



THE WIM HOF METHOD EXPLAINED



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By Isabelle Hof, June 2015

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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 Radboud University. Initial results have shown that the method appears to affect the autonomic 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 is leading training sessions and workshops, and he is giving interviews to national 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 which fields the method can be applied to.

History

Wim Hof has trained his body and spirit in hard natural environments, particularly under conditions of extreme cold. Under these circumstances, breathing and *mindset* enhance the ability to withstand such extreme temperatures. Through enhancing his resilience in the face of extreme conditions using these techniques, Wim has been able to constantly explore his own physiology and mental capacity in greater detail. In doing so, he has continually developed and perfected his method over the years, constantly shifting his goalposts higher and higher.

Wim's 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, as well as many others.

In 2007 Wim Hof was examined by the well-known *Feinstein Institute*. The results showed that Wim Hof appeared to be able to influence his autonomic 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 this report.

Method

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

There are various methods that separately deal with breathing techniques, the training of 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 and 2014; Kamler, 2009). The method consists of three components that reinforce each other and is characterized 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, the above mentioned components will first be separately highlighted, followed by an explanation why the interaction between these three components is so effective.

Breathing practices

Regulated by the autonomic nervous system, inhaling oxygen is an unconscious process. Fortunately it's an unconscious praxis, otherwise we simply wouldn't have a break, as we'd have to deal with it incessantly. The amount of oxygen that we inhale through our breathing influences the amount of energy that is released into our body cells. On a molecular level, this progresses via various chemical and physiological processes. Breathing is the easiest and most instrumental part of the autonomic nervous system to control and navigate. In fact, the way you breathe

strongly affects the chemical and physiological activities in your body. Throughout the years, Wim Hof has developed special breathing exertions that keep his body in optimal condition and in complete control in the most extreme conditions. The breathing technique is first and foremost premised on inhaling deeply and exhaling without any use of force!

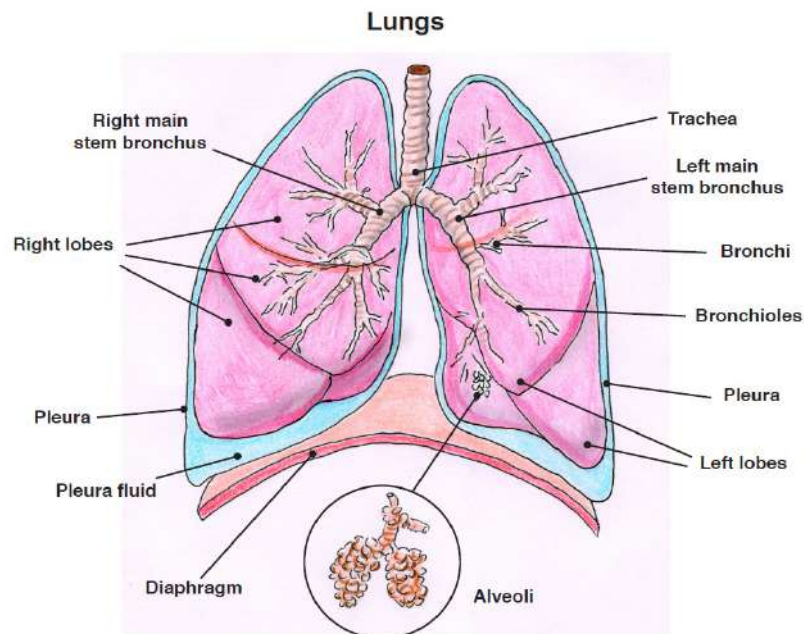
Hof: "By not breathing out entirely, you come to a point where a residual of air remains in the lungs. After doing this thirty times, you exhale again without any use of force. This time though, you don't immediately inhale again, but wait with inhaling until you sense your body needs new oxygen. After this, the whole process starts again. While you start to sensations of lightness, laxity and tingling, these rounds are repeated a number of times".

By training you breathing actively, you increasingly gain control over a range of physiological processes in the body. To really grasp why these breathing exercises are such an essential component in the WHM, we will first delve deeper into the physiological impact of respiration on the body.

Physiology: breathing, body and blood

Breathing is the ultimate life source. Every day, we inhale and exhale on average 20.000 times to make sure we absorb sufficient oxygen. Oxygen (O₂) is delivered through our lungs, whereas carbon dioxide (CO₂), which is just a byproduct, (that your body nevertheless needs) flows out. Our lungs have a hierarchical branch structure and consist of two parts (the left and right lung). The respiratory system supplies oxygen so that the air can be transported via the primary bronchus to the bronchiole (the smaller respiratory tract). These bronchioles effuse into lung bubbles, where oxygen and blood cohere. During this diffusion, O₂ is absorbed via the blood, whereas CO₂ is dissolved. This process is a biological process known as gas exchange. After this exchange, oxygen rich blood is transported to enter the body cells.

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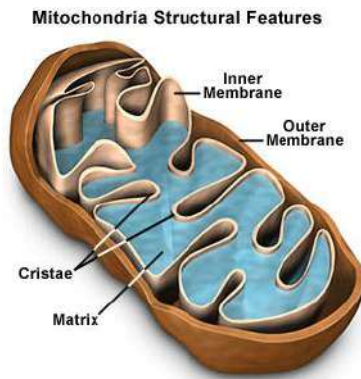
representation of lungs

Due to their great elasticity, lung bubbles generally have significant diffusion capacity. Hence, the so called “diffusion surface” is where the exchange between O_2 and CO_2 takes place. When you breathe calmly, this can stretch up to 70 m^2 , yet when you inhale deeply this can expand to 100 m^2 (Mandigers & Van Straaten-Huygen, 2004 p.290 up to p.316). The WHM breathing technique is designed as such that anyone can reach the largest surface possible. By practicing the breathing technique, you will influence the ratio between O_2 en CO_2 in the blood. Based on scientific research (Kox et al., 2012), Wim Hof’s blood levels indicated, after 30 minutes of implementing the breathing technique, a significantly low dose of CO_2 . After an hour, the CO_2 -levels were even lower. On top of this, the amount of O_2 -consumption had doubled after 45 minutes.

On oxygen and body cells

What happens with the oxygen when it enters the body cells? For starters, oxygen will convert into CO_2 and H_2O , which takes place in the mitochondria.

These double membrane-bound organelles are one of the organs of the cell that

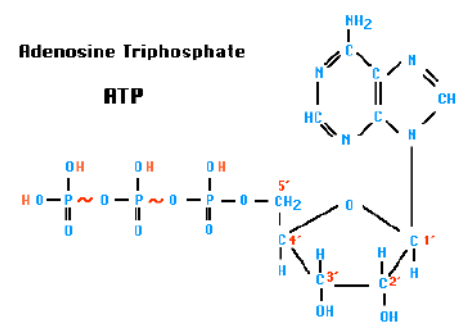


are responsible for releasing energy, all with the purpose for our bodies to function properly. Hence, they are the energy suppliers of a cell. The demolition of nutrients is connected to the transference of oxygen. This results in a molecule known as ATP (adenosine triphosphate). This mechanism is named **aerobe dissimilation**.

This atom is essential in virtually any bodily activity, from the motion of our muscles to the transfer of nutrients and waste materials in and from the cells. Furthermore, ATP is essential for the generation of electrical signals in the nervous system. without oxygen (and adequate nourishment) there simply would be no ATP. put differently: without ATP we simply wouldn't be able to move, let alone have the capacity to think.

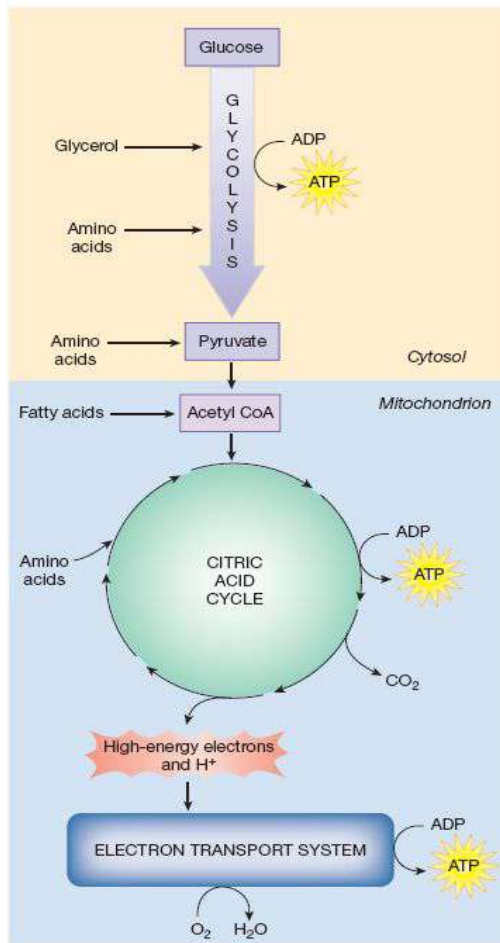
One of the pillars of the WHM is to increase stamina.

When practicing the breathing techniques, by thoroughly inhaling and exhaling, people often become aware of just how easy it is to do a round of push-ups during the inhaling process. The efficacy of these breathing techniques can be explained down to the molecular level within the cells.



Is oxygen vital for producing ATP?

No, ATP can also be produced in the absence of oxygen. For example, when we fully exert into any kind of activity, the oxygen levels in our blood then decrease to



adequately supply all cells with this atom. This process is called **anaerobic dissimilation** and is highly inefficient.

The relation between oxygen use, the demolition of nutrients and the production of ATP

To get the most out of a glucose molecule, the metabolic route (as shown in the representation) should be progressed entirely. In the first phase, glucose is converted into pyruvate. This process is termed glycolysis and results into two ATP molecules. When there is sufficient oxygen in the cell, pyruvate is conveyed in the mitochondria, where it is further dissected into acetyl CoA to enter the citric acid cycle. This process results in one molecule of ATP.

Subsequently, in the Electron Transport System, the production of ATP molecules is connected to the ingestion of products stemming from the citric acid cycle, where oxygen is simultaneously converted into CO₂ and water.

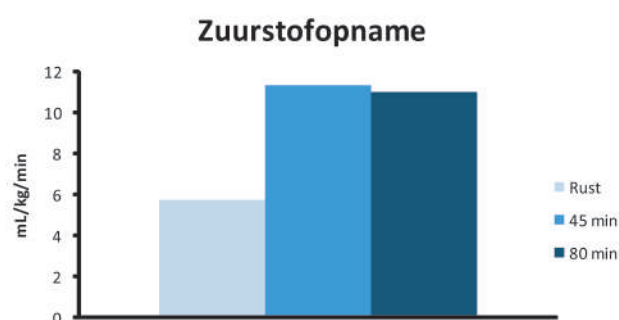
When this process has been fully completed, **1 molecule of glucose has generated about 30-32 ATP molecules**. Be aware: this will only occur when there is enough oxygen. When you feel out of breath during an extensive work out, this often means there is insufficient oxygen to finish this process. Thus, your muscle cells then can only make use of the first part of the route, namely the glucose, which **per glucose molecule results in two ATP molecules**. In doing so, this is highly inefficient. To make matters worse, the pyruvate is also altered into lactic acids, which lower the pH-values in the body, making the body more acidic.

What happens with your blood levels during breathing exercises?

By thoroughly inhaling and exhaling while doing the breathing exercises, you will

consume a lot of oxygen. In addition to this, the concentration of CO₂ lessens almost immediately. While doing so, a shift takes place in the CO₂ and O₂ ratio in the blood. By systematically and deeply breathing in and out, the pH-value in the blood increases (making the blood more alkali) whereas the acidity lessens. Normally, on average the pH-value is 7.4. By exerting the breathing techniques, this becomes significantly higher. During the E-coli experiment, values have been measured up to 7.75. As such, bodily cells can produce (via aerobic dissimulation) ATP much longer and far more efficiently, while at the same time prevent the production of lactic acids. Having said that, the values in the blood will normalize after some time.

Histogram 1: Oxygen consumption measured on Wim Hof, before, after 45 minutes and 80 minutes after the breathing exercises



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 realize your inner strength. Concentration/meditation is an important part of this. This concentration is required for 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.

Autonomic nervous system and concentration techniques

Normally, the autonomic nervous system is independently and subconsciously regulated by the body. The autonomic 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 autonomic nervous system.

It has emerged from a variety of studies, however, that certain concentration/meditation techniques can result in independent, autonomic 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 autonomic 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 autonomic nervous system and the (natural) immune system. During the course of this experiment, components of E-coli bacteria were injected into Wim Hof and 112 other trial participants. The test subjects were injected with this bacteria in a previous study. 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 produced less than half the number of inflammatory proteins in comparison to the average of the test subjects who were injected with this bacterium. 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.

When you think about it, it is quite outstanding that it is possible to influence your immune system by practicing a method. The question was: is Wim Hof just an extraordinary case? And can his achievements be attributed to the fact that he practiced this method for many, many years? Or can others also regulate their immune system by doing what he does? Hof is a strong believer that anyone can accomplish what he has realized. In 2013, a research team consisting of Kox en Pikkers (Kox et al.,2014) examined whether others were also capable of influencing their immune system and autonomic nervous system by practicing the Wim Hof Method. To get to the bottom of this, Hof trained 12 Dutch volunteers over the course of 10 days (4 days in Poland with Wim and 6 days at home alone). The volunteers practiced all the ins and outs of the breathing techniques, the meditation techniques (in order to gain superior focus) and were additionally gradually exposed to frosty conditions.

Back in the Netherlands, 24 volunteers –the 12 test subjects that trained with Wim Hof in Poland and a control group of 12 people- received an injection with elements of the E-coli bacteria (the same dose that Wim Hof received in previous studies).

Under normal conditions, the body can react quite strong to this, resulting in almost all cases in flu symptoms. Remarkably though, the volunteers that had practiced the WHM reported far less signs of influenza (meaning symptoms of nausea, headaches, shivers and muscle and/or back pains) than the control group. In addition to this, the body temperature of the first cohort didn't increase as much in comparison to the control group.

Similarly, the body temperature of individuals belonging to the test group normalized much faster than those who didn't practice the techniques. Even more important were the blood results. As the studies revealed, the blood values of the test group indicated ***far less inflammatory proteins than the control group***. As a consequence of practicing the WHM, the test group produced more stress hormones. This hormone is released by enhanced activity of the sympathetic nervous system, which can suppress the natural response of the immune system. This is pretty extraordinary, particularly when you consider that for decades on end the standpoint in medical discourse has been that the autonomic nervous system *cannot* be influenced. The blood results however, unequivocally demonstrated that the autonomic nervous system and immune system *can* be regulated. ***And has thus far never been proven scientifically. Another remarkable finding is that the immune system can be improved even after a relatively short training session. Tests even showed that showed that even "normal" people are more than capable of channeling their immune system. The research results have fervidly demonstrated that by practicing these simple yet effective techniques within a short timeframe, anyone can gain more control over their health.***

The study also showed that the autonomic nervous system can be influenced. The difference between this study and others (Lush et al., 2009; Phongsuphap, Pongsupap, Chandanamatta & Lursinsap, 2008; Wu & Lo, 2008; Paul-Labrador et al. 2006) on the influence of concentration/meditation on the autonomic 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 autonomic nervous system in the above case.

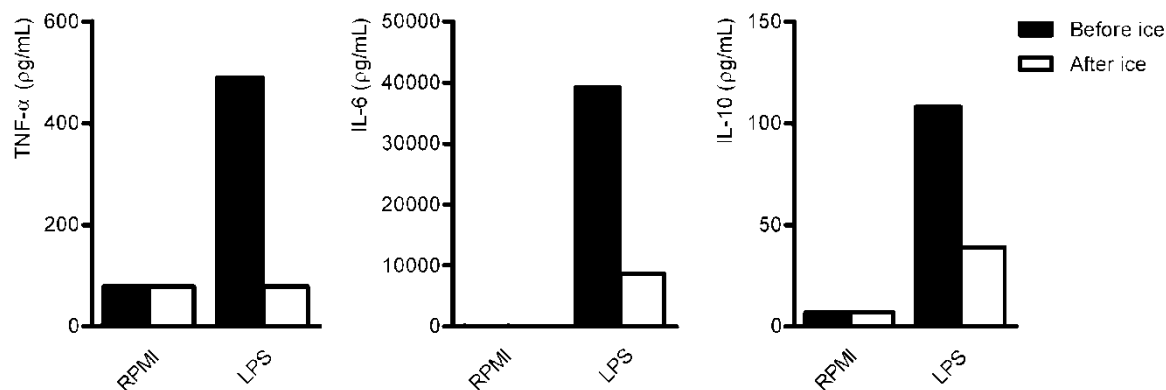
The outcome of multiple tests also outlined that Wim Hof and those who practice his method are able to actively increase the concentration of stress hormones in their bodies. In the process, the production of inflammatory proteins decelerates. By doing so, it appears as though a stress reaction, the typical *fight of flight* response, can be steered. 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 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 heat 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 autonomic 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.*** Due to the exposure to ice, the number of inflammatory proteins had almost decreased to zero (view the histogram for the results). The reason for this is that increased levels of cortisol had been registered in the blood circulation.

Surprisingly, the results also revealed that white blood cells showed a lower production of cytokine, even after 6 days.

Histogram 2: The effects of exposure to ice on LPS (bacterial membrane compounds) induced cytokine production in white blood cells.



The bar charts above demonstrate that the production of cytokines (inflammatory proteins) as a response to the inoculation of LPS (components of bacteria), are much lower in white blood cells stemming from blood samples that were taken during exposure to alidity. The inflammatory protein TNF- α (Tumor necrosis factor- α) plays a major role in inflammation processes and the acute phase protein. In fact, it is a decisive factor in the development of inflammation related diseases such as arthritis and Crohn's disease. Heightened levels of inflammatory proteins can stir an increase in inflammations that can cause necrosis of the tissue. On top of this, the protein is commonly associated with all kinds of physical ailments, such as fatigue and anemia. IL-6 (Interleukine-6) is a protein that can trigger influenza symptoms, particularly among individuals with autoimmune diseases and infections. IL-10 (Interleukine-10) on the other hand, is an anti-inflammatory protein that counteracts the effects cytokines such as TNF- α and IL-6. Presumptively, the low production of this protein is due to the fact that the production of TNF- α and IL-6 is also low.

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, hypothermia 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 3 minutes (Stephen, 2009).

However, Hof manages to influence his body to such an extent that he is not yet undercooled after 80 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 2 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 autonomic nervous system - and thus the temperature - are automatically and autonomic regulated by the body. According to Hopman, Hof appears to be able to influence his autonomic 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 autonomic 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 to 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 et 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 adipose on PET-CT scans of healthy young man

Thermo neutral temperature



Cold exposure



Source: The new England journal of Medicin

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 36.4°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 ice

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. The breathing technique is to activate various physiological responses and will energize and strengthen the body. Furthermore, practicing the breathing technique changes the ratio between the concentration of O₂ and CO₂- levels; the CO₂-concentration will significantly decrease. Balancing this correlation will optimize the functions of the body. At the same time, they can activate or ease down the immune system. 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 autonomic 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.

Science

In 2007, Wim Hof was examined at the renowned *Feinstein Institute* and the results show that Wim Hof appears to influence his autonomic 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 remarkable ability of the results obtained, a follow-up study was rapidly initiated.

In 2011 this resulted in the endo-toxin experiment. The aim of this study was to see whether the concentration technique practiced by Hof can influence the immune system. The immune system is part of the autonomic 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 practiced 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 and cytokine levels 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 endo-toxin 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 level 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; they still produced lower inflammation proteins.*

To check whether it was only the concentration technique that led to an increase in the cortisol level, 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 level 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 analyzed. 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 which took hold for about 10 minutes. 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 level 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 autonomic nervous system, raising the question whether the method can also be learned by others. After all, the ability to influence the immune system and the autonomic nervous systems would have major consequences for the health care industry.

Given that health is a diligent matter and to make sure people are not given false hope, we decided to intensify our collaborations with Radboud University. Under the supervision of Kox and Pickkers (2013), research has been executed in which practicing the WHM -and more specifically, whether we are all capable of regulating our autonomic nervous system- was severely put to the test. Thirty participants were randomly categorized in either the experimental group or the control group. The cohort (n = 18) that took part in the experimental group was subjected to Hof's training regimen in Poland over the course of 4 days and continued to practice the techniques at home for 6 more days. The training consisted of 1) meditation that was focused on full relaxation, 2) gradual exposure to cold. The test subjects walked in snow barefoot for 20 minutes and climbed a mountain of 1590 meters wearing nothing but a pair of shorts. While doing so, they endured temperatures varying from -5 en -27 degrees Celsius and 3) Hof's controlled breathing exercises. When the participants returned home, they continued their practices up until the endotoxin experiment (for 6 days). To give an example: for the cold training they took cold showers every day.

One day prior to the endotoxin experiment, the experimental group participated in a final training session with Wim Hof. From the 18 volunteers that took part in the experimental group, 12 volunteers were randomly assigned to take part in the endotoxin experiment. Both the control group as well as the experimental group received injections with elements of the E. Coli bacteria. Throughout the 3 hours of

the experiment, the participants from the experimental group practiced the breathing and focus techniques under the supervision of Wim Hof. The control group did not.

Again, the test results showed that those who did participate in the training showed far less signs of influenza than those who were categorized in the control group. The blood results verified this: the experimental group produced less inflammatory proteins (such as TNF- α , IL-6 and IL-8) than the control group. Similarly, the experimental group produced more anti-inflammatory proteins (cytokine IL-10) than the control group. The researchers also concluded that this experiment confirmed that a clear voluntary activation of the autonomic nervous system triggers an increase in the production of the stress hormone adrenaline. In turn, this resulted in a suppression of the activation of the immune system.

*The website www.wimhofmethod.com provides 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 practiced 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/her autonomic 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 a 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

According to various tests the WHM has a number of health benefits. The Endotoxin experiment and the publication of this particular test in PNAS showed that Wim Hof and the test subjects who took part in the training sessions produced more stress hormones such as cortisol and adrenaline.

Stress hormones suppress 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 practicing the WHM has a favorable effect when it comes to maintaining brown fat levels. The following is a description of the effects of the WHM on various types of physical illnesses.

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 defense system. Under normal circumstances, the body produces defense 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 defense cells erroneously produce protein bodies that cause inflammation of, for example, the joints and tendons (Reumafonds, 2012). The body thus attacks itself. As practicing the method can result in temporary accrual of stress hormones in the blood, the WHM method could potentially have a positive effect on this.

While doing so, this can also lead to a limitation of inflammation bodies, which in turn can result in a reduced risk in developing inflammation in the joints and tendons. People who suffer from autoimmune diseases such as rheumatism, can as such profit from the WHM. Further research is needed to show this.

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 blood flow.

Through exposure to cold you train these little muscles within the blood vessels and by this blood will flow more fluently through your vessels.

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 are supposed to have none or hardly any. It has emerged from the study, however, that adults still have some 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).

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. This could effect in a faster loss of body weight.

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 very effective in generating more energy. By practicing the breathing exercises, waste materials are more easily released. As such, the body is thoroughly cleansed. In effect, the released energy is not just beneficial to the body, but also for overall energy balance. In addition, by practicing the technique, your body will release high doses of adrenaline, which releases energy immediately. Furthermore, 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.

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 like Laird Hamilton, Allistair Overeem, Maarten Hermans and Janneke Vermeulen, among others.

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