Some like it cold

Cold-water swimming is all the rage, but do the health claims stand up to scrutiny? **Alison George** investigates

"IT'S like pressing Control-Alt-Delete on a computer," says Cath Pendleton. "When I'm in the water, I'm so focused on my body, my brain switches off. It's just me and the swim."

Pendleton, an ice swimmer based in Merthyr Tydfil, UK, is hardier than most. In 2020, five years after discovering she didn't mind swimming in very cold water, she became the first person to swim a mile inside the Antarctic circle. Part of her training involved sitting in a freezer in her shed.

She is far from alone in her enthusiasm for cold water, however. Thanks to media reports of the mental health benefits of a chilly dip and pool closures due to covid-19, soaring numbers are now taking to rivers, lakes and the sea – once the preserves of a handful of seriously tough year-round swimmers. An estimated 7.5 million people swim outdoors in the UK alone, with an increasing number swimming through the winter. Global figures are hard to come by, but the International Winter Swimming Association has seen a boom in registered winter swimmers around the world, even in China, Russia and Finland, where water temperatures can drop below 0°C.

But is there anything more to it than the joy of being in nature, combined with the perverse euphoria of defying the cold? According to the latest research, the answer is maybe. Recent studies have begun to turn up evidence that cold-water immersion may alleviate stress and depression and help tackle autoimmune disorders. It might even tap into a hibernation mechanism shared by all mammals to protect the brain, potentially offering new treatments for dementia.

The idea that cold water can shock the body back to health isn't new. In Victorian Britain, the great and the good flocked to the spa town of Malvern to take the "water cure", a treatment that involved being wrapped in cold, wet sheets and taking regular cold showers and baths. Nursing pioneer Florence Nightingale credited it with restoring her health after the Crimean war. Charles Darwin believed it cured him of fatigue and stomach pains. "I feel certain that the Water Cure is no quackery," he wrote at the time.

The practice fell out of favour in the 1870s, but now the popularity of getting cold to feel good is on the rise again, prompting scientists to start looking at whether it works. Much of the research so far has focused on the fact that plunging a warm body into cold water brings about some very predictable physiological changes, some of which may affect health.

The first thing to happen is a "cold shock" response stimulated by cold receptors on the skin. Studies by Mike Tipton at the University of Portsmouth, UK, who researches the effects of extreme environments on the body, suggest that this response is strongest in waters with a

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temperature of around 10 to 15°C. Below 8°C, the cold also triggers the skin's pain receptors.

The aim of the response is to signal imminent danger. "Water is so much more efficient than air at taking heat from the body," says Tipton. "Cold shock is an exaggerated fight-flight response to alert the body to all the heat it's losing." During cold shock, concentrations of the hormone noradrenaline, which prepares the body for action, shoot up to more than five times resting levels, while levels of dopamine, a neurotransmitter involved in reward processing as well as adapting to shock, are more than doubled. It is no wonder that swimmers feel invigorated after a chilly dip. "It's like an amphetamine rush," says Tipton.

On the downside, cold shock also causes a strong involuntary gasp, which is almost impossible to suppress, followed by hyperventilation. "This is the body's way of trying to get more oxygen into the system to deal with the emergency it senses," say Tipton. If this happens when your mouth is submerged, however, there is a high chance of inhaling a lungful of water, which could lead to drowning.

Plunging the body into cold water stimulates the release of a cocktail of invigorating chemicals

"There is evidence the benefits of cold water come down to 'what doesn't kill you makes you stronger'"

Shockingly cold

Heart attacks are another risk at this stage, even for people without existing heart conditions. While the cold-shock response revs up the nervous system, cold water on the face simultaneously triggers a "diving response" via the trigeminal nerve in the cheek, which slows down the heart rate and breathing. When the body tries to increase and decrease heart rate at the same time, the heartbeat can become dangerously irregular. Even if this isn't fatal on its own, it can incapacitate a swimmer for long enough to cause drowning (see "Swim safe", page 49).

Survive the initial shock, however, and there is evidence that the benefits of cold-water swimming come down to that familiar idea: what doesn't kill you makes you stronger.

We know that chronic stress harms the body, not least by increasing levels of inflammation, which is linked to long-term health problems including heart disease, cancer and depression. Acute stress, though, seems to do the opposite, allowing the body to habituate and become resilient to future stressors. This is a concept known as hormesis, and there is some evidence that building resilience to one kind of stress can help people adapt to another. In one study, volunteers who were immersed in cold water for 5 minutes showed an improved ability to exercise at low oxygen levels afterwards. "When we train our body to respond to an acute stressor, we are building fitness of our stress-response systems, much like we would build a muscle," says Elissa Epel at the University of California, San Francisco. "I believe that cold water is a beautiful way to build stress inoculation."

The full picture of exactly how this kind of "toughening" response might work is still being established. Epel is working on a trial using the methods of Dutch cold-water evangelist Wim Hof, also known as the iceman, who advocates a mixture of ice baths, meditation and breath control to build resilience and holds a number of world ›

Secrets of the ice swimmers

The "cold shock" response that occurs when suddenly entering cold water may turn out to be good for our health, but that doesn't make it pleasant. Still, practice helps. "As few as five 3-minute exposures can halve the cold-shock response," says Mike Tipton at the University of Portsmouth, UK.

Ice swimmer Lewis Pugh has taken this to the next level. His pre-swim routine, which often includes psyching himself up with rousing music, increases his body temperature by over a degree before he dives in. Researchers speculate that this happens because he is raising his body's adrenaline levels before entering the water.

Pugh still feels the cold, but other swimmers have trained their bodies to feel warm even in ice water. This "hypothermic adaptation" takes a lot of practice and isn't necessarily a good idea. "It's dangerous to take away the perception of getting into trouble as the body temperature cools," says Tipton.

No big deal: ice swimmer Lewis Pugh has trained his body not to panic when he dives into cold water

REUTERS

records for tolerating extreme cold.

In 2014, researchers at Radboud University in the Netherlands investigated one of Hof's bolder statements: that his regime can be used to control the immune system. They put his claim to the test, injecting him with a bacterial toxin that causes an immune response to see how his body would respond.

Blood tests revealed that Hof's adrenaline levels were unusually high at baseline, peaked during the breathing exercises he uses to prepare for cold exposure and which he also did before the injection. This was followed by an unusually low immune response to the toxin. A further study, using 12 healthy volunteers, yielded similar results, backing up Hof's claim that anyone could do the same.

The researchers concluded that the unusual immune response was to linked to the fight-or-flight response. The very high levels of adrenaline "correlated beautifully with higher levels of anti-inflammatory mediators", says Matthijs Kox, who led the study. This, in turn, correlated with lower levels of pro-inflammatory markers.

In 2019, Kox and his colleagues reported that Hof's intervention was safe for use in young people with rheumatoid arthritis. After eight weeks, people who followed Hof's regime "showed fewer symptoms and had lower inflammatory markers and a higher quality of life", says Kox. It isn't yet certain which aspect of Hof's technique gives rise to the effect. Kox's team has a study in the works to pick this apart, which should be published soon.

Inflammation may also be relevant to the many anecdotal reports that cold-water swimming helps to alleviate depression. So far, however, there is little in the way of hard evidence. A 2018 case report in the *BMJ* found that, for one woman, a programme of weekly cold-water swims resulted in an immediate lifting of mood. She was also able to stop taking medication for the depression and anxiety she had been experiencing for many years. The team behind the case study is working on bigger trials in larger numbers of people with anxiety and depression.

While the jury is still out on the mental health benefits of extreme dips, the news that got every cold-water swimmer's pulse racing came last year, with new findings about how exposure to cold water affects the brain in ways that may guard against dementia.

Regular winter swimmers have higher levels of a cold-shock protein known to protect the brain against degeneration

It has long been known that cooling can protect the brain – it is used medically after head injuries and during cardiac surgery – but it wasn't known why. An answer came from studying hibernation. When mammals hibernate, they cool down, their metabolism slows and the synapses that connect their brain cells are dismantled to save energy. In spring, when the animals awaken, their synapses are reassembled at a furious pace. This process is controlled by a cold-shock protein called RBM3, which is produced in the brain and other key organs in response to a drop in body temperature.

A loss of synapses is a key feature of dementia, so Giovanna Mallucci, who heads the UK Dementia Research Institute's centre at the University of Cambridge, and her team wanted to see what effect cooling had on both RBM3

"It may be possible to get similar effects by cooling only a small part of the body"

REUTERS/NEIL HALL

levels and synapses in mice with dementia-like symptoms. The results were striking: cooling the mice, and hence boosting the levels of RBM3 in their brains, "completely protects them from neurodegeneration", says Mallucci.

Due to the ethical difficulties of inducing hypothermia in healthy people, Mallucci wasn't hopeful about repeating the study in humans. But after discussing her research in the media, she was contacted by Martin Pate, who swims at London's Parliament Hill Lido throughout the winter. Together, they devised a study to test RBM3 levels in a group of 44 winter swimmers compared with a control group who practised tai chi at the poolside, while the swimmers were in the water.

The study, due to be published this year, found that the longer and more frequently that people swam in the water, which was between 4 and 14°C, the higher their RBM3 levels. The cold-shock protein wasn't found in the tai chi group. "It is a very strong trend," says Mallucci.

Mallucci didn't scan the swimmers' brains to measure their connectivity, but based on animal experiments, she speculates that increased RBM3 levels may have a measurable impact on their brains. "My prediction would be that it's going to protect from brain cell loss and keep their synapse levels nice and boosted," she says.

Mallucci is now researching the molecular pathway of RBM3's action, to see if levels of this protein could be boosted by drugs rather than freezing temperatures. If so, it might one day be possible that the brain benefits of cold shock will be available in pill form, offering a new way to treat neurodegeneration.

This would be good news, not only for people with an understandable aversion to the cold but also because it avoids the dangers of cold-water immersion, both from the initial shock and the longer-term effects of hypothermia.

Human survival depends on keeping core temperature between 36.5 and 37.5°C. At 36°C or below, the body starts to shiver to generate more heat. If this fails and the core temperature drops below 35°C, hypothermia sets in. If cooling continues, the result is unconsciousness and death.

Even in ice-cold water, it takes around 30 minutes to reach the point of hypothermia, but, during this time, cooling of the nerves and muscles makes the limbs slower to respond to the brain's instructions. This explains why it can be so challenging to get dressed after a dip in the sea, and why it can also lead to serious consequences, where even experienced swimmers become incapacitated and drown.

Given these dangers, it is encouraging that there might be no need to cool to the core. Tipton believes that many of the benefits of cold-water exposure come from the initial shock and changes in skin temperature. It may not even be necessary to chill the whole body. In studies, he found that when volunteers immersed only the right side of the body in cool water and became acclimatised to the cold shock, their left side became acclimatised too. Perhaps cooling an even smaller part of the body, say a hand or foot, might be enough? Tipton plans to look into it. "We don't yet know which areas it is important to cool and how long we need to cool them," he says.

And, while a quick paddle may not give you quite the same thrill as a full dip – nor the same bragging rights on social media – the health benefits may turn out to be much the same. ▮

Swim safe

Cold-water swimmer Cath Pendleton shares her tips for safe winter dips:

- **Never swim alone: nerve and muscle cooling can incapacitate even strong swimmers.**
- **Start slowly to allow your body to acclimatise.**
- **Don't dive in: the gasp reflex could mean you inhale water.**
- **Start in late spring and then swim all the way through the summer before the water gets really cold. If you start in the winter, be prepared to only be in the water for a minute.**
- **Warm up slowly afterwards: a hot drink will warm you from the inside, but a hot shower is best avoided because it can cause blood to rush to the skin and increase the risk of fainting.**

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