007, Wim Hof was examined at the renowned *Feinstein Institute* and the results show that Wim Hof appears to influence his autonomous nervous system; it particularly appears that he is able to suppress inflammatory bodies in his blood stream that are associated with chronic illnesses (Kamler, 2009). From this moment onwards, Hof has wanted to share the possibilities offered by his method with the world. He welcomes further cooperation with scientists under the motto "to measure is to know". He thus hopes to collect scientific proof and thus to extend the further options offered by his method.

In 2010, these experiments and studies were furthered by new research conducted by the physiology department of Radboud University. Under the guidance of Professor Hopman, Wim Hof was subjected to an 80-minute ice bath, while various measurements were conducted (see appendices). Given the remarkability of the results obtained, a follow-up study was rapidly initiated.

In 2011 this resulted in the endotoxin experiment. The aim of this study was to see whether the concentration technique practised by Hof can influence the immune system. The immune system is part of the autonomous nervous system; according to current medical opinion, this can currently not be consciously influenced. This would therefore mean that it is also not possible to influence the immune system.

Hof and 112 other male participants (*M* = 22,4) were allocated endotoxins - a dead component of the cell wall of E-coli bacteria. Wim Hof's data, which included information about inflammatory proteins, body temperature and symptoms of disease, were compared to the data of these participants.

Three different experiments took place on different days. In the first experiment, Hof exposed his entire body (except for the head) to ice for a period of 80 minutes. Once Hof had practised his concentration technique for 30 minutes before exposure to the ice and bacteria, the first blood measurement was conducted. Hof was then exposed to the ice for a period of 80 minutes. Hof applied his concentration technique during the entire period of exposure to ice. After exposure to the ice, Hof's blood values were taken once again. The cortisol and anti-inflammatory levels in the blood were measured.

In the second experiment, which took place on another day, Hof applied his concentration technique, but was not exposed to ice and also did not receive any components of the E-coli bacteria. His blood values were measured before any of Hof's techniques were applied. The blood values were then measured again after 1.5 and 3 hours. The last experiment investigated the effect of Hof's concentration technique on the physiological effects obtained by administering the bacteria. This experiment had the same set-up, but this time Hof was not exposed to ice. As a control experiment, he had not been exposed to ice or cold

during the 6 weeks before the study. During the experiment, the cortisol content and cytokine quality were measured among other values. In addition, the blood pressure, heart rate, respiration rate, EEG and sympathetic muscle activity were measured. Once again, Hof started to apply his concentration technique 30 minutes before the administration of the components of E-coli bacteria, finishing 2.5 hours thereafter. All other participants followed the same endotoxin protocol, without application of the concentration technique.

The results of the first experiment, in which Hof was exposed to ice and components of the E-coli bacteria, showed that the cortisol content in his blood stream was already relatively high after he had applied his concentration technique for 30 minutes (even before exposure to the ice). This rose even further after exposure to the ice. The amount of inflammatory protein after exposure to ice was significantly lower in comparison with the moment before (see Table 1). It was remarkable that, after a period of 6 days, Hof's cells still reacted differently to before.

To check whether it was only the concentration technique that led to an increase in the cortisol content, i.e. without the administration of components of the E-coli bacteria, a second experiment was conducted for verification purposes. This comparison showed that the cortisol content did not change merely as a result of the application of this technique without components of the E-coli bacteria being administered.

Finally, the effect of the concentration technique on the inflammatory proteins before, during and after administration of components of E-coli bacteria was analysed. Hof started applying his technique 30 minutes before administration of the bacteria and ended 2.5 hours after administration. The blood analysis showed a reduced CO2 concentration in the blood stream as a result of this concentration technique. During the second measurement, after Hof had applied the technique for a longer period, this concentration was even lower. The results also showed that Hof did not suffer from any significant symptoms of illness as a result of the bacteria. He only reported a slight headache 1.5 hours after administration of the bacteria. This is the period when the symptoms are usually at their worst. Before components of the E-coli bacteria were injected into Hof and 15 other participants (a sub-group of the 112 participants), the cortisol content in Hof's blood stream was the same as that of the other participants. However, Hof's cortisol levels increased more significantly after administration of the bacteria than those of the other participants. Furthermore, Hof's level of inflammatory proteins was particularly low.

In summary, it was shown that - when components of the E-coli bacteria were injected - Hof's concentration technique resulted in increased cortisol values and to a relatively low content of inflammatory proteins in the blood stream. These effects were even greater on exposure to ice. Moreover, the effects only occurred during (and before) the administration of the bacteria. There were no changes to the cortisol levels and inflammatory proteins when only the concentration technique was applied. There was, however, an increased

cortisol level when the bacteria had not yet been injected and before Hof was exposed to the ice, but during the preparatory activities. This indicates that the physiological reaction achieved by the WHM only occurs when this is required by circumstances.

Once again it was shown that Wim Hof is able to influence his immune system and thus his autonomous nervous system, raising the question whether the method can also be learnt by others. After all, the ability to influence the immune system and the autonomous nervous systems would have major consequences for the health care industry.

As a person's health is something to be treated with care and false hopes should not be raised, we are working in close cooperation with Radboud University as a team. A new study is being prepared, with Wim Hof training ten people, who will attempt to acquire his method within a period of two months. Under the supervision of Professor Hopman (physiology) and Professor Pickkers (intensive care), it will be investigated whether his method is transferable.

*The appendices provide an overview of previous studies, results, articles, etc.

Applying the Wim Hof method

We are cooperating with scientists because we find it important that the effectiveness of the method should be scientifically proven. Various persons, including healthy persons, persons with a physical disability and athletes, have experienced the power of the WHM. They may have practised the method to cope with a physical disability or to improve their physical performance. The aim is to establish beyond any speculation that the method has a positive (physical) effect on various levels. We trust that it will be proven in the near future that anyone can influence his autonomous nervous system and immune system and that this is only the beginning of a new (or possibly a very old) approach to health. Until such time, we can make use of the results obtained in scientific studies thus far to obtain an indication of what possibilities we can expect the method to provide.

Health

Various studies have shown that the WHM is effective for various health purposes. The endotoxin experiment, for example, showed that Wim Hof produced significantly more cortisol than other trial participants due to his breathing exercises. Cortisol suppresses inflammatory bodies in the blood stream. Those suffering from an overactive immune system, for example, could benefit a great deal from this. Furthermore, the brown fat tissue examination showed that Hof still had brown fat. This indicates that practising the WHM has a favourable effect when it comes to maintaining brown fat levels. Here follows a description of the effects of the WHM on various types of physical illnesses and health in general.

Auto-immune disease

People suffering from an auto-immune disease have an over-active immune system. The immune system regards the body's own cells and substances as intruders and thus attacks them by producing antibodies.

People suffering from rheumatism, for example, have an over-active immune system. This results in irregularities in the body's defence system. Under normal circumstances, the body produces defence cells to protect the body against viruses and bacteria. Everything that does belong to the body is tracked and attacked by these cells. When a person suffers from rheumatism, these defence cells erroneously produce protein bodies that cause inflammation of, for example, the joints and tendons (Reumafonds, 2012). The body thus attacks itself. The WHM method would have a positive effect on this, as it potentially results in an increase in the cortisol content in the blood. This results in the suppression of the inflammatory bodies, which in turn results in a lower chance of inflammation in the

joints and tendons. People suffering from diseases of the auto-immune system, including rheumatism, may benefit a great deal from practising the WHM.

Heart and vascular diseases

Exposure to the cold has a major effect on the heart and vascular system. The Wim Hof Method (WHM) can be used to strengthen the cardiovascular system, so that the heart needs to pump less frequently, as all muscles in the blood vessels support the function of the heart. To this may be added that the WHM breathing exercises provide the system with more oxygen, thus allowing the blood stream easily to transport more oxygen. The combination of these two WHM components ensures that a healthy cardiovascular system is able to supply the entire body.

Overweight and obesity

The study has shown that exposure to the cold has a positive effect on the development of brown fat. This type of fat makes it possible to convert energy (glucose and body fat) directly into body heat. This is possible because brown fat cells contain numerous mitochondria, which act as the energy providers of a cell. Unlike the mitochondria in white fat cells, the mitochondria in brown fat cells contain the uncoupling protein UPC1 (thermogenesis). Where necessary, this protein causes a chain reaction in which mitochondria directly transform energy from glucose and fat into heat (Kirsi et al., 2009). To place this in perspective: white fat cells contain far fewer mitochondria and thus also no uncoupling protein UPC1. This means that there can be no chain reaction in which direct energy is transformed from glucose and fat into heat.

New-born babies have a relatively large amount of brown fat, so that they can make up for any heat losses within a relatively short time, where necessary. After nine months, the amount of brown fat tissue in babies is drastically reduced and over the years it decreases even further. Adults were supposed to have none or hardly any. It has emerged from the study, however, that adults still have such brown fat and that brown fat tissue can be activated by cold (van Marken-Lichtenbelt et al., 2009). It is interesting to know that a negative, significant linear relationship was found between body fat and the amount of activated brown fat tissue, both as BMI and as brown fat tissue. A person with a higher BMI or more body fat thus had less brown fat tissue. Overweight people had less of this type of fat or none at all (Ouellet et al., 2011; van Marken- Lichtenbelt et al., 2009). This indicates that brown fat plays a role in overweight. It is especially this group of people who would thus benefit from exposure to the cold by increasing the amount of brown fat. Exposure to the cold can result in more brown fat tissue, ensuring that fat can be more rapidly dissolved to provide the body with heat. This would result in a more rapid decrease in body weight.

The study also indicated that the amount of brown fat, which depends on the exposure to cold, can be increased (study). Brown fat tissue already becomes active at 18°C. During this process, fatty acids are removed from the body to provide it with the heat it requires (Carpentier, 2011). It also appears that the colder it is, the more brown fat tissue is activated to provide the body with heat (Ouellet et al., 2011). The study also indicated that, on exposure to water with a temperature of 20°C, the metabolic rate doubles. At a temperature of 14°C, it is more than four times the normal rate (Sramek et al., 2000). Minor changes can thus have a positive effect on overweight. The WHM is an excellent way of dealing with the cold while counteracting overweight.

Finally, the study indicates that there is a negative relationship between brown fat tissue and age. As we get older, we have less brown fat tissue and are able to activate it less (Ouellet et al., 2011). However, on exposure to the cold, Hof's body appears to contain the same amount of brown fat as that of a young adult. The results indicate that brown fat may well be maintained in the body over many years by training in cold conditions.

General well-being and energy balance

The WHM is also quite effective for increasing energy levels. The respiratory exercises increase the amount of O2 in the blood stream and ensure that waste products are more rapidly eliminated from the body. The body is "purified". The larger amount of oxygen in the body is able to release more energy, which benefits the body and its energy balance.

In addition, the inflammatory protein TNF-α is also responsible for fatigue. It has been found that the concentration exercises result in a reduction in the amount of this inflammatory protein (Pickkers et al., 2011; see Table 1). This may have a positive effect on fatigue-related complaints. In addition, exposure to the cold - for example in the form of cold showers - trains the blood vessels. This directly stimulates the blood stream, increasing the metabolic rate, which in turn results in an increase in energy.

In addition, the respiratory techniques, concentration and exposure to cold release more dopamine into the body. This substance ensures a feeling of pleasure, well-being and happiness, making people experience their lives as easy and more positive. This creates another type of awareness. A person who feels mentally better also feels physically better.

Sports

Wim has trained several (top) athletes and it appears that their endurance levels and general condition are improved by following the WHM. This method has resulted in better physical performance among various (top) athletes. The possibility of a scientific study of the effect of WHM on the physical performance of (top) athletes is now being discussed.

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Appendices:

1	**Radboud University, Professor Pickkers, 2011**
2	**Radboud University, Professor Hopman, 2010**
3	**World record attempt, Dr. Kamler, 2009**
4	**Media articles**

Appendix 1

The influence of concentration/meditation on autonomic nervous system activity and the innate immune response: a case study

Matthijs Kox MSc[1], Monique Stoffels MSc[2,6*], Sanne P. Smeekens MSc[2,6*], Nens van Alfen MD PhD[3], Marc Gomes MD PhD[4], Thijs M.H. Eijsvogels MSc[5], Prof. Maria T.E. Hopman MD PhD[5], Prof. Johannes G. van der Hoeven MD PhD[1], Prof. Mihai G. Netea MD PhD[2,6] and Prof. Peter Pickkers MD PhD[1]

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Abstract

Objective To investigate whether a special concentration/meditation technique employed by a Dutch individual known as 'the iceman' can influence anatomic nervous system activity and the innate immune response. The iceman holds several world records with regard to tolerating extreme cold and claims he can influence his autonomic nervous system and thereby his innate immune response.

Methods We performed a case study of the iceman. The subject's *ex vivo* cytokine response (stimulation of peripheral blood mononuclear cells with lipopolysaccharide [LPS]) was determined before and after an 80-minute full-body ice immersion during which the subject practiced his concentration/meditation technique. Furthermore, the subject's *in vivo* inflammatory response was studied while practicing his concentration/mediation technique during human endotoxemia (i.v. administration of 2 ng/kg LPS). The results from the endotoxemia experiment were compared with a historical cohort of 112 subjects who participated in endotoxemia experiments in our institution.

Results The *ex vivo* pro- and anti-inflammatory cytokine response was greatly attenuated by concentration/meditation during ice immersion, accompanied by high levels of cortisol. In the endotoxemia experiment, concentration/meditation resulted in increased circulating concentrations of catecholamines, and plasma cortisol concentrations were higher than in any of the previously studied subjects. The subject's *in vivo* cytokine response and clinical symptoms following LPS administration were remarkably low compared with previously studied subjects.

Conclusions The concentration/meditation technique employed by the iceman volunteer appears to evoke a controlled stress response. This response is characterized by sympathetic nervous system activation and subsequent catecholamine/cortisol release, which appears to attenuate the innate immune response.

Appendix 2

Can meditation influence the autonomic nervous system? A case report of a man immersed in crushed ice for 80 minutes.

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Departments of [1] Physiology and [2] Obstetrics and Gynaecology, Radboud University Nijmegen Medical Centre and [3] Department of Rehabilitation, St Maartenskliniek; Nijmegen, The Netherlands; and [4] Research Institute for Sports and Exercise Sciences, Liverpool John Moores University, Liverpool, United Kingdom.

Background: The autonomic nervous system responds independently, autonomously and automatically to changes in the homeostasis of the cardiovascular system and thermoregulation. However, the world record holder of full-body ice immersion claims he can influence his autonomic nervous system through the Asian Tummo meditation technique, which is associated with descriptions of intense sensations of body heat. We, therefore, assessed the cardiovascular and thermoregulatory responses to full-body ice immersion in this individual.

Methods: A 51 year old male was fully immersed in crushed ice for 80 minutes whilst performing Asian Tummo meditation. Blood pressure and heart rate were measured continuously using an automatic blood pressure device. Core body and skin temperature were measured continuously using an ingestible telemetric temperature pill and wireless sensors, respectively. Oxygen consumption was measured using pulmonary gas exchange every 30 minutes.
Results: Core body temperature during the 80-minute ice immersion period decreased gradually from 37.7 to 37.1°C. Skin temperature decreased at the upper limbs from 28 to 5°C and at the lower limbs from 28 to 18°C. No immediate blood pressure or heart rate response at the beginning of full-body ice immersion was observed. Over the full 80-minute ice immersion period, blood pressure gradually increased from 128/84 to 163/97 mmHg and heart rate from 70 to 90 bpm. Oxygen consumption doubled from 5.7 at baseline to 11.0 ml/min/kg during immersion and remained stable.

Conclusions: No immediate blood pressure and heart rate responses were observed, as typically observed when (partially) submerged into ice(water). Despite 80 minutes of full-body ice immersion and significant heat loss through the skin, core body temperature was maintained probably by an increased energy expenditure (and therefore heat production). This individual may have influenced the autonomic nervous system, thereby actively regulating the cardiovascular system and thermoregulation.

Appendix 3

Date: Thu, Sep 17, 2009

Subject: World Record attempt on Regis and Kelly ABC TV Show

Core temperature was recorded by Granis Stewart, RN, using Vital Sense monitor capsule swallowed by Wim Hof prior to ice immersion.

First recorded temp (before ice immersion) while still clothed was 98.6
Just before they began pouring the ice in the chamber: 98.16
15 minutes after ice immersion began: 96.36
30 mins after ice immersion began: 97.44
45 mins after..... 95.07
52 mins after..... 93.74
56 mins after..... 88.79
65 mins after..... 89.94
75 mins after..... 88.08
(oral temp at same time was 92.7)
90 mins after..... 93.38
95 mins after..... 94.10
100 mins after..... 94.10
One minute before breaking his world record of 1 hour 43 minutes: 92.71

Wim was completely fine and conversational throughout and he barely showed a shiver. His practice of Tibetan Tumo meditation has given him incredible abilities.
He believes that he can teach people his skills and prevent many diseases--particularly those associated with inflammation/elevated inflammatory markers (elevated cytokines, etc which we are finding out are elevated in most diseases). He is able to decrease certain markers through meditation as suggested by one blood test done at the Feinstein Institute of North Shore University Hospital.

The brain is the largest consumer of oxygen in the body. Wim believes that by meditation he diverts some of his

brain oxygen to his peripheral blood vessels to increase blood flow and thereby maintain body warmth. Standard medical dogma states that once your core temperature falls below 90 degrees you stop shivering - a process that generates heat. From that point on, if a source of external heat is not provided, your body temperature will continue to spiral downward and you will eventually die of hypothermia. Wim has proven this wrong. His body temperature dropped to 88 degrees and then came back up to 94 - WITHOUT ANY EXTERNAL HEAT SOURCE. He has dramatically shown us that there is incredible power within the human body that modern medicine does not clearly understand.

Letter of recommendation by Kenneth Kamler:

November 22, 2009

To Whom It May Concern,

I am pleased to very highly recommend Wim Hof as a public speaker. As a physician and author of two books on the human body's ability to survive extreme environments, I have made multiple appearances with Wim on various nationally broadcast television shows including ABC News 20/20, the NBC Today Show, and ABC's Live with Regis and Kelly Show. These are all very highly rated American TV shows, each with an audience of 10-20 million people. In addition, Wim and I lectured together at the highly prestigious Rubin Museum of Himalayan Art in New York City. At each of these events Wim and I explained the amazing physiological responses that he has been able to teach himself through meditation and the power of the mind. Wim has a charismatic stage presence. Even while encased in ice up to his neck, he is able to laugh and joke with the audience and his TV hosts in an entertaining manner while at the same time transmitting a very strong educational message about what the human body is capable of achieving.

My role at two of these events was to monitor Wim's vital signs as he broke his ice immersion world record. His temperature gradually dropped 10 degrees to a level which would be fatal to an average person. Wim, however, was then able to raise his body temperature by 6 degrees entirely through his meditation practice--a feat heretofore considered impossible by medical science. While in New York City, Wim was invited by Dr. Kevin Tracey, director of The Feinstein Institute for Medical Research, to study changes in his blood during meditation. Dr. Tracey found a significant decrease in a key inflammatory

marker that relates to many common chronic diseases of aging. This is an intriguing clue as to how the mind can control the body to fight disease. Research such as this is at the forefront of the new movement to develop preventative health measures rather than to treat diseases after they occur.

Wim is an entertainer, but far more importantly, he is a futuristic thinker. His goal ultimately is to teach people to prevent or even reverse chronic circulatory and inflammatory diseases, such as diabetes, arthritis and heart disease. His message has far reaching implications for the health and wellness of the general population. Because Wim embodies a unique combination of intelligence, wit, and ability, he is a dynamic stage presence and a highly effective speaker and educator.

Very sincerely yours,

Kenneth Kamler, MD

Appendix 4 (Media articles)

The New York Times

May 22, 2011

Dutch 'Iceman' Controls Body Through Meditation

By THE ASSOCIATED PRESS

ROTTERDAM, Netherlands (AP) — The sun beams down on a warm Dutch spring morning, and the Iceman's students look wary as they watch him dump bag after bag of ice into the tub of water where they will soon be taking a dip. The plan is to try to overcome the normal human reaction to immersion in freezing slush: gasping for air, shivering uncontrollably, and getting back out again as soon as possible. Instead, under the direction of "Iceman" Wim Hof, the group of athletes is going to stay in the water for minutes practicing his meditation techniques, seeking possible performance or health benefits.

Hof, 52, earned his nickname from feats such as remaining in a tank of ice in Hong Kong for almost 2 hours; swimming half the length of a football field under a sheet of ice in the Arctic; and making the Guinness record books for running a half-marathon barefoot in Finnish snow in deep subzero conditions. He tried to climb Mt. Everest in 2007 wearing only sandals and shorts, but suffered frostbite and turned back at 7,400 meters (24,300 feet) — he wants to test the limits of human potential, not die trying. He climbed Mt. Kilimanjaro instead the same way in 2009.

Hof tells his students meditation in the cold strengthens mind and body. Some scientists also say ice bath treatments may have circulatory benefits for athletes, or help them recover quicker after training, although this remains controversial. For most people, hypothermia begins shortly after exposure to freezing temperatures without adequate clothing, and it can quickly lead to death once the body's core temperature falls below 90 degrees Fahrenheit (32 degrees Celsius). Hof says he can endure cold so well because he has learned to activate parts of his mind beyond the reach of most people's conscious control, and crank up what he calls his "inner thermostat."

In one well-documented demonstration in 2008, Hof remained encased in a glass box filled with ice on a New York City street for 71 minutes, at that time a record. Doctors monitoring his vital signs said his body temperature descended gradually to 93.6 degrees as his heart rate rose slowly into the 120s. He didn't shiver. It was as if he were running a race without moving. Hof describes what he does as a kind of internal conversation, in which his mind

and body send each other signals. During the Hong Kong stunt, he said he mentally directed warmth toward a specific part of his lower back when he sensed it was feeling too cold and starting to hurt.

"I never had a teacher, and I never had lessons, other than hard Nature itself," he says in an interview at his apartment in Amsterdam. "If you do it wrong, it hurts and you take some knocks, and if you do it right, then you really learn."

Dr. Anders Cohen, chief of neurosurgery at Brooklyn Hospital Center, who had never heard of Hof, said he wasn't surprised at Hof's ability to influence his body temperature, given the growing body of evidence that Tibetan monks who practice "Tummo" meditation have similar abilities. "In a way it makes perfect sense," he says. "They spend thousands of hours practicing this, while we spend that time doing other things," he says.

A new medical test released last month suggests Hof may be able to exercise some influence over other body functions considered involuntary. "We have one result, from one person, that is extraordinary, but it doesn't prove that meditation is responsible," said Professor Peter Pickkers of Nijmegen's Radboud Medical University, who oversaw the test and has no commercial ties to Hof.

The Iceman was injected with endotoxin, a component of bacteria. Although harmless, the bacterial material essentially tricks the body into thinking it is under attack. In most people, exposure provokes flulike symptoms: headaches, muscle pain, and fevers. These last several hours and then go away with no lasting ill-effect. Hof reported experiencing only a mild headache. Pickkers said the unexpected part came in the laboratory: Hof produced only half as much inflammatory defense protein as average among more than 200 other healthy male test subjects. The apparent reason, Pickkers said, was a sharp rise in levels of cortisol, the "stress hormone" known to suppress the immune system. Hof appeared to be intentionally influencing a system thought to be automatically regulated, Pickkers said. "If you get into a fight on the street, and your heart races, that happens by itself, you can't just summon it up," Pickkers said. "What he has shown is that he can with his meditation, apparently, summon it up that his cortisol rises like that." He said the next step would be to see whether others using similar techniques can do the same.

Cohen found the Nijmegen results intriguing. "It would be unwise to ignore this just because we don't understand the mechanism," he said. Cohen, who is also a former professional tennis player, says science is divided about whether cold water or sauna treatments actually aid athletes, though many use them. One theory is that forcing blood vessels to contract and expand can strengthen them and improve circulation. Athletes often use cold baths after practice to reduce muscle inflammation and soreness. However, Cohen said it would

be difficult to conduct a rigorous test of whether meditation in cold conditions could benefit sick people, since it would be unethical to put them at risk.

Hof tells his students at the Rotterdam workshop that viewing mental and physical training as separate may hinder their performance during competition. "Technically you're completely trained and ready and everything," he says. "But there is still a difference between how you feel — the flow isn't there — because there's no unity," he says, gesturing to his head and chest. Hof describes the three main elements in his method as controlled breathing, paying close mental attention to signals coming from the body, and crucially, keeping an open mind. Edith Bosch, who won silver and bronze medals in judo at the 2004 and 2008 Olympics, said her only remaining goal is gold. "If this helps me improve, to cope better with matches, then, yeah, it's definitely worth the effort to try," she says.

Hof says that as he grows older, he wants to avoid what he calls the "circus sideshow" of extreme physical tests, and become more of a teacher. But daredevil habits die hard. To prove that he can also adjust his "inner thermostat" downward, he's planning to run a marathon in desert conditions — without drinking any water. Pickkers, aware of this plan, shakes his head in dismay. "I have warned him not to do this, it can be extremely dangerous or lethal," he said. "But if you had asked me ahead of time whether I thought he would have had a different reaction than anybody else to the endotoxin test, I would have said, 'no.'"

Sterling reported from Amsterdam.

de Gelderlander

Iceman lijkt zijn zenuwen de baas

door Hans Gulpen woensdag 20 april 2011 | 08:04 | Laatst bijgewerkt op: woensdag 20 april 2011 | 09:19

NIJMEGEN - Kou kan hem niet deren. Vorige week vestigde 'Iceman' Wim Hof in Lapland nog een wereldrecord: ongetraind liep hij de tien kilometer op blote voeten en gekleed in slechts een korte broek. Het vroor tien graden. Zijn tijd: 56 minuten.

Eerder beklom de Amsterdammer blootsvoets besneeuwde bergen en zwom hij op de Noordpool, onder een veertig centimeter dikke ijslaag door. Ook stond hij ongekleed bijna twee uur tot aan zijn kin in een bak met ijsklontjes. Hoe dat kan? Wim Hof is in staat zijn zenuwstelsel aan te sturen. Hij is zijn zenuwen letterlijk de baas. Daardoor kan hij delen van zijn lichaam afsluiten van de kou. Dat doet hij door opperste concentratie. Hij mediteert.

De bewering van Hof dat hij zijn autonoom zenuwstelsel beheerst en reacties van zijn immuunsysteem kan onderdrukken, wordt nu voorzichtig onderschreven door wetenschappers van het Nijmeegse academische ziekenhuis UMC St Radboud, die de

Iceman onderzochten. Hoogleraar experimentele intensive caregeneeskunde Peter Pickkers noemt de resultaten van het onderzoek 'opmerkelijk'. Want volgens de huidige medische inzichten is wat Hof kan eigenlijk onmogelijk. Niemand is de baas van zijn autonoom zenuwstelsel. Daarom heet het 'autonoom'.

De Nijmeegse onderzoekers dienden Hof en 240 andere proefpersonen endotoxine, een deel van een dode bacterie, toe. Pickkers: "We zagen in zijn bloed dat hij veel minder ontstekingseiwitten aanmaakte. Gemiddeld was de immuunrespons van Hof 50 procent lager. Bovendien vertoonde hij nauwelijks griepsymptomen."

Hof, die vandaag 52 jaar wordt, zegt 'meer dan verheugd' te zijn over de resultaten van het onderzoek. "Zelf wist ik al lang dat het kan, maar nu is het ook aangetoond."

Artikel Nu.nl 26 05, 2010

Wat 'the Iceman' kan, kan niet

NIJMEGEN - Wim Hof is bekend als de man die in staat is om naakt vijf kwartier lang in een bak met ijs te blijven zitten.

The Iceman, zoals zijn artiestennaam luidt, probeert zijn kouderecord steeds te verbeteren.

Twee Nijmeegse wetenschappers hebben vorige week tijdens de try-out voor een optreden zijn lichaamsreacties gemeten en komen woensdag tot de conclusie dat het medisch gesproken onmogelijk is wat the Iceman kan. Hoogleraar fysiologie Maria Hopman: ''Hof lijkt zijn autonome zenuwstelsel te kunnen beïnvloeden, wat normaal gesproken onmogelijk is. Ook lijkt hij bewust zijn bloedvaten te kunnen openen en sluiten.'' Haar collegahoogleraar en internist Mihai Netea heeft vastgesteld dat de cellen in Hofs bloed zelfs na zes dagen in het laboratorium nog anders reageren dan gewone bloedcellen. De hoogleraren zijn zo geïntrigeerd door wat er in het lichaam van the Iceman gebeurt, dat zij zo snel mogelijk samen met Wim Hof nader wetenschappelijk onderzoek gaan doen.

Temperatuur

De meetgegevens hebben uitgewezen, dat de lichaamstemperatuur van the Iceman constant op 37 graden Celsius blijft, terwijl hij in het ijs zit. Ook blijft zijn hartslag laag en zijn bloeddruk normaal. Zijn metabolisme stijgt binnen enkele minuten, nadat hij in het ijs is gezakt, met 300 procent. ''Hof kan kennelijk zijn kachel wel drie keer zo hoog opstoken. Hij

rilt en bibbert ook niet, wat het lichaam normaal gesproken doet om warm te worden. We begrijpen niet hoe dat kan'', aldus Hopman, die ook bekend is door haar onderzoek naar de fysiologie van Vierdaagselopers en hardlopers.

Bloed

Netea onderzoekt in juni het bloed van Hof opnieuw, nadat er bepaalde stoffen aan zijn toegevoegd. Zij en Hopman hopen daarmee uit te vinden hoe the Iceman de weerstand van zijn boedvaten kan variëren, wat gewoonlijk geen bestuurbaar mechanisme is. Een groep van tien mensen gaat onder leiding van Hof proberen om op dezelfde manier hun geest te beïnvloeden.

Mensheid

Hof zelf zegt: ''Het gaat mij niet om de ijscapriolen. Ik wil de mensheid helpen. We kunnen veel meer met ons immuunsysteem. Dat is belangrijk voor allerlei ziektes.'' The Iceman benadrukt dat hij het net zo koud zou hebben als iedereen als hij zich niet bovenmatig zou kunnen concentreren. Het Nijmeegse onderzoek is de eerste wetenschappelijke poging om vast te stellen in hoeverre iemand bewust kou kan weerstaan.

Bron: Nu.nl / Copyright ANP

LIFE

Title: Cold comfort: Wim Hof has an astounding resistance to freezing temperatures. (LIFE)(Cover story)

Date: December 11, 2009 **Author:** Fraser, Stephen

On September 16, the guests on Live/ with Regis and Kelly included actor Megan Fox (Transformers: Revenge of the Fallen) and tennis superstar Serena Williams. But it was Wim Hof who stole the show. Wim who?

Hof is a 50-year-old athlete from the Netherlands. On that day's show, Hof, wearing nothing but a pair of shorts, climbed into a tank and was buried up to his neck in ice. Not only was Hof unfazed by the extreme cold, he seemed to enjoy it. Hof, who calls himself "The Iceman" set a Guinness world's record that day for "longest full-body ice contact": 1 hour, 43 minutes. "I like to go to the limits of my physical and psychic being," Hof told Kelly Ripa. Scientists are gradually probing the source of Hof's amazing powers of endurance.

HUMAN POPSICLE

Most people, when exposed to extreme cold, risk getting frostbite. The body automatically goes into survival mode and shuts down the flow of blood to the legs and arms, diverting it

to the vital organs (the heart, lungs, liver, and kidneys). The skin then starts to freeze. It tingles, burns, or loses all feeling, and turns white or yellow. If the freezing penetrates to the bone, the tissue may swell, blister, turn black, and die. Hypothermia also occurs when the body's core temperature drops lower than 35 degrees Celsius (95 degrees Fahrenheit). Signs of life (pulse, breathing, blood pressure) fall below normal, and fatigue and weakness set in. Eventually, the person loses consciousness and could die after more than an hour. In ice water, hypothermia sets in after just 30 minutes of exposure.

None of that happened to Hof in the ice tank. "His skin was still pink," says Kenneth Kamler, the attending physician at the TV show. Turning himself into a human Popsicle is nothing new for Hof. In 1999, he ran a half marathon in Finland in his bare feet, 160 kilometers (100 miles) north of the Arctic Circle. The ground temperature was -37 degrees Celsius (-35 degrees Fahrenheit). In 2002, Hof swam a distance of 80 meters (260 feet) under the ice at the North Pole. And in 2007, he attempted a climb of Mount Everest, wearing only shorts and sandals. He reached an altitude of 7,400 meters (24,280 feet). Everest is 8,850 meters (29,035 feet) high. Altogether, Hof has broken at least 10 world records for exposure to extreme cold.

INNER FIRE

Mount Everest is located in the Himalayas, where Buddhist monks practice a form of meditation called tummo, which means "inner fire" in Tibetan. The monks, wearing only loincloths, meditate in below-freezing temperatures at high altitudes. By visualizing fire and heat, they are said to be able to control the flow of blood in their bodies and stay warm, resisting frostbite and hypothermia. In one amazing feat, the near-naked monks are draped in wet sheets while they sit on glacial ice. Within minutes, their bodies dry the cold sheets. The ice around them melts too. Hof has practiced tummo for years and is thought to be the only non-monk to have become successful at it. "He's able to endure cold because he's able to change his body's physiology," contends Kamler. "He's able to call forth some powers that lie dormant in most of us." Kamler has followed in some of Hof's footsteps. "I have been in sustained extreme cold in Antarctica and on Mount Everest," he told Current Science. "I survived, as virtually all Westerners do, by creating a microenvironment around me---clothing and shelter--that protected me enough to tolerate the cold. What Wim does is very different. He exposes himself to the cold and adapts to it."

COLD SHOCK

Last year, scientists at the hypothermia lab at the University of Minnesota tested Hof. They examined his heart rate, breathing rate, and core temperature after he had submerged himself in a tank of extremely cold water for 35 minutes. The normal response to immersion in frigid water is called the cold-shock response. The blood vessels constrict, the heart beats faster, and the breathing rate accelerates. Panic may set in too. From there, the body

enters the cold incapacitation phase. The pain of the cold subsides, and numbness sets in. Breathing returns to natural rate, and to shiver to generate extra heat Hof wasn't shivering when he withdrew from the tank. He showed no signs of pain or damage to his skin. He "obliterated" the normal response to cold, says hypothermia researcher Larry Wittmers. Exactly how Hof--and the Tibetan monks--manage to control the flow of blood through the body and obliterate that response is still a puzzle. "It's a mystery that we have not yet come close to solving," says Kamler. "It tells us that there's enormous potential within the brain that is going untapped. And if we can study them more, and study people like them more, maybe we can unleash that potential for the rest of us.