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Health effects of alpine waterfalls

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Abstract

Traditionally, numerous beneficial health effects have been attributed to waterfalls in various regions of the world, including areas around waterfalls in Austria. In most cases, the folk memory describes mitigating effects concerning respiratory diseases.

During a three-year field campaign we monitored five different waterfalls in the Hohe Tauern National Park and revealed a specific environment around different waterfalls. Breakup of small water droplets in the waterfall forms a specific nano aerosol comprising mainly negatively charged intermediate ions, which are assumed to trigger a variety of biological effects.

In randomized, controlled clinical studies, we addressed the question, whether the specific environment of different waterfalls provides beneficial effects on:

A) pediatric allergic asthma (Krimml waterfall, n=54, Hohe Tauern National Park Salzburg)

B) stress-immunology and burnout prevention (Gartl waterfall, n=102, Hohe Tauern National Park Carinthia)

C) lung and heart physiology, mucociliary clearance (Krimml and Gartl waterfall, n=450)

In *asthma bronchiale*, exposition to the aerosol of the Krimml waterfall significantly reduces the expression of pro-asthmatic and inflammatory cytokines, and induces immunological mechanisms leading to an improved sustainability of the positive effects on lung function and asthma symptom score compared to a control group. Exposition to the Gartl waterfall in combination with hiking in the Hohe Tauern National Park induces significantly higher antibody titers to cholera vaccine and significantly reduces stress compared to two control groups. Furthermore exposition to alpine waterfalls significantly accelerates the mucociliary clearance rate, alters lung physiology and has systemic effects on different parameters of the cardiorespiratory system.

In summary, we found and characterized positive health effects of waterfall aerosol on the human immunology and physiology thus providing a new health rationale for protecting alpine areas and their invaluable water resources.

Keywords

Waterfall, health, allergy & asthma, stress & burn-out

Introduction

Thanks to its natural environment, Austria is lucky enough to possess a multitude of healing climate regions with health promoting potential. A highlight among the various natural health resources of Austria is the Hohe Tauern National Park, with its still largely unexplored and untapped climate therapy and health tourism possibilities. The protected water resources within the Hohe Tauern National Park in particular offer entirely new health aspects with the Krimml Waterfall (Salzburg) and the Gartl Waterfall (Carinthia) being particularly noteworthy (HARTL et al. 2010).

As of December 1st, 2009, 50% of the Austrian population lives in urban areas (STATISTIKAUSTRIA 2012). And the European trend exceeds the situation in Austria by far: in Germany for example, 85% live in cities and agglomerations like the Ruhr, the Rhine-Main conurbation or the city cluster of Wiesbaden/Mainz/Frankfurt/Offenbach (UNITEDNATIONS 2007). This enormous lack of "natural experience" in industrialized countries is accompanied by a change of people's way of life (lack of exercise, crowding stress), in some cases with environmental health risk factors such as smog and fine dust. Known consequences are lifestyle diseases such as allergies and asthma, cardiovascular diseases, diabetes mellitus type 2, obesity, certain forms of cancer, skin diseases and the resulting mental disorders (GODFREY & JULIEN 2005; SCHOTTENFELD et al. 2013). For the treatment of these chronic illnesses and lifestyle diseases, the focus of medical science is being placed more and more on natural health resources as preventive and therapeutic remedies (KOCH et al. 2004). Against the backdrop of the increasing development pressure applied on the sensitive mountain regions by energy suppliers

and ski companies, the protection of alpine water resources also becomes an important medical measure (HARTL et al. 2010; KÖHLER 2012; ÖSTERREICHISCHERALPENVEREIN 2009; RIEDL 2009).

The medical effective agent of alpine waterfalls

A particularly valuable unique feature of the Hohe Tauern National Park, in terms of the healing climate, is the nano-aerosol, the nanometer-sized reparable atomized water droplets of alpine waterfalls. The charged nano aerosol is formed within micro seconds after the ionization of primary ions, due to hydration and cluster ion formation processes. Waterfalls mainly produce negatively charged ions, referred to as Lenard ions. As a result of the aerosolized water hitting the ground, the droplets created in the waterfall form dipoles with a negatively charged surface. Due to the waterfall wind, the negatively charged particles, atomized by thermophoretic processes, drift away from the waterfall, whereas the positively charged droplets quickly sink to the ground. This causes surplus of negatively charged air ions in the proximity of the waterfalls, which can be of the order of several 10.000 ions/cm3 air (KOLARZ et al. 2012). It is remarkable, that each waterfall has its own physical signature and different waterfalls thus have different effects on human physiology (KOLARZ et al. 2012; PARTS et al. 2007). In recent years we have conducted research on the physiochemical properties of waterfall aerosol and the physiological effect the aerosol of alpine waterfall have and its effect on allergic asthma and stress/burnout prevention in a series of randomized controlled clinical trials.

Physiological effects of waterfall aerosol on the human body

What is it that makes the waterfall climate so special? How far is a space in open countryside different from a place close to a waterfall? What effects does a waterfall have on human physiology and the respiratory tract after just a few minutes? On behalf of the Hohe Tauern National Park we investigated these questions in a randomized clinical crossover study with 60 test persons, using the results to create a "health map" of the Krimml Waterfalls. In comparison, to a control location in the open countryside of Krimml proximity to the waterfall creates a parasympathetic tonus (a relaxed state characterized by calmness and relaxation). The heart rate slows down and the better synchronization of abdominal and thoracic breathing as well as deeper inhalation improves blood circulation in the lungs. Overall, the transport of oxygen in the blood is facilitated, increasing oxygen saturation. A parameter of key importance for those suffering from asthma, the nitric oxide exhaled (FeNO) was particularly reduced on the orographic right side of the Krimml Waterfalls.

Allergies and asthma

Asthma and allergic rhinitis are among the most common chronic diseases worldwide. Since the 1950s, the prevalence (susceptibility to the disease) of allergies and asthma in Western Europe has increased drastically; now one third of the Austrian population suffers from allergies and 11 % of children are affected by allergic asthma. The allergy and asthma rate increases as communities adopt a Western lifestyle and become urbanized. According to current estimates, another 100 million people worldwide could be suffering from asthma by 2025 (BACHERT, LANGE & VIRCHOW 2005; BOUSQUET et al. 2005; EDER et al. 2006; EDER & VON MUTIUS 2004).

In a series of preclinical studies in a mouse model of asthma we evaluated the waterfall aerosol effect of three different alpine waterfalls (Gartl waterfall, Hohe Tauern National Park Carinthia, Krimml Waterfall Hohe Tauern National Park Salzburg, Stuibenfall Ötztal, Tyrol). Each individual waterfall is characterized by a specific physicochemical signature – and just the Krimml waterfall induced a bettering of lung function and an antiallergenic immunprofile in this controlled, placebo free mouse model of allergy and asthma. As a result of these preclinical studies we examined the Krimml waterfall aerosol's effect on clinical, functional, molecular and immunological parameters of allergic asthma in the human system: In an asthma camp, 54 patients aged 8 to 14 with mild and moderate bronchial asthma were tested on the effects of waterfall climate therapy on allergic asthma in a controlled randomized study setup and with completely identical living, housing and nutrition conditions (GAISBERGER et al. 2012).

For a period of three weeks, the children were divided into two groups. Every day both groups spent an hour outdoor exposition, the waterfall group close to the waterfall, the control group 6 kilometers away. Pulmonary function, breathing gas exhaled and two blood samples were tested and a combined symptom and medication value was determined.

Over the three weeks of exposure, the waterfall caused an anti-allergic and anti-asthmatic immune response in the young asthma patients. This positive and balancing immune modulation (reaction of the immune system) is characterized by a change in the ratio of allergic/anti-allergic biochemical messengers, the induction of anti-inflammatory messengers as well as the production of anti-allergic regulatory T-cells, and is specific to the waterfall - the control group did not show as many beneficial effects, especially not on a long-term basis.

- Only exposure to the waterfall improves pulmonary function by 30 % with a measured effective duration of at least two months.
- Even four months after exposure, the asthmatic symptoms of the "waterfall children" are still considerably alleviated compared to the control group.

This highly relevant data from a medical and health economy perspective (GAISBERGER et al. 2012) was used as the basis for the health tourism project Hohe Tauern Health, offering the benefits of the Krimml Waterfalls in combination with specialized anti allergenic hotels as a therapy option, which can already be booked by patients from all over Europe suffering from allergic asthma (www.hohe-tauern-health.at).

Stress and Burnout-prevention in the Hohe Tauern National Park

Stress is an omnipresent part of life and a stressful event causing hormones such as cortisol or adrenaline flushing our body and triggering a "fight and flight" response. Modern lifestyle, when everything from crowding in big cities, high-pressured jobs and busy traffic can keep the organism in an alarm state called chronic stress (NAKATA 2012). This affects people of all ages, genders and circumstances and can lead to a major psychological and physical health issue going along with high susceptibility to anxiety, depression, heart disease, metabolic syndrome, cancer and other concomitant medical phenomenon's of modern civilization and urbanization (ZACHARIAE 2009; GODBOUT & GLASER 2006).

The Gartl waterfall in the community of Grosskirchheim in the Hohe Tauern National Park in Carinthia produces a remarkable high concentration of negative air ions (>20.000 ions/cm3) compared to other waterfalls in the Eastern alps (KOLARZ et al. 2012). We have studied the effect of a daily 1h exposition in the particulate Gartl waterfall microclimate in combination with six hiking tours in the Hohe Tauern National Park in a randomized, controlled clinical study (n=102) with patients suffering from chronic stress. We have chosen a vaccination model using cholera vaccine for conducting this psychoneuroimmunological research in the intersection of climate therapy, behavior, neuroendocrine functions, immune response and health (PHILLIPS 2012). Daily exposition at the Gartl waterfall in combination with hiking in the Hohe Tauern National Park induces significantly higher antibody titers to cholera vaccine and significantly lower psychological and physiological stress levels compared to a non - intervention control group and a "hiking alone" group. Thus using the Gartl waterfall in connection with hiking tours in the protected Hohe Tauern National Park area as medical remedies boosts immune function via reduction of stress by acting on the hypothalamic-pituary-adrenal axis and their succeeding endocrine and immune pathways (HARTL et al. 2010).

The medical and psychological evidence is now the gateway for the development of health tourism products and prospective boost for regional added value in the Hohe Tauern National Park, Carinthia.

In summary, alpine waterfalls produce a distinct environment characterized by a negatively charged nano-aerosol. This specific microclimate acts on the human physiology and immunology and offers new therapeutic remedies for allergy and asthma and for chronic stress and burnout prevention. This scientific and medical evidence provides a new health perspective for relevant diseases of civilization and is a powerful argument for the protection of alpine areas and their invaluable water resources.

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