SCIENCE AT THE ENVIRONMENTAL RESEARCH STATION SCHNEEFERNERHAUS/ ZUGSPITZE

Prof. Dr. Michael Bittner; Ed.
(Coordinator Science Team UFS)

Umwelt
Forschungsstation
Schneefernerhaus

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17 Environmental Medicine in the Alpine Region

Claudia Traidl-Hoffmann and Volker Schiller
University of Augsburg, Institute for Environmental Medicine

17.1 Introduction

17.1.1 Environmental health sciences and environmental medicine

Until the turn from the second to the third millennium, our standpoint as medical researchers had been mainly defined [1, 2] by the science of the physical response, especially immune mechanisms, in case of disease. With the start of the 21st century, however, **the interactions between the body and its exposome** has become more and more the focus of health sciences. The exposome is either of biogenic origin, such as pollen and UV irradiation, or anthropogenic origin, such as air pollutants from traffic. Today, plenty of newly classified environments define various interactions. One exemplary environment are microbe populations that co-exist on the surfaces of bodies likewise from men and animals as well as on elementary materials such as soil and water or even on more abstract objects like industrial dust or pollen. Another environment comprises natural factors such as geographic characteristics or soil properties but also plant diversity and air conditions. (Psycho-)Social relations constitute another environment, with discernible effects on people's well-being and care. Many more environments have been and will be defined. All the environments interact with each other and with the body. Environmental medicine explores all possible environments and consequent interactions on a molecular level and in their full reciprocity with the body system.

17.1.2 Environmental medicine in the alpine region

At different altitudes exist alternating climatic, floric, and faunic conditions. Some alpine regions feature less harmful and less numerous environmental factors and additionally provide lower noise and stress levels. Patients with severe diseases who retreat to the alpine region often report a decrease in symptoms and a general uplift of mood and physical strength [3]. Now, **our research mission is to investigate the interactions and molecular mechanisms** that cause these benefits – with a focus on allergic diseases – and to make them applicable **for** diagnosis, **therapy, and prevention** of allergies and allergy related, chronic inflammatory skin diseases. Therefore, we as scientists and physicians perform patient monitoring and treatment together with a minute documentation of clinical parameters. We also precisely observe and measure environmental factors. As a co-benefit, this research delivers results about health effects caused by climate change and environmental pollution. Research in the alpine region, moreover, helps us to develop a set of educational measures: how to avoid risk factors, how to treat and prevent properly, and how to improve the quality of life for patients and relatives in rural and urban regions.

17.2 Basic information

17.2.1 Biology of pollen

Pollen grains primarily bear a natural mission: Pollen is produced for matters of reproduction by flowering plants such as deciduous trees, conifers, and weeds. This natural mission is an unitary adaptive function to reach a receptive stigma and to deliver two haploid nuclei to the recipient ovary in order to transmit genetic information from the male parent to the offspring. For fertilisation to be achieved, pollen must establish molecular congruity or compatibility with the stigma. Thus, there must be a continuous exchange of both physical and chemical signals between pollen and pistil from the moment a pollen grain arrives on the stigma to the moment the pollen tube enters the ovule (reviewed in [4]). Allergists and immunologists have neglected the view about the "natural mission" of pollen grains for the last decades. Instead, they have focused basically on the allergen alone. However, the immune system is not necessarily exposed to the allergen in pure manner, but rather in particulate form, either by pollen or by their starch granules. Most probably, a pollen grain that lands on the mucosal surface tries to find out whether it is on the right germination surface. Consequently, a cross talk similar to the natural process will start with the release of an array of substances from the pollen to become recognised – however, without success on men. Nevertheless, the nasal mucosa is exposed to all the substances responsible for the pollen-stigma intercourse. In summary, pollen resemble complex biological packages that deliver a composition in myriads of substances which – as discussed in detail below – do indeed have a biological function on the human immune system.

17.2.2 Pollen monitoring

Pollen monitoring is the basis to detect the number, localisation, prevalence, and variety of airborne allergens in different altitudes and under consideration of varying environmental factors [5, 6]. Concomitant measures of air pollutants, like nitric oxides, and environmental factors, such as ozone, can be correlated to the microbial load and allergenicity of pollen [7]. Together, sites for pollen observation deliver comprehensive data that is a prerequisite to compare the effect between aeroallergens and air pollutants on health at moderate to high altitudes and between urban versus non-urban environments.

The **personal pollen trap** is of special interest to environmental medicine as it enables the researchers, first of all, to receive information about indoor airborne particles. Secondly, this sampler is of interest to physicians because the obtained results give a clue about each patient's personal exposure to allergens. The portable pollen sampler has a steady draught of 10 litres of air per minute, which equals an average human breath. The **volumetric pollen and spore trap** operates on the principle of Hirst. Again, 10 litres of air is ducted within one draught of the sampler to an adhesive tape where fine air particles stick on it. The tape is placed in a cylinder that rotates by clockwork for the duration of one week. After its removal, the ready tape is prepared on microscope slides and thus becomes analyzable for several decades. By the use of a microscope, scientists can identify the pollen types and count their number with statistical methods. A volumetric pollen trap gives evidence about pollen flight in two-hour intervals. Theoretically speaking, it was possible to count other airborne particles on the slides, too. The **fully automated pollen sampler** has a draught of 1000 litres air per minute. The air particles tap to an object carrier which is then directly analyzed in the pollen monitor. Inside the monitor, the particles become digitalized by a high-resolution camera. The individual pollen are further identified and counted by an image recognition software as well as by the help of a neuronal network. Finally, the collected data becomes available in a file. This file can be immediately sent to a server and graphically depicted on screen.

A combined analysis of data from different pollen samplers and data from weather and climate stations [5, 6, 8] makes a detailed and accurate pollen forecast possible. However, solely the automatic pollen sampler allows an online information service about real-time pollen concen-

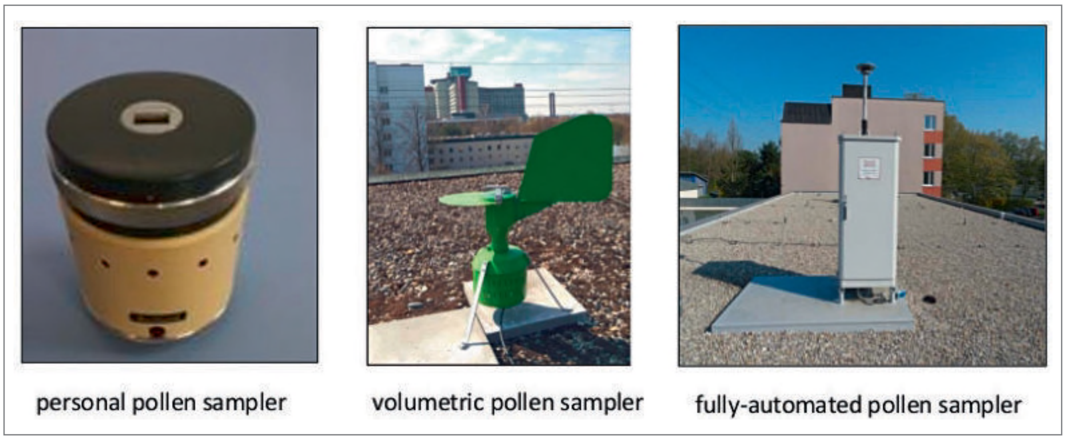

Fig. 1. The current three methods for pollen data collection: personal pollen sampler, volumetric pollen sampler, and an automatic pollen sampler. The Klinikum Augsburg und the UNIKA-T office premises are visible in the background of the latter two photos.

tration [9]. The combination of forecast and live data empowers allergic patients to correctly adjust their medication and to carefully plan leisure activities. The pollen data, moreover, contributes to political decisions, for example to the sensible construction of green areas in urban regions or the reduction of climate pollutants in air and soil. The primary objective of pollen observation is an increase in the quality of life for allergic patients. As a secondary consequence, the financial and organisational burdens for likewise health systems and employers could be lowered because of less sick reports caused by allergic diseases.

17.2.3 Allergies and skin diseases

The basis for a focus on therapy and prevention in the alpine region with regards to allergies and allergy-related, chronic inflammatory (epithelial) diseases stems from the fact that these diseases recordably rise in incidence and prevalence, notably among children and foremost in highly industrialized regions. **Allergic diseases pose the most hazardous epidemiological threat** worldwide at the start point of the 21st century. Allergies are non-communicable diseases (NCDs) and further characterized by their tendency for chronicity, their suggestibility to environmental factors, and their potential to trigger comorbidities such as atopic eczema [10].

17.2.3.1 Pathogenesis of allergic diseases

An allergen is per se a harmless protein to which the immune system normally develops a tolerogenic (immune) response [11, 12]. Importantly, allergen carriers like pollen release not only the (allergenic) proteins but also low molecular substances such as lipid mediators or adenosine that function as danger signals [11, 13–15]. These adjuvant factors pave the way in susceptible indivudals towards an Th2-dominated immune response. According to Coombs and Gell, four different types of allergics responses exists. The allergies of type I (immediate reaction) and type IV (delayed type reaction) are of immediate relevance for environmental medicine because their pathogenesis is largely associated with environmental factors such as pollen, house dust mite, food (type I allergy), and fragrancies or nickel (type IV allergy). An allergic disease begins with a **sensitisation phase** and can lead over to an **inflammation phase** after subsequent exposure to the allergen. During sensitisation, i. e. on first contact with an allergen, allergenspecific antibodies (IgE for type I allergy) are produced by B-cells and bound to mast cells, basophils, eosinophils, dendritic cells, and many more. The phase of the allergic cascade does not come along with symptoms. This "phase" of sensitisation can persist for many years. After a certain time – and it has not become clear yet when and why someone is susceptible, not even the someone – the re-exposure to the allergen results in the induction of an allergic inflammation with clinical symptoms. Note that only the presence of allergic symptoms legitimates for the diagnosis "allergy", not the mere existence of antibodies.

17.2.3.2 Disease progression in allergies

Allergy designates not one disease but acts as an umbrella term for various diseases [1, 2, 16]. The cascade often starts with children from six months onwards, who develop an atopic eczema – a severe inflammation of the skin. The second stage is frequently a food allergy. Whereas children show an allergic reaction towards new food substances such as fish, wheat, soy, egg, or milk products, adults often suffer from pollen-associated cross reactions with pre-existing food allergies. Further stages are asthma or rhinitis. Children regularly lose their food allergies which means that they develop tolerance. If we come to understand the respective mechanisms of "natural" tolerance development, we could be able to actively induce tolerance at other ages. The latter is relevant because the elderly often (re-)develop atopic eczema.

17.2.3.3 Skin structure and epithelial barrier

Environmental factors and pollutants first impinge on the epithelia of skin, lung, or gut. An epithelium is a multi-layer surface that works like an organ on its own, senses harm, and induces defence. First of all, we need to investigate the epithelial barriers' structure and function before we can holistically describe **the mechanisms of atopies**, i. e. the tendency to develop allergic symptoms on the skin or respiratory tract such as eczema, asthma, or rhinitis. Four barriers define the epithelial structure. Its main fabric consists either of skin cells or mucosal tissue. The following figure shows an epithelial barrier on the example of the skin.

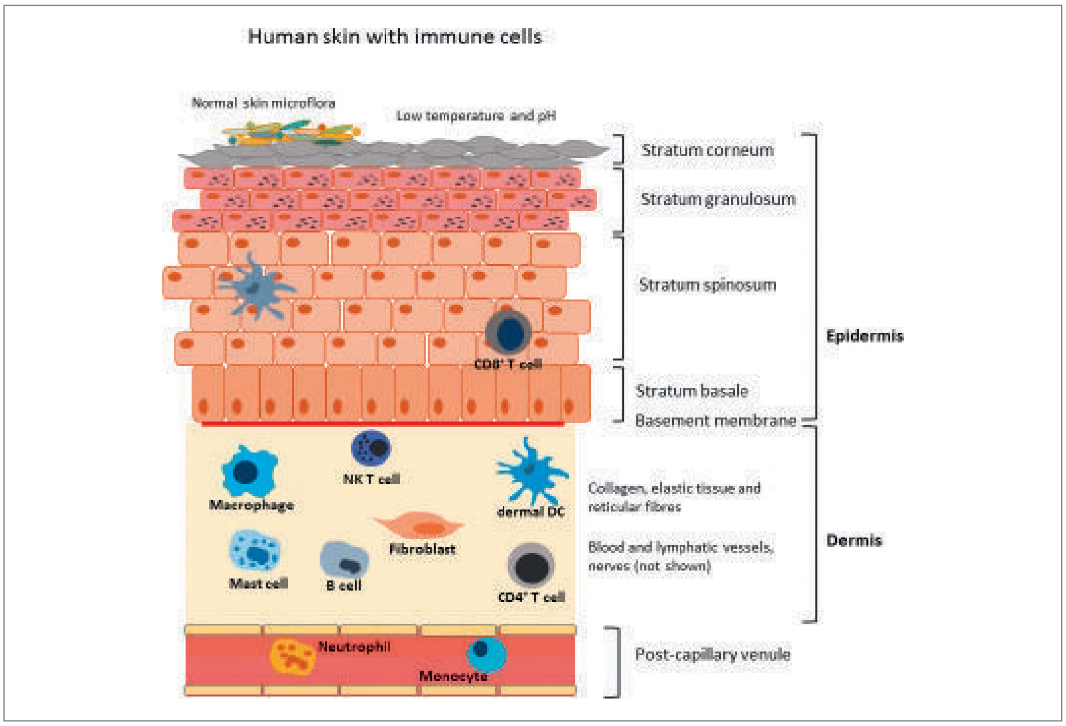

Fig. 2: The structure of the skin with its four barriers. The epidermal layers form the physical barrier. A chemical and microbial barrier are predominantly working on the skin's surface. The immune barrier consists of immune cells that work from the *Stratum spinosum* down to the lymph and blood vessels.

At the skin, two important markers of the **chemical barrier** are its pH value and the natural moisturizing factor (NMF). The **microbial barrier** consists of bacteria, viruses, and fungi. Together, they form an extensive ecosystem with a homeostasis as its healthy status. The **physical barrier** is structurally connected to with the chemical, microbial, and **immune barrier**. Furthermore, the physical barrier functionally interacts with the other three barriers in order to ensure a full protection from external assaults, like pathogens, xenobiotics, or UV irradiation, and to prevent the loss of water and solutes. Each epithelium's interactions are a pre-requisite for its functionality and defence mechanisms [17].

17.2.4 Clinical studies in the alpine region

A clinical study that examines the possible correlations between allergies, skin diseases, and the effect of a stay in the alpine region requires test persons that suffer from atopies plus urban and alpine test regions. Fig. 3 shows that the Umweltforschungsstation Schneefernerhaus / Zugspitze, the Hochgebirgsklinik Davos, and the facilities of Environmental Medicine in Augsburg and Munich provide all the necessary clinical institutions and scientific facilities for such a study.

17.2.4.1 Clinical studies – structure, test persons, environmental factors

By the help of questionnaires and allergy specific biomarkers, the formation of a study group becomes possible that features exactly the allergic disease patterns of interest. As soon as the number of test persons fits a study design, the clinical part begins. At first, each study participant stays in the urban environment for several weeks and then retreats to the alpine region for several days or even weeks. The subjects undergoes regular visits by physicians who take blood, skin, and mucosal samples. Thereby, **the identification of specific environmental factors** becomes possible that are probable involved in the pathogenesis of each test person's disease. Follow-up studies address multiple environmental factors and compare the study results with the data from volumetric pollen traps and automatic pollen samplers, supplemented by meteorological and biological data. This study concept allows for a detailed description of alpine

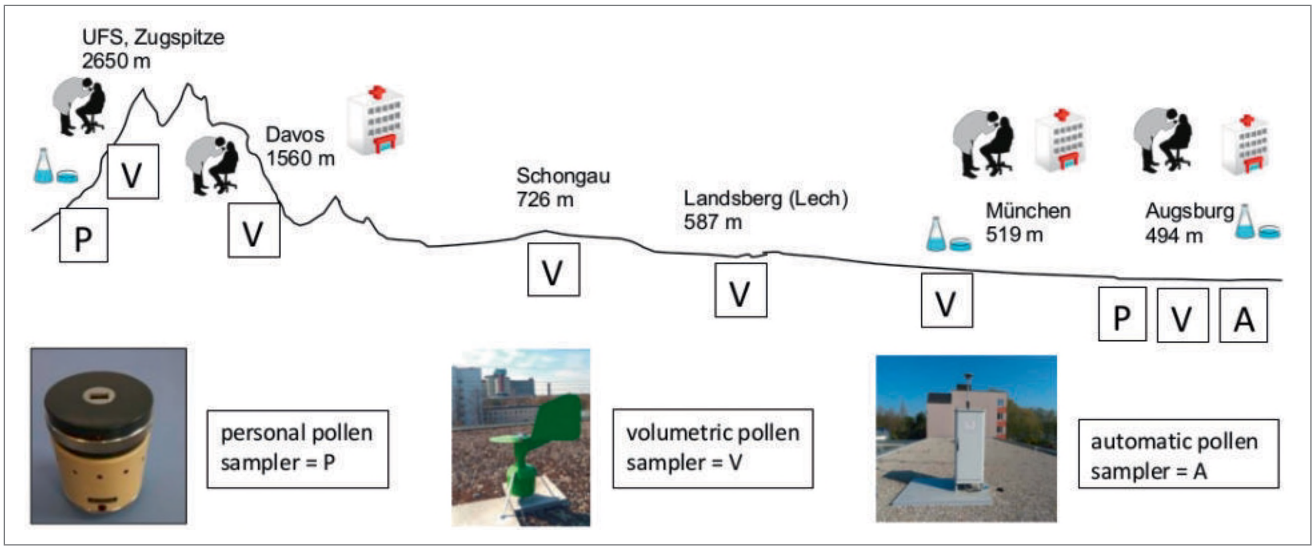

Fig. 3: (the elevation profile is illustrative not geographical): Six major pollen stations at lowland to high altitudes deliver pollen data. Several minor pollen stations function as supplement. The volumetric pollen sampler can be mounted at almost every subsurface and altitude (even the Weißfluhjoch and the Zugspitze). The personal pollen sampler was mainly designed for indoor air. The automated pollen sampler delivers the pollen data in real-time. In Munich and Augsburg, clinics and lab facilities allow for treatment, clinical tests, and research. The Hochgebirgsklinik in Davos provides space for treatment and clinical tests, and the Umweltforschungsstation Schneefernerhaus / Zugspitze has lab facilities and the possibility to conduct clinical trials.

effects on health. At the same time, the patient number can be reduced by the help of this study design since every patient is her or his own control for symptoms and immunological reactions both in alpine and urban regions.

17.2.4.2 Laboratory work and clinics

A number of high-end laboratory devices is set up to analyse **biomarkers**, i. e. biological parameters such as the IgE levels in blood serum, cell counts, or a change in microbial patterns from epithelial surfaces. Of special interest is the epidermal water loss, nasal secretion, and respiratory capacity. The results from the laboratory work become further analysed by physicians, technicians, and scientists (notably bioinformaticians). Alpine clinics are very suitable for the collection of specific data about the effect from a stay in the alpine region because they provide the necessary equipment and medical staff. Patients with severe chronic inflammation of skin or respiratory tract need intense medical care. Their sickrooms have to be largely free of environmental factors, such as pollen and house dust mite, or air pollutants, like ozone and nitric oxides. The test person's participation in a study is essential as they represent the patient group with severe symptoms. One exemplary alpine clinic is the **Hochgebirgsklinik in Davos**, which offers best standards and a very healthy environment.

17.3 Results

17.3.1 Patient recovery in the alpine region

Allergies can cause a permanent decrease in the quality of life. Therefore, a sustainable recovery is among the major goals when it comes to patient treatment in the alpine region [18–20]. But the Alps themselves face climate effects and undergo constant change. Scientific knowledge about the alpine region as a place for regeneration and therapy could also help to protect this region from substantial damage for now and for future generations.

17.3.1.1 Benefits of recovery in the alpine region

The less allergens, environmental pollutants, and stress factors are present in the environment, the better for the recreational value. Because patients are not distracted by their day-to-day life during recovery in the alpine region, their medication can be minutely adjusted and consumed

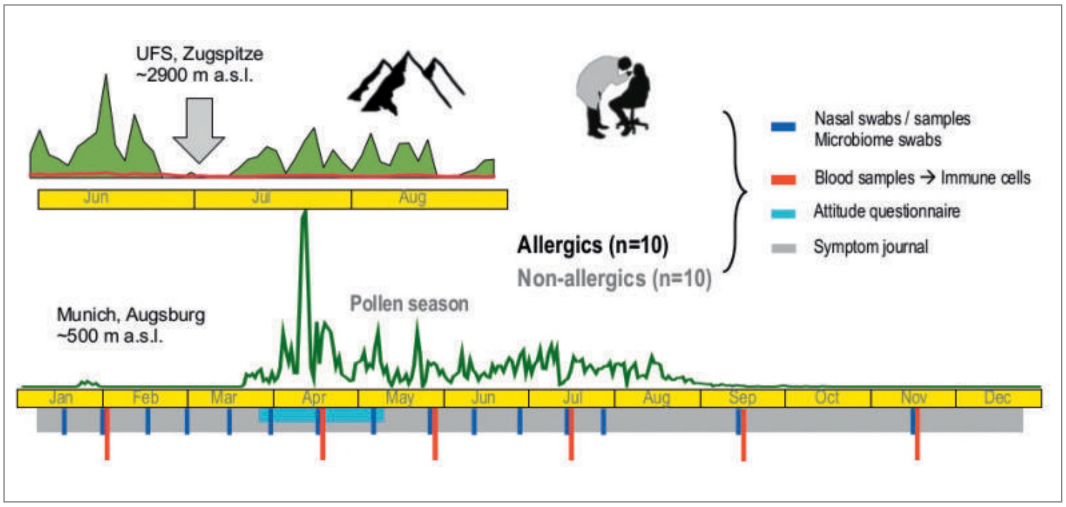

Fig. 4: By pollen monitoring, it is possible to match symptoms with pollen flight. Patients and controls had been clinically observed from January to December 2016 in Augsburg. During a multi-day stay at the Umweltforschungsstation Schneefernerhaus / Zugspitze in summer 2016, patients showed significantly less allergic symptoms due to a clearly reduced amount of pollen in the environment.

on schedule. A drug's effect can be clearly observed, and a prompt reaction to changes in health status becomes possible. Under alpine conditions, biomarkers are best suitable for both the exact assessment of the patient's status and for the research on the disease patterns. The pollen samplers at the alpine research stations (see Fig. 3) show that pollen, mites, or spores are variably less in number and variation in Davos or the Zugspitze. The Bavarian State Ministry of the Environment and Consumer Protection granted and funded a project at the University Center for Health Sciences at the Klinikum Augsburg, UNIKA-T, in order to compare symptoms from allergic individuals with the symptoms from non-allergic subjects in an alpine and urban environment.

One prerequisite for a general relaxation of the patient's mood and for a success in medical treatment is the reduction of symptom triggers, but also educational matters become much more effective if less symptoms strain the patient.

17.3.1.2 Short-term and long-term effects of recovery in the alpine region

Bersuch et al summarize in the publication "Lung function improvement and airways inflammation reduction in asthmatic children after a rehabilitation program at moderate altitude" results from a study at the Hochgebirgsklinik Davos [21]. The study shows **the regenerative effect of a stay in moderate alpine altitude**. Next to a reduced number of airborne allergens, the factor time is of particular significance for recovery. More than 14 days of stay delivered a better therapeutic effect of medicine and brought an increase for regenerative mechanisms like that of the lung. We can label this the "alpine effect" as Karin Fieten explains in her publication "Relation between regional exposure and allergic sensitisation in (pre-)school children in Davos"[19]. Besides allergen tests, the researchers in this study performed measures of dust particles. A comparison between the Davos group and the test group from the urban places Munich and Günzburg allows for further correlations. A third study "*Perception of climate change in patients with chronic lung diseases*"[22] indicates that more and more allergic patients lament about the effects of climate change. The fact that days with cloudless sky and high temperature mean an additional cardiovascular (and general) health risk has not raised the necessary awareness, yet. But especially those kind of days cause stronger symptoms due to dehydration, high UV irradiation, and aggressive pollen. Such factors harm the epithelium of the skin and respiratory tract and thus enforce pathogenic microbes and environmental pollutants to cause even more damage to the epithelial barriers.

17.3.2 Results from environmental medicine research in the alpine region

The formulation of correlations between the human health and climate effects, environmental factors, air pollutants, or microbial loads requires an interdisciplinary research network that consists of physicians, scientists, and technicians. From the hundredfold collection of pollen or blood samples, over to exact climate and weather observations, and up to the development of new laboratory methods and computer algorithms, environmental medicine unites distant research fields for the purpose of practical help to patients and relatives.

17.3.2.1 Health differences in urban, rural, and moderate to high altitude environments

Results from studies that investigated the recovery capacity in the alpine region prove that an industrially characterized environment usually contains more air pollutants. This circumstance, first of all, commonly results in a reduced barrier functionality at skin, gut, and lung. The barrier's inherent function was to stop environmental factors such as pathogenic microbes, pollen, or UV irradiation from causing a damage to cell structures, but **a disrupted barrier opens the doors way to the exposome**, i. e. the sum of external environmental factors and pollutants. Secondly, science hypothesizes that the immune system loses the capacity of tolerance development if sparse microbial exposition takes place. This circumstance is extremely relevant for atopy prevention at infancy [23, 24]. It partly explains why diversity is the key to health in many contexts. There seems to be a time window of a few years during early childhood that favours the preventive effect of life in non-urban environments with regards to atopy development in adolescence [25]. Whether the microbial homeostasis of adults benefits from a stay in a rural or alpine environment has still to be investigated. A follow-up study with the Amish people in the USA brought evidence that the contact to cattle seems to be of considerable advantage for prevention, besides that this study has further confirmed the positive effect of a diverse environment. A stay in an environment of moderate to high altitude and in a rural environment combines the beneficial effects of a non-urban environment with significantly less airborne allergens and pollutants.

17.3.2.2 Psycho-social factors and health improvement in the alpine region

One major benefit of recovery in the alpine region stems from the fact that patients avoid those psycho-social stress factors that are continually present in their usual environment. Some studies already showed that the factor "psycho-social stress" is clearly relevant and can be associated with allergic diseases in general and atopic diseases in particular. For example, Patterson et al investigated whether perceived stress can be linked to allergy flares [26]. Therefore, they analysed online diary entries on allergy flares, stressful events, perceived stress and mood. Moreover, they collected salivary cortisol levels in two blocks of 14 days. Before each fortnightly period, perceived stress and depressive symptoms were obtained. Finally, they could show that those subjects who reported allergy flares had higher perceived stress levels and lower mood levels than the subjects without allergic symptoms. The authors concluded that subjects with persistent psycho-social stress very likely have more frequent allergy flares. In another study, Rod et al investigated whether psychosocial stress can lead to adult-onset allergies or atopies [27]. Therefore, they analysed longitudinal data from the Copenhagen City Heart Study of 5,648 participants that had no allergies. At baseline (1981–1983), the participants were asked for perceived stress and ten years later they were asked for self-reported asthma, allergic rhinitis, and atopic eczema. The authors found out that **psycho-social stress can be strongly associated with asthma incidence, allergic rhinitis, and atopic eczema**. The results suggest that stress release might be an important first step towards the improvement of the quality of life for allergic individuals and towards the prevention of allergic diseases in adults.

17.3.3 Results from pollen research and pollen monitoring

Pollen research does not only comprise the observation of pollen flight and the phenological studies of allergenic plants but also includes the study of environmental pollutants such as ozone and nitric oxide. What is more, we observed that even pollen has an individual microbiome. This fact means that new correlations become observable and modes of interaction multiply [7].

17.3.3.1 Ar pollutants and pollen allergenicity

Zhao et al discuss in recent publications the effect of nitric oxide on pollen. The respective studies prove the enhancing effect of nitric oxides on pollen amount and plant allergenicity of the neophyte ambrosia [28–30]. In grass pollen, the bioavailability of allergens may also be modulated by NO_2 [31]. NO_x in general belongs to the classical and most aggressive air pollutants. The main sources of NO_2 are combustion processes from energy production, industrial processes, and car traffic. NO_2 affects human health by irritating the bronchial tubes and thus influences the respiratory tract's functionality [32, 33]. With regards to the ecosystems, NO_2 concentrations of around 100 ppb substantially damage plants. This results in leaf necrosis, reduced growth, and premature senescence [34, 35]. But also growth promoting effects were described, however, at lower NO_2 concentrations of 50 ppb [36]. Another interesting result from pollen research reveals the nitrosylation and nitration of allergens by NO_2 that can enhance the allergenic responses of both pollen and food allergens [37–39]. Ozone [40, 41] and urbanisation [42] are correlating with changes in pollen's allergenicity, too. Therefore, future studies about environmental conditions in urban and alpine regions have to address the investigation of plants and pollen with respect to their allergenic potential.

17.3.3.2 Changes in pollen season

Airborne pollen measurement has been a research subject for a long period of time and are also among the most recent datasets of biological origin. In this respect, the data **represents a valuable proxy of climate effects**. Extensive research over the last decade has showcased that airborne pollen increase in abundance, but also that pollen seasons shift to an earlier start and different duration [8]. The average temperatures increase all over the planet: in lowlands, seas, riversides, and mountainous regions as well as in the troposphere. Next to temperature means, peaks of heat and frost continue to become more numerous [43]. Both phenomena change the sequences in pollen season of endemic plants. Hazel shrubs and trees for instance have started to flower much earlier in winter, sometimes even as soon as late autumn. Whether this outcome is a result of increased pollen production per floral unit and per individual plant or the output of changes in land usage has still to be researched. To date, the main causative factors for described shifts and changes have been considered as either **air pollutants** and higher **air temperatures**, associated with a global increase of average temperatures, or **urbanisation rates** and **changes in land usages** [44]. We know that air pollutants are responsible for a higher biomass production (including flower and pollen) but also for a higher allergenicity of pollen. Wan et al [45] and Wayne et al [46] experimentally found out that – specifically in combination with elevated air temperature – increased CO_2 does not alter pollen production per se but enhance plant biomass in *Ambrosia artemisiifolia*. That is one reason, consequently, why individual plants produce more pollen. Ziska et al [47] also studied the Ambrosia plant species, this time under realistic environmental conditions, or rather in a gradient that simulated distinct climatic scenarios. Again, they explored that plants exhibited higher biomass, pollen production, and earlier flowering dates. Ziska et al additionally concluded that plant expansion rates and regional abundance may increase, too. At a wider spatial scale, an escalation of allergenic pollen exposure rates becomes probable. An indirect consequence of the climate effect is the introduction of foreign plant species, often by means of international transport. They enter left growth niches because they put forward a better resistance to temperature shifts or peaks. Such plant species are often more allergenic. For example, seeds of *Ambrosia artemisiifolia* have entered the European continent presumably via transport boxes of international traded goods [6, 48]. Ambrosia seeds probably endure the transport distances more easily when the weather is warm and dry, preventing the seeds from germination. Besides the fact that Ambrosia produces a highly allergenic pollen, it survives temperature peaks and flimsily fills the empty-left niches of regressing endemic plants.

17.3.3.3 Variations in landmarks of airborne pollen

Pollen research by its nature contains the observation of allergen fractions in the air and in different altitudes as well as in terms of their landmarks. We observe that the climate effect resulting from warmer and drier days changes the pollen seasons towards earlier start points and towards a prolongation of bloom phases. Further results indicate differences in pollen flight at day and night. Now, measurements of pollen concentrations at different altitudes has shown two tendencies: pollen can travel over long distances, even cluster in pollen clouds and pass mountains and seas, i.e. very high and very low land surfaces [5]. Moreover, the air in areas which up to now have been considered as more or less free of pollen verifiably contains larger amounts of pollen. The reason for the latter is on the one hand that higher average temperatures allow plants to grow at altitudes other than their original habitat. On the other hand, changes in the pollen seasons' start and stop points together with a surplus in pollen amounts of plants necessarily increase the number of pollen in the air in general. As a consequence, **pollen shows higher numbers in moderate to high altitudes as well**. An interesting fact is that some alpine areas function like an air cavity that houses pollen and air pollutants like CO_2. In contrast, other alpine regions benefit from the surrounding walls of mountain peaks and crests that keep pollen or polluted air all around the outer edges.

17.3.4 Pollen information services and educational measures

Results from research on allergies and environmental factors can help the population to keep healthy, especially at times when the pollen season starts and symptoms appear or worsen. Knowledge about interactions between disease patterns and the climate, the weather, pollen flight, the microbiome, and immune mechanism, furthermore, essentially complement already formulated educational measures.

17.3.4.1 UNIKA-T pollen flight service and ePIN

At the University Center for Health Sciences at the Klinikum Augsburg, UNIKA-T, a very modern pollen super site has been operating since 2016. The site consists of two automatic and two volumetric pollen samplers. In an attached pilot project, the UNIKA-T offers **real-time information about the current pollen flight** on its website (www.unika-t.de/pollenflug) which is of relevance to the population of Augsburg and its region. Every three hours, new pollen data is uploaded to a server and from there, an algorithm prepares the date for an optimal readability on the UNIKA-T website. For allergic patients, the direct access to actual pollen flight counts as vital information for a better quality of life. Pollen information includes the number of pollen, the time of flight, and the pollen species. The data from the volumetric pollen samplers helps the scientists to compare both the non-automated and the automatic pollen monitoring methods. Public institutions in Bavaria have initiated the network ePIN, which is the acronym for electronic pollen information network. For this network's implementation, a vast number of fully automated pollen monitors in addition to the many already existing volumetric ones has to be installed all over the country. The pollen sites make it possible to provide the (Bavarian) population permanently with regional pollen flight information.

17.3.4.2 CK-CARE

The CK-CARE foundation (Christine Kühne – Center for Allergy Research and Education; www.ck-care.ch) has initiated a platform for research, therapy, and prevention that directly addresses allergies and allergy-related skin diseases like atopic eczema. **Prevention works primarily by means of educational matters** both for physicians and care staff as well as for patients and their relatives. CK-CARE offers courses that are well-organized and teach the central aspects of allergic diseases. Often, life style is one of the reasons why allergies become so prevalent. Children are the least defendable and most vulnerable members of our society with regards to both environmental factors and air pollutants. Therefore, how to manage allergies properly and what strategies work to prevent allergy pathogenesis make up two major aspects of the CK-CARE education program. The improvement in the quality of life is central to every allergic person. The courses of CK-CARE teach how to improve quality of life by following certain rules such as the careful planning of medication and leisure activity. Additionally, **patient care is essential for a successful medical treatment.** That is why physicians and nurse staff undergo courses at CK-CARE that tell them how to best adapt to a patient's situations and how to treat symptoms with the most modern techniques and medicine. In general, CK-CARE education methods rely on the research results that stem from various fields of science. The interdisciplinary approach of this foundation has led to a global initiative with the goal of addressing allergies as the most dangerous epidemic threat in the 21st century.

17.4 Conclusion

The performance of environmental medicine research in the alpine regions is an absolutely necessary pre-requisite for the formulation of plausible preventive and therapeutic options to people that suffer from atopies. Above the latter, environmental studies help to gain full knowledge about the interactions between climate, nature, man, and health. As a result, the protection of the alpine region becomes the basis for its use as a place of retreat to allergic patients. The observation of pollen flight and abundance at different altitudes together with the data from weather and climate stations allow, in addition, to identify exactly those environmental factors that are mainly present in urban environments and that are trigger factors for allergies. Finally, research in the alpine region is of real benefit to patients: stress relief, improvement in the quality of life – and above all, less symptoms.

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