German Federal Institute for Risk Assessment

FAQ

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Allergies: The most important questions and answers at a glance

Allergies are widespread throughout the population. According to estimates, more than 30% of people in Germany will develop an allergy in their lifetime. A wide variety of substances can be the cause: plant pollen, certain foods, and even some substances in household dust. Insecticidal toxins, medications, and chemicals, such as those found in cleaning products or cosmetics, may also provoke allergic reactions. Symptoms range from itchy eczema to, rarely, potentially life-threatening anaphylactic shock. In this text, the BfR answers the most important questions about allergies. More detailed information as well as sources on this topic are available in a comprehensive BfR Science Report.

What is an allergy?

An allergy is a hypersensitivity reaction of the immune system. Allergies are triggered by substances foreign to the body. In people with allergies, the immune system classifies these typically harmless substances as dangerous and fights them with excessive rigour. Substances capable of triggering allergies are called allergens. Allergens are found, for example, in plant pollen, insecticidal toxins, and food.

Typical symptoms of a skin allergy include itching, wheals, reddening, and swelling. Allergic rhinitis leads to a blocked or runny nose as well as to sneezing. Food allergens can also cause skin rashes, in addition to gastro-intestinal symptoms, shortness of breath, and fatigue. Particularly severe cases may result in anaphylactic shock.

Why do people suddenly develop allergic reactions to substances which previously triggered no reaction?

Allergic reactions are typically divided into two phases. The first phase is the “sensitisation phase” and can be understood as the “familiarisation phase”. This phase appears at first to be harmless: the body comes into contact with the substance, but no allergic symptoms occur at this time.

During this sensitisation phase, the immune system is introduced to the substance and develops what is known as an “immunological memory”. Certain immune cells in the body then recognise these substances as foreign, meaning they are “sensitised” to them. Substances which can cause the immune system to react in such a way are therefore also called “sensitisers”.

If a person comes into contact with the substance after the sensitisation phase, this can trigger the second phase of the allergy, the “elicitation phase”. The immune system recognises the allergen and considers it a threat which must be fought off. This leads to a symptomatic allergic reaction.

What are allergens?

All substances which can cause an allergic reaction are called allergens. Although these substances are often generally harmless, for people with allergies, the immune system has a hypersensitive reaction, meaning the immune system identifies the substance as foreign.

Contact with an allergen may occur via the skin, the respiratory system, or the digestive system as well as through an injection such as with insecticidal toxins or medications.

In terms of their chemical nature, allergens are often proteins commonly found, for example, in plant pollen, fungal spores, or animal hair. However, metals or certain naturally occurring or synthetically manufactured chemicals, such as pharmaceutical drugs, can also be allergens. Current research is focusing on the mechanisms with which specific substances act as allergens in the human body.

The amount of or intensity of a contact with an allergen necessary to cause an allergic reaction differs between individuals. With some allergens, even very low concentrations can trigger symptoms.

How many allergens are currently known?

There is no complete list of all known allergens. However, the World Health Organisation (WHO) has a database with known protein allergens. Currently (as of February 2024), approximately 1,100 proteins are listed which are known to be able to cause allergies.

There are also many chemicals which have the potential to cause allergic reactions. By now, the EU has officially declared over 1,200 such substances as “skin sensitisers” and approximately 120 additionally or exclusively as “respiratory sensitisers”. Many chemicals have also been classified as skin sensitisers by manufacturers, importers, or companies using these substances (self-classification). In Anton De Groot’s book Patch Testing, over 4,900 substances are currently listed as potential contact allergens.

Additionally, there are other substances which are suspected to have a sensitisation effect or for which such an effect has already been shown in individual cases.

Which allergies are particularly common?

Allergies are relatively common. According to a survey conducted by the Robert Koch Institute, more than 20% of children and more than 30% of adults in Germany develop an

allergy during their lifetimes. However, there is a large degree of uncertainty regarding these numbers, as they are primarily the result of surveys and people with allergies, for instance, might participate more frequently and thus be overrepresented in the results.

The different types of allergies and the corresponding allergens are often categorised according to the route of exposure via which humans come into contact with the allergen in question.

One of the most well-known and widespread allergies is hay fever. Hay fever is a general term for allergic reactions to different allergens in plant pollen, particularly grass and tree pollen. Because the allergens are in this case absorbed through respiration, they are also termed inhalation allergens or aeroallergens. Other common examples of aeroallergens may be found in fungal spores, wood dust or in household dust. Dust or fumes from certain chemicals or volatile components of plastics or coatings can also trigger allergy symptoms if inhaled.

Injectant allergens enter the body via a type of injection. Typical examples include toxins from insects, such as from honeybees, bumblebees or wasps, as well as injected medications and contrast agents.

Food allergens can trigger allergic reactions if consumed. In Germany, an estimated 3 to 6% of the population have a food allergy. The most common triggers for children and adolescents are cow's milk, chicken eggs, peanuts, wheat, and tree nuts. Adults who experience allergic reactions to plant pollen also frequently have cross-reactions to apples and other fruit as well as to nuts, soy, celery, and carrots. Some adults have allergic reactions to wheat, peanuts, fish, and crustaceans. Food allergies are different from other food hypersensitivities, such as lactose intolerance, in which the body cannot fully digest lactose. Such food intolerances develop without the involvement of the immune system.

Contact allergens are often industrially manufactured chemicals, but also include natural fragrances and certain metals. Allergic reactions to nickel are particularly common. According to estimates, around 11% of the EU population reacts to this metal in allergy tests. However, other metals such as cobalt, chromium or palladium can also cause allergic contact eczema. This is also true for a wide variety of non-metal chemicals, such as fragrances, dyes or preservatives.

What are allergic "reaction types"?

Science distinguishes between different types of allergic reaction depending on the mechanisms and components of the immune system involved.

The reaction occurs particularly fast with the very common type I allergies ("immediate hypersensitivity reactions"), which comprise most allergies. This type involves certain antibodies called immunoglobulin E (IgE) antibodies. In these cases, contact with an allergen can trigger an allergic reaction within seconds or minutes. Facilitated by the IgE antibodies, histamine or other messenger substances are released which in turn elicit defensive reactions in other organs. Type I allergies include pollen allergies as well as insect allergies and food allergies. The latter two can sometimes lead to anaphylactic shock.

With type II and III allergies, there are other immune system mechanisms at play. Reactions typically occur after approximately 6 to 12 hours. For instance, with a type II allergy, the

body reacts with antibodies against certain components of body cells, as is, for example, the case with rejection reactions after transplants or with blood group incompatibility. Type III allergies involve the formation of complexes of allergens and antibodies. Provided that the body does not metabolise these complexes, they settle in the tissue or in the blood vessels. One example is serum sickness. With this condition, a type III reaction occurs following the injection of a vaccine serum from an animal source, e.g. after delivery of a serum derived from vaccinated horses after a venomous snake bite.

In type IV allergies, the main involvement comes from what are known as T cells. The “T” stands for thymus, an organ in the lymphatic system in which the T cells develop. Activated T cells cause inflammation, but this process takes longer. The full elicitation of these allergic reactions typically occurs within 12 to 72 hours. For this reason, this type of allergy is also referred to as a “delayed hypersensitivity reaction”. Typical type IV allergies include allergic contact eczema or various reactions to medications.

Additionally, other mechanisms can contribute to the allergic reaction. These may include a damaged skin barrier (for instance through contact with cleaning agents), inflammatory metabolic processes, or direct interactions of substances with immune cells.

What allergy symptoms are known?

Allergy symptoms vary widely from case to case. The symptoms depend, for example, on the route of exposure and the quantity of allergens consumed. They range from light issues to life-threatening or chronic conditions. Symptoms may occur directly at the site of contact (local) or independent of the site of contact (systemic).

Every person with allergies has their own threshold for allergen exposure beyond which symptoms occur. This threshold can change over time and can sometimes be directly targeted with therapeutic treatments (known as hypo-sensitisation).

The amount of time before the allergic reaction occurs may also differ. When contact with allergens occurs through the skin, e.g. after use of cosmetics, it can sometimes take one or several days until an allergic contact eczema develops on the affected site (“delayed hypersensitivity reaction”).

Anaphylaxis or anaphylactic reaction, on the other hand, is a type of allergic reaction that occurs rapidly. In this case, the symptoms can start immediately after contact with the allergen and affect the entire body. The most severe form of anaphylaxis is anaphylactic shock, which can be deadly.

If ingested through the lungs (inhaled allergens), allergens can cause seasonal or year-round allergic rhinitis (also called hay fever), bronchial asthma, allergic inflammation of the pulmonary alveoli, or even life-threatening cardiovascular collapse (anaphylactic shock).

Injected allergens can also cause potentially life-threatening allergic reactions (including anaphylactic shock and severe skin reactions).

With food allergies, reactions of the skin or mucous membranes, such as itching, redness, hives (urticaria), eczema, and swelling of the oral mucous membrane, are common. Watery eyes as well as reactions of the respiratory pathways such as persistent rhinitis and sneezing, cough, shortness/lack of breath or wheezing and asthma are also widespread.

Other possible symptoms include nausea, gas, abdominal pain, vomiting, diarrhoea, or inflammation of the stomach and intestinal mucous membranes. The cardiovascular system can also be affected. For example, people may experience dizziness, elevated heart rate, or even anaphylactic shock.

How are allergies diagnosed?

To diagnose type I allergies (for example to foods, pollen, insecticidal toxins), the health history and potential allergies in a person's family are typically examined. Then, a sensitisation test is carried out (skin prick test or IgE detection in the blood). In the skin prick test, individual drops of different test fluids containing the allergens to be tested are dropped next to each other onto the inner side of the forearm. After administering the fluids, the skin is superficially pricked and then the skin reactions are observed. Formation of wheals on the individual prick sites after about 15 to 30 minutes suggests an allergy to the corresponding substance and the wheals' dimensions correspond to severity. Via a blood test, the presence of specific IgE bodies reactant to individual allergens can be detected.

A positive skin prick test or IgE detection in the blood determine a sensitisation to a certain substance, however, it does not necessarily mean that symptoms will occur in daily life. Therefore, so-called provocation tests are conducted in certain situations, primarily for food allergies. Provocation tests involve patients being purposefully exposed to a certain allergen under medical observation. This exposure may occur via the nasal mucous membrane, inhalation of a test substance, or ingestion of certain foods.

Contact allergies are diagnosed by patch testing. In this case, test substances are typically applied to the back for 48 hours and covered with a plaster. Then, it is tested whether or not a skin reaction occurs, which may include redness, swelling, blistering or eczema, and the severity of the reaction is assessed.

What are cross-allergies or cross-reactions? What role does plant pollen play here?

Simply put, a cross-allergy is when an allergy to a substance occurs due to an already-present allergy to another substance. For example, it may occur that a person allergic to birch pollen triggered by inhalation may suddenly develop an allergic reaction to apples, hazelnuts, and celery.

Such a cross allergy can develop with allergens or substances which are similar in their chemical structures. In the immune system, the same antibodies or T cells react to the similar substance.

Pollen plays a special role in cross-allergies, because the allergens found therein are often very similar to proteins in foods. Other examples include cross-reactions between allergens from dust mites and crustaceans (e.g. shrimp) or chemical allergens, such as cross-reactions between nickel and palladium. However, it is often not obvious whether an actual cross-reaction is present or if the phenomenon being observed is actually an independent sensitisation to the second substance. This is why cross-allergies are also a current research topic.

Why do some people have allergic reactions while others do not?

The specific reasons for the development of allergies and the partial increase in the frequency of allergies are still being studied. Even if much has yet to be understood, a range of factors are already known which may influence the development of allergies.

Genetic predisposition appears to play a role with inhalation and food allergies. If both parents have allergies, it is more likely that their child will also develop an allergy. With some people, genetic variants may lead to a damaged skin barrier, which can facilitate the development of contact allergies.

However, other life circumstances and environmental influences can also impact the development of allergies. There is evidence to suggest that lack of contact with certain bacteria during childhood can facilitate the development of allergies. There are also suggestions that damage to barriers of the body (i.e. skin, mucous membranes) due to a wide variety of different causes, e.g. frequent contact with laundry detergent (in textiles), or air pollution, may impact allergy development. Tobacco smoke also seems to contribute to the development of allergies in some people.

Finally, there are certain professions with an increased risk for allergy development, because they involve more frequent contact with substances which trigger allergies. These professions include people in medical and caretaking professions, hairdressers, cleaning personnel, and professions in plastics and metal processing.

Can allergy development be prevented?

It is not really possible to prevent the development of an allergy or a sensitisation to allergens that are very common in the environment and it is hard to predict on an individual basis if a person will develop an allergy. In addition to genetic predisposition, life circumstances and environmental influences impact the development of certain allergies. For instance, children who are raised on a farm are less likely to develop asthma and allergies. Smoke-free and low-pollution environments, too, reduce the allergy risk.

It is generally prudent to reduce contact with chemicals known to contribute to triggering allergies. In work contexts, this can be done with, for example, technical means such as vacuum systems as well as through modified workflows. Additionally, gloves, respiratory masks, and protective clothing should be worn if appropriate.

How can people protect themselves from allergic reactions or treat allergies?

If an allergy has been diagnosed, further contact with the corresponding allergen should be, if possible, avoided, for example by abstaining from certain foods or problematic cosmetics. However, this is only possible if the triggering allergen has been identified and this is not possible with every allergy and every professional and life situation.

Treatment of allergies includes treating the symptoms, such as with ointments, creams, nasal sprays, and eye drops. It also includes attempts to familiarise the immune system with the allergen. This is called hypo-sensitisation therapy (also called desensitisation). To start, tiny amounts of the allergen are applied, for example via injection. As the therapy proceeds, the dose is slowly increased. If the therapy is effective, the tolerance threshold of the

immune system for the substance increases step by step. Allergic reactions no longer occur in daily life after every minimal contact with the allergen. Sometimes, allergic reactions no longer occur at all or only do so after contact with very large amounts of the allergen.

These types of therapies are currently mostly available for inhalation allergens such as grass pollen, dust mite excrement or insecticidal toxins. For other allergies, such therapy procedures are still in development. However, hypo- or desensitisation are not equally successful for everyone. Individual differences play a large role here, too.

What is the difference between food allergies and food intolerances?

With a food allergy, the immune system reacts to certain allergens in foods, such as certain proteins in nuts, soy, milk or chicken eggs.

Food intolerances, on the other hand, are not allergies, because the immune system is not involved. Food intolerances are frequently caused by an enzyme defect. A well-known example is lactose intolerance, in which the body does not properly break down and digest lactose (milk sugar), which in turn leads to symptoms such as cramps and diarrhoea.

Food allergies and food intolerances are jointly referred to as food hypersensitivities.

Do food allergens have to be labelled on foods sold in Germany and the EU?

In the EU, in accordance with Regulation No 1169/2011, the 14 most common substances or products which may trigger allergies and intolerances must be labelled on foods in which they are used as ingredients. The list includes the following substances as well as products manufactured therewith:

- Grains with gluten (specifically wheat such as spelt and Khorasan wheat, rye, barley, oats, or hybrid strains)
- Crustaceans
- Eggs
- Fish
- Peanuts
- Soybeans
- Milk
- Nuts (specifically almonds, hazelnuts, walnuts, cashews, pecans, Brazil nuts, pistachios, and macadamia and Queensland nuts)
- Celery
- Mustard
- Sesame seeds
- Sulphur dioxide and sulphites (from 10 mg per kg or l)
- Lupins
- Molluscs (e.g. snails, muscles, oysters, squid)

Allergens inadvertently introduced into foods, however, do not need to be labelled. Corresponding labels (“May contain traces of...”) are voluntary and are often used by manufacturers as a precautionary measure. For this reason, people with food allergies cannot rely on the presence or absence of such labels to know if and in what amounts

allergens are truly present in foods. The EU and the WHO are currently discussing mandatory labelling that includes unintentional allergen presence.

Insects as a food source: a problem for people with allergies?

From 2021 to 2023, four species of insect were approved in the EU as "novel foods": the larvae of the yellow mealworm, the European locust, crickets, and the larvae of the lesser mealworm. Other insects have been submitted for approval as foodstuffs.

There is no conclusive evidence as to whether or not eating insects itself can cause a (primary) food allergy. Some human studies from Laos and China have reported symptoms of food allergies among population groups which consume insects. Due to the fact that the proteins found in insects are similar to those in dust mites and crustaceans, cross-allergies might also be the cause of these allergic reactions. For this reason, foods must be labelled if they contain insect components. Overall, however, there is still much research to be conducted. The BfR is therefore conducting its own studies to assess the allergic potential of insects in Europe.

How are cosmetics labelled?

The ingredients of cosmetic products must be provided in written form. The labelling is carried out according to the INCI system (International Nomenclature of Cosmetic Ingredients) . This information is helpful for people with allergies. People familiar with the INCI name of the relevant allergen can potentially avoid products with corresponding ingredients.

More detailed information about cosmetic labelling is provided by the German Federal Office of Consumer Protection and Food Safety (BVL).

How is the use of sensitising chemicals regulated in the EU?

The use of sensitising chemicals is governed by a range of legislation across Europe. This includes the CLP Regulation, the REACH Regulation governing chemical use, the EU cosmetics regulation, the EU biocide regulation, and the EU toy safety directive. Among other things, labelling requirements, threshold values, and potential approval processes following risk assessment are legislated.

How is it determined if a chemical is skin-sensitising?

For a long time, sensitising properties of chemicals were predominantly determined through animal experiments, such as the "local lymph node assay" in mice. Now, however, EU legislation directs that animal experiments should be avoided whenever possible, calling instead for the use and development of animal-free methods. Therefore, use of tissue samples and cell cultures is also increasing when it comes to identifying substances which might trigger allergies. The BfR participates in the development and standardisation of such testing methods.

Several alternative testing methods have already been recognised and are, for example, codified in the EU REACH regulation or the biocide and plant protection regulations. Animal experiments are now only permitted if alternative methods are not feasible or if their results are not meaningful.

Hitherto unknown triggers of allergies might also be discovered when patients develop skin rashes after contact with previously “unsuspicious” substances or products and the particular allergen can then be identified.

For substances consumed with food (oral exposure), there is not yet a recognised testing method for allergy triggers. There are, however, at least some indirect tests which can suggest allergy-triggering proteins.

Many skin-sensitising chemicals are now restricted in their use or even forbidden. What effect does this have?

In their practical application, use restrictions for substances which might be skin-sensitising lead to fewer people coming into contact with these substances and potentially developing an allergy to them. One successful example is the EU restriction on the use of nickel in jewellery. Particularly among younger people, far fewer cases of such allergies have been observed since the regulation’s implementation. Similar developments have also been found for other substances, the use of which in cosmetics or household cleaning products has been forbidden or restricted.

Can toys or clothing trigger allergies?

When it comes to toys and clothing, the use of many substances which might trigger allergies is heavily regulated. For example, certain fragrances are entirely forbidden in toys or at least must be labelled. Additionally, there are limits for the maximum permitted release of metals such as nickel, cobalt, and chromium. However, there continue to be cases in which allergic reactions are triggered by clothing or toys. It is often very difficult to determine precisely which ingredient caused the allergic reaction.

Why can tattoo inks cause allergies?

Allergic reactions to tattoo inks are not common, but they do occur and are not easy to treat. The identification of the most important underlying allergens remains a relevant research topic, including at the BfR. A whole host of substances in tattoo inks are potential culprits, including preservatives or heavy metals such as nickel. Red ink is particularly frequently tied to allergic reactions.

During the tattooing process, ink is introduced directly into the skin, where it makes contact with immune cells and lymphatic fluid. At this point, sensitisation and/or an allergic reaction can occur, which may be aggravated by the damage done to the skin during tattooing.

Additionally, substances in tattoo inks can be transformed into other chemical compounds over time (for example through sunlight) or during laser removal. These new substances can also have an allergenic effect. Allergic reactions to tattoo inks can therefore occur both directly after the tattooing and years later.

Since 2022, the use of substances known to be hazardous to health (such as those which are carcinogenic or skin-irritating) in tattoo inks and permanent make-up has been restricted by an expansion of the EU chemical regulation, which also target several well-known sensitising substances.

Can exposure to nickel through food lead to a nickel allergy? Is this a problem for people with nickel allergies?

Traces of nickel are primarily found in plant foods. The nickel concentrations are comparatively high in pulses, nuts, and oilseeds (approx. 2 mg/kg), chocolate products (approx. 3.8 mg/kg), and cocoa products (approx. 9.5 mg/kg). By comparison, baked goods as well as meat and sausage contain far less nickel.

There have yet to be known cases in which exposure to nickel through food consumption has led to a nickel allergy. However, in cases of existing sensitisation, certain symptoms can be triggered when nickel is consumed through food in isolated cases. Generally, though, exposure to nickel through food is not a health risk for people with a nickel allergy.

How does the BfR contribute to improving protection of consumers against allergy-triggering substances?

The BfR, for example, within the framework of the EU REACH regulation, regularly assesses if and to what extent chemical or other substances can elicit allergies. The BfR also develops proposals for the classification and labelling of allergy-triggering substances within the scope of the CLP Regulation (EU Regulation on Classification, Labelling and Packaging). These assessments form the basis for laws and guidelines which might restrict the use of such substances in order to better protect consumers.

Furthermore, the BfR conducts intensive research in both independent projects and collaborations with other institutions in order to better understand and assess allergy risks.

Finally, BfR employees are members of many national and international committees. In this capacity, they contribute to the development of evaluation guidelines and assessment strategies in order to protect the population from allergens.

Further information about allergies on the BfR website:

A-Z Index: Allergies
https://www.bfr.bund.de/de/a-z_index/allergie-4868.html

BfR Science Report: “Allergies: Background and facts”
https://www.bfr.bund.de/cm/343/allergien-hintergruende-und-fakten.pdf

Spelt can also trigger allergies – low level of public knowledge about spelt being a type of wheat (Opinion)

https://www.bfr.bund.de/cm/349/spelt-can-also-trigger-allergies-low-level-of-public-knowledge-about-spelt-being-a-type-of-wheat.pdf

About the BfR

The German Federal Institute for Risk Assessment (BfR) is a scientifically independent institution within the portfolio of the Federal Ministry of Food and Agriculture (BMEL) in Germany. The BfR advises the Federal Government and the States ('Laender') on questions of food, chemicals and product safety. The BfR conducts independent research on topics that are closely linked to its assessment tasks.

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