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Ionisers and health

Information sheet

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Report in brief

Ionisers and health

GGDs are increasingly faced with questions about the effectiveness of ionising air purifiers commonly referred to as ionisers for short. This fact sheet provides a systematic review of the scientific literature on health effects of ionisers in everyday living spaces (homes, schools, childcare and office spaces).

Ionisers produce a stream of charged particles (ion flow) in the air that precipitate (fine) dust particles in the environment. In theory, this has a beneficial impact on air quality, and therefore potentially on air-quality-related health complaints, especially asthma. However, the impact on air quality is more limited in larger rooms and areas where the air is more in motion (e.g. due to activities or wider ventilation). In addition, ionisers tend to generate ozone. This in turn can lead to the formation of new substances in the air including aldehydes.
A second effect of ion current involves an effect on the metabolism of serotonin, a neurotransmittor in the brain. This has been demonstrated in laboratory animals, but not yet in humans. In theory, changing the amount of serotonin in the brain could have an effect on neuropsychological symptoms of depression and learning difficulties related to imprinting.

A beneficial effect of ionisers for people with asthma has not been demonstrated in scientific research. The effect on gloomy mood and depression, and attention and imprinting has been studied but the research is insufficient for conclusions. Research on other health effects does not meet scientific criteria so no conclusion is possible on these yet.

Keywords: Ioniser, asthma, depression, learning disabilities, indoor environment, air quality

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Content

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Summary

GGDs are increasingly faced with questions about the effectiveness of ionising air purifiers commonly referred to as ionisers for short. This fact sheet provides a systematic review of the scientific literature on health effects of ionisers in everyday living spaces (homes, childcare, schools and office spaces).
Ionisers cause a flow of charged particles (ion flow) in the immediate environment, some of which diffuse into the room. Hypothesised effects of the ion flow are an improvement in air quality and neurophysiological changes. In theory, this could have an effect on asthma, depression, or problems with attention and imprinting.

Effects on air quality
The effectiveness of ionisers in reducing particulate matter depends on many factors including the concentration and nature of the particles, relative humidity, size and design of the room, degree of ventilation, strength of the ioniser and use of the room in terms of the number of people and type of activities. Ionisers can inactivate microorganisms and allergens in indoor air and reduce their quantities. However, ionisers can also lead to adverse effects on air quality.
On the one hand, through the production of ozone; on the other, through the formation of volatiles and ultrafine particles through chemical reactions with ozone.

Neurophysiological effects
In animal experimental research, there is evidence that negative ions lead to a decrease in the amount of serotonin in the brain and positive ions to an increase. In humans, this has not been sufficiently studied and no conclusion is yet possible.

Health effects
For asthma, no effect of ionisers on symptoms, lung function and use of medication has been demonstrated. Research on the effectiveness of ionisers on mood and depression is not yet sufficient for an informed conclusion. No research is yet available on the effectiveness of ionisers in the daily living environment for other health effects, especially attention and imprinting.

Conclusions

- An ioniser has a limited impact on air quality.
- The use of an ioniser has no effect on asthma symptoms.
- Available research does not (yet) allow a conclusion on the effectiveness of an ioniser for depression and problems with attention and imprinting.

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1 Introduction

The importance of indoor environmental quality for health is increasingly recognised. There is an increasing demand from the public and political decision-makers for measures to promote indoor environmental quality. Ventilation is an important factor for indoor environmental quality. Lack of ventilation can cause an accumulation of contaminants from indoor sources. Major sources include building and finishing materials, combustion appliances, furniture and upholstery. These sources provide a mix of volatile organic compounds (VOCs) such as formaldehyde, aromatics, pesticides and inorganic volatiles such as chlorine and bromine compounds (flame retardants) and the radioactive radon gas with associated decay products (1). In addition, ventilation affects the moisture balance and thus the growth of biological components in the indoor environment, such as moulds and other micro-organisms, and mites (2). There is a tension between ventilation and energy saving. Energy bills can be a reason to ventilate less. Moreover, in buildings there may be insufficient possibility to ventilate or ventilation leads to a reduction in living comfort due to the feeling of 'draught'.

1.1 Reason

The use of air purifiers seems to be an attractive alternative to ventilation. There are air purifiers with a variety of operating mechanisms. Some air purifiers contain a combination of different air-cleaning techniques. Ionisers in particular have high expectations from manufacturers and suppliers. One argument for a beneficial effect on health is a supposed relationship between naturally occurring ionic currents and health. Meteorological research in the early 20ste century showed a high concentration of negative ions in waterfalls and in sea winds and an increased concentration of positive ions in föhn winds and during thunderstorms. This led to the hypothesis that weather-related health complaints were the result of charged particles in the atmosphere (3). Ionisers can be bought from white goods, electronic goods or building materials companies, among others. Manufacturers claim that (fine) dust, viruses, bacteria, allergens, harmful and irritants are removed with high efficiency (see Annex 1). The purifying effect is said to go so far as to make indoor air cleaner than outdoor air. It is suggested that air purifiers have a beneficial effect on general wellbeing and health. The question is to what extent the claimed and suggested effects of offered air purifiers are supported by scientific research.

1.2 Purpose and demarcation

The aim of this fact sheet is to provide professionals in environmental medical care with an up-to-date and as complete as possible overview of available research on the health effectiveness of ionisers. To this end, the method of a systematic literature review was used, as described in Annex 2, in which published research was collected and reviewed using a predetermined search strategy. Only publications of comparative studies with and without an ioniser were reviewed.

For a description of the hypothesised mechanisms of the health effects of an ioniser, additional literature review was conducted, formulating search strategies based on the results of the health effects literature review, as described above. For a detailed description of the search strategies, see Annex 2.

1.3 Reading guide

Chapters 2 and 3 provide a description of background literature on the presumed effects of ionic currents on air quality on the one hand (chapter 2) and neurophysiology on the other (chapter 3). These chapters can be thought of as explaining possible mechanisms by which an ioniser can affect people's health. The effectiveness of an ioniser on health problems is described in chapter 4. Here a distinction is made between the effectiveness on asthma (chapter 4.1), mood and depression (chapter 4.2) and attention and imprinting (chapter 4.3). Finally, chapter 5 presents the conclusions.

2 Effects on air quality

An ioniser produces a stream of electrically charged particles in direct ambient air, often within the device (1). This flow of charged particles leads to ionisation of particles in the ambient air. The effect of the ion flow on air quality consists of a decrease in the number of particles in the air by deposition and by changing particle properties.
Charged particles in the ambient air can adhere to surfaces with an opposite charge (electrostatic deposition), such as built-in filters, walls or furniture
(1). Changing electrical properties of particles can lead to changes in physico-chemical properties which can then cause conglomeration of particles. The conglomerates formed can precipitate on surfaces on the basis of gravity ('gravitational deposition'). In addition to removing particles from indoor air, ion flow can change particle properties, e.g. properties of microorganisms and allergens (4). However, ionisers can also lead to adverse effects on air quality, mainly through the formation of ozone (5). Ozone can irritate the airways and can increase the amount of harmful particles in indoor air (6).

When assessing effects on air quality, a large number of factors play a role including the nature of particles in the ambient air, environmental factors such as temperature and humidity, room usage and formation of pollutants. Studies on the effects of ionisers on air quality have usually been conducted in a controlled setting with a small number of effect parameters. This limits the interpretation of the results for the everyday living environment. Especially as the available research does not provide information on possible interactions between different substances.

2.1 Dust particles

Grinshpun et al (2005) investigated the effectiveness of five ionisers in a controlled laboratory setting and found a reduction in the number of dust particles with a diameter of 0.3-3.0 µm ranging from 30 to 90% over a period of 60 minutes (7). However, it is questionable whether these results apply to use of ionisers in living spaces such as homes, schools, etc. The study by Grinshpun et al (2005) took place in small rooms with controlled uniform pollution, with no human activities and no exchange of air with surrounding rooms and outdoors. Contradictory results were obtained in another test situation. In an experimental setting, no reduction of particulate matter ($PM_{2,5}$) was found (8).
Hacker et al (2005) found that dust particle reduction was dependent on particle size with the removal of small (< 1.0 µm) being worse than that of larger particles (> 1.0 µm) (9).

Results from studies in the living environment are also contradictory. Nogrady et al (1983) found no difference in dust particles ('total dust') in air from bedrooms with and without an ioniser (10). In contrast, a decrease in dust particles was found in work situations when an ioniser was used. Rosen et al. (1999) found particle reductions of 54% and 78% for fine dust (3.0-7.0 µm) and ultrafine dust (0.3-3.0 µm), respectively, in one of two nurseries studied (11). In similar studies in office spaces, Richardson et al. (2001) found a 40% and 70% reduction in particle counts for fine (3.0-7.0 µm) and ultrafine dust (0.3-3.0 µm), respectively (12;13). Skulberg et al. (2005) compared

office spaces with an active and an inactive ioniser and found a 32% greater reduction in total dust particles with an active ioniser; for the different fractions, the difference was 32% for particles < 5 µm, 25% for particles from 5-10 µm and 27% for particles > 10 µm (12;13). Croxford et al (2000) also found more efficient removal for the larger dust particles: a reduction of 63%, 54% and 51% for total dust, particles of 0.5-10.0 µm and particles of 0.5-2.0 µm, respectively (11;12;14).

2.2 Microbiological particles

Bacteria, viruses and fungi are scavenged and/or inactivated by ionisers through a combination of electrostatic deposition and biochemical modification of membrane proteins (15-18). However, this may also be a consequence of ozone formation by the ioniser (19). As yet, the contribution of ion current and related ozone formation to inactivation of microbiological particles, respectively, is not known.

2.3 Allergens

A decrease in ambient air has also been shown for allergens, particularly those from house dust mites and cats, when an ioniser is used (5;20). In the study by Goodman et al (2002), this concerned a controlled laboratory setting and in the study by Warner et al (1993) the bedrooms of children with asthma. Hypothesised mechanisms of action are, as for microbiological particles, electrostatic deposition and biochemical alteration of allergens by ionic current or ozone formation. Laboratory studies have shown a change in the allergenicity of Japanese cedar pollen under the influence of an ioniser, shown by an 80% decrease in binding to specific antibodies (IgE) (21).

2.4 Volatile organic compounds and other gases

As for gaseous substances, there is no effect of an ioniser on the concentration of formaldehyde, other volatile organic hydrocarbons (VOCs), carbon monoxide and ozone (22). The effect on tobacco smoke is twofold with a decrease in the number of dust particles (0.01-7.5µm) and no effect on the concentration of gases (carbon monoxide, ammonia, nitrogen (di)oxide, hydrogen cyanide or formaldehyde and other hydrocarbons) (23). For radon, there is insufficient research on the effect of an ioniser on especially harmful decay products of radon (1).

2.5 Environmental factors

The effect of an ioniser on air quality depends on many environmental factors, such as particle concentration, physical environmental conditions (relative humidity, ventilation, turbulence), room characteristics (volume, relative size of surfaces) and ioniser characteristics (room placement, capacity).
With a higher concentration of particles, an ioniser leads to a greater decrease (13). Humidity affects the concentration of ions in the air, with the influence depending in a complex way on the distance from the ioniser (24). No publication has been found on the influence of ambient temperature. Ventilation affects the effectiveness

of the ioniser. On the one hand, by exchange of particles between indoor and outdoor air; when ventilation is intensive, there is a continuous supply of newly introduced particles. If the indoor air is moving a lot due to ventilation, less particle deposition is to be expected. Also, activities inside the room can cause air turbulence and thus resuspension of deposited particles.
The decrease in the concentration of dust particles by an ionising air cleaner also depends on the volume of the room and on the number and type of surfaces in the room. The ion concentration decreases with distance from the ioniser. The layout of the room is important in relation to the surface area available for electrostatic deposition. The effectiveness of an ioniser is a function of its operation and the ratio of surface area to volume, with higher effectiveness at higher ratios (7).

2.6 Side effects

Side effects of ionisers include noise pollution, static charging, contamination of surfaces by precipitation of particles, resuspension of particles and formation of reaction products such as ozone. An ioniser can electrostatically charge objects in the environment, with annoying electrical discharge on contact with such objects (7). Static charging and discharging depends on the strength of the air purifier. This limits the use of a strong air purifier to suit large rooms.
Resuspension of precipitated particles may pose a health risk, depending on the properties of the particles. However, there are no known data on this. In weighing up positive effects of allergen reduction and negative effects of ozone production and resuspension, Goodman et al. (2002) recommend limiting the use of ionisers in living spaces to periods when the spaces are not in use (5). This is pending improvements in technology for lower ozone production.
A third side effect of ionisers is the production of ozone. Room ozone production increases with the strength of the ioniser and indoor air ozone concentration decreases with room volume (25). Goodman et al (2002) found an ozone concentration of 0.025 ppm (50 $\mu g/m^3$) based on a short-term measurement in the immediate vicinity of the ioniser (5). While this one-time measurement is lower than the WHO advisory value of 100 $\mu g/m^3$ (8-hour mean), it concerns a measurement over a shorter time period where it is unclear whether it is representative of ozone production over longer time periods. Ozone can cause respiratory symptoms, especially in sensitive, atopic, individuals (6). In addition, ozone can lead to the formation of aldehydes, other volatile compounds (VOCs) and ultrafine particles through chemical reaction with commonly occurring substances in the indoor environment (e.g. limonene), which can pose a health risk (6).

3 Effects on neurophysiology

Based on a series of laboratory animal experiments, Krueger formulated the serotonin hypothesis in 1960 (3;26). Serotonin is a neurotransmittor in the brain, which plays a role in mood and imprinting. The serotonin hypothesis assumes that positive ions lead to an increase and negative ions to a decrease of serotonin in brain tissue. This hypothesis is based on observations in animal experimental research. Studies in humans show varying results (27;28). Charry (1984) concludes in a systematic review that the interpretation of human studies conducted is limited by flaws in the study design, procedures used and statistical analysis (27). It is unknown how ions in ambient air can lead to internal exposure and alter serotonin metabolism. A respiratory route is generally assumed, but dermal exposure has also been suggested (29).
As yet, not enough is known to assume a relevant effect on serotonin in humans. No research is available on any other physiological or pathological effects of exposure to ionic currents via ambient air.

4 Effects on health

In this chapter, the following three health effects are discussed in more detail: asthma, mood and depression, and attention and imprinting. The former is related to the assumed effect on indoor air quality due to ion flow (see Chapter 2), while the other health effects assume neurophysiological effects due to exposure to charged particles (see Chapter 3).

4.1 Asthma

For asthma, the effectiveness of an ioniser in the daily environment was determined in six controlled studies: one in the occupational setting (13) and five in the home setting (10;20;30-32). The five studies in the home situation were all *randomised controlled trials* with *crossover*. The intervention took place at night during sleep. This is because the mattress is a reservoir for house dust mites and the ioniser is expected to reduce the amount of house dust mites. The duration of the intervention varied from 2-8 weeks. The intervention involved an ioniser producing negative ions in all studies and an inactive ioniser in the control situation. Only in one study was the ion concentration actually determined; it was 1546 and 1675 per millilitre in the control situation and 203,000 and 183,000 per millilitre, respectively, during the intervention period (10). Limitation of all mentioned studies is the lack of statistical power calculation, which leaves unclear which effect is considered clinically relevant.
Three studies also evaluated exposure. Nogrady et al (1983) found no difference in particle counts between the period with active and the period with inactive ioniser (8 weeks each), despite a more than 100-fold difference in ion concentration (10).
In contrast, Skulberg et al. (2005) found a lower amount of total dust in ambient air with an active ioniser (13). In none of these studies did further determination of the dust particles take place.
Warner et al (1993) observed a decrease in the concentration of house dust mites in the ambient air of bedrooms during the period of an active ioniser (6 weeks) without an effect on clinical features (symptom score, lung function and medication) (20).
None of the studies found any difference between the intervention and control groups in terms of asthma symptoms, medication use, or lung function. This finding confirms the conclusion of a Cochrane Review on ionisers and asthma (33).

4.2 Mood and depression

Research on the effectiveness of an ioniser for depression involves six controlled studies, three of which were conducted in a clinical setting (34-36) and three in the home setting (37-39). In all studies, except that of Skatsche et al (1988) for which no exposure data are known, subjects sat at a distance of 32-92 cm from an ioniser for 30-60 minutes daily over a period of 3-5 weeks. The intervention group used an ioniser with an output of 2.7×10^6 negative ions per second and the control group with an output of 1.0×10^4 negative ions per second. For maximum displacement of charged particles to the body, subjects were grounded via a band around the wrist.

A higher concentration of negative ions in ambient air had a beneficial effect on seasonal depression: a clinical improvement of depression occurred in 20-40% of patients; in the control group (low output negative ions), a clinical improvement was observed in 5-17%. The improvement under the influence of high concentration of negative ions was similar to the results for light therapy which led to a clinical improvement of depression in 33-53% of patients (35;38).
Two studies found beneficial effects of an ioniser on self-reported feelings of depressed mood, without clinical diagnosis (34;36). The advantage of ion therapy over light therapy is said to be that the former does not interfere with the partner's sleep and, compared to bright light, is perceived as less disruptive by some people (37).

However, research on the effect of ionisers on depression and self-reported depressed mood is still too limited for a definitive conclusion. The recent studies were all conducted by two US research groups with partly the same investigators. The results need to be confirmed in other research. Moreover, the results of these studies contradict the supposed mechanism of action of negative ions on serotonin metabolism. Health effects of negative ions could be explained by a reduction in the amount of serotonin in the brain (see chapter 3). By contrast, in depression, a beneficial effect of drugs that actually increase serotonin levels is seen. Therefore, the positive findings of negative ions on depression calls for further research on neurophysiological effects.

4.3 Attention and imprinting

Problems with attention and imprinting manifest themselves at an early age in learning difficulties at school. Increased activity of serotonin in the brain seems to play a role in this, as shown in studies in laboratory animals and a positive effect of serotonin lowering medication in children with learning difficulties (40). Theoretically, an ioniser could have a beneficial effect on problems with attention and imprinting due to the supposed effect of lowering the amount of serotonin in the brain (see chapter 3).

Six controlled studies have been published on the effect of ionisers on attention and imprinting, including one in the occupational setting (34) and five in an experimental setting (40-44) Three studies evaluated word imprinting (40;42;44) and three evaluated motor tasks (34;41;43). The results suggest a beneficial effect of negative ions on word imprinting, but no effect on motor task performance. To date, no research results are available on the effectiveness of ionisers on concentration and learning problems in a daily setting of school or work; thus, no statement can be made in this regard.

4.4 Other health effects

General health complaints
Two controlled studies determined the effectiveness of an ioniser on general health complaints such as headache, fatigue, irritation of eyes or the nasal mucosa (13;22).

Both studies took place among employees in office buildings. The study by Daniell et al (1991) used a crossover design.
In both studies, a similar decrease in health complaints was observed in both the intervention and control groups (13;22). In this regard, Daniel et al. (1991) found no change in dust particle counts in the situation with and without an active ioniser (22). In contrast, Skulberg et al. (2005) found a greater decrease in dust particle counts with an active ioniser (13).

Absenteeism
One study evaluated the impact of an ioniser on sickness absence (11). The study took place in two Swedish nurseries over a three-year period. Inconsistent results were found in this study. In one nursery, sickness absence decreased in the year with an active ioniser and increased in the year with an inactive ioniser. However, this was not confirmed in the other nursery.

4.5 Negative health effects

None of the studies used for this fact sheet systematically evaluated any adverse effects. Sulman et al (1978) investigated the safety of exposure to an ioniser for 16 hours per 24-hour period over a two-month period in 10 subjects. No difference was found for a wide range of physical and physiological characteristics, including neurohormones in urine, liver function, general urinalysis (acidity, albumin, glucose, bilirubin, occult blood), blood cell counts), heart rhythm (ECG), and neurological function (EEG) (45). Goel et al (2006) investigated perception in a healthy population of students and found no difference between active and inactive ioniser (36).

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5 Conclusions

Air quality

- The effectiveness of ionisers for dust particle reduction depends on many factors including the concentration and nature of the particles, relative humidity, size and design of the room, degree of ventilation, strength of the ioniser and use of the room in terms of number of people and type of activities.
- An ioniser can reduce the number of vital microorganisms in indoor air, especially bacteria and fungi. On the one hand by decreasing the number, and on the other hand by decreasing the properties of the particles.
- An ioniser can reduce the number of allergens in indoor air and reduce the allergenic properties of these particles.
- Ionisers are not effective in reducing the concentration of gaseous components in ambient air. On the contrary, chemical reactions can increase the concentration of volatile compounds.
- Ionisers produce ozone that can lead to the formation of ultrafine dust particles and volatile compounds through chemical reactions.

Neurophysiological effects

- In animal studies, evidence has been found that negative ions decrease serotonin levels and positive ions increase serotonin levels. This has not been confirmed in human research, so no substantiated statement is possible.

Health effects

- For asthma, no effect of ionisers on symptoms, lung function and medication use has been demonstrated.
- The effectiveness of ionisers on mood and depression has not yet been studied sufficiently for a substantiated conclusion.
- No conclusion on the effectiveness of ionisers on problems with attention and imprinting is possible because research is still too limited.

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Annex 1: Information ionisers from manufacturers

Manufacturer A

New study results show that traffic-induced increases in particulate matter load are causing an increase in asthmatic bronchitis and sensitisation to pollen and other common allergens.
The US Environmental Protection Agency (EPA) concludes that there is more concern about indoor than outdoor air pollution.
Scientific research by the EU commission has shown that in the European Union, the air in indoor spaces contains a variety of pollutants that are even more dangerous than the pollutants in outdoor air and pose just as great a danger to our health.

Harmful substances in indoor air
Indoor space has become the typical abode for modern humans: often up to 90 per cent of time is spent here. Per day, the average-sized adult human breathes about 20 cubic metres of air. This air volume corresponds to a mass of about 25 kilograms, far exceeding the mass of food and drinking water used per day. While food and drinking water can be carefully selected, this is generally not possible with air. Reason enough to pay attention to indoor air quality.

Allergy & Asthma
[redacted] air purifiers are particularly suitable for allergy and asthma sufferers. People who are sensitive to airborne allergens such as pollen, mould spores, cat or dog dander and house dust mite droppings can reduce the likelihood of exposure to these allergens in indoor spaces by using highly effective air purifiers.
[redacted] supplies high-efficiency air purifiers for removal of allergens and other irritants.

Babies & Children
New study results show that a baby on the floor breathes the equivalent of 4 cigarettes a day.
Cause: Mold spores, dust, pollen and allergens-all indoor air pollutants found in a home and even more concentrated close to the floor. Therefore, achieving an allergy - friendly home is crucial for babies.

Swine flu
[redacted] air purifiers reduce the risk of infection with the H1N1 - swine flu virus - in rooms with large numbers of people.

Manufactur er B

Cleans and refreshes the air

[redacted] The air cleaner removes dust particles, pollen, toner dust, smoke, unpleasant odours, is effective against allergic reactions to dust mites, eliminates bacteria and has a virus-killing effect, thanks to the air ioniser and a photocatalytic nano-filter.

Bactericidal and virucidal effect through application of UV light.

[redacted] The air cleaner contains a UV lamp with a bactericidal and virucidal effect,this technique is also used for disinfecting the air in hospitals, or for killing bacteria in swimming pool water. Of all types of light, UV light has the highest frequency, the shortest wavelength and therefore contains the highest amount of energy whose radiation pierces the organism's outer membrane and destroys the DNA. The remains are filtered out of the air by the electrostatic action of the dust-collecting plates of the electrostatic air filter.In the air purifier, the effectiveness of the UV lamp is maxi[redacted]ving the lamp in combination with a photocatalytic nano-filter.

Clean air thanks to air ioniser

The[redacted]atures an air ioniser. Negative ions are negatively charged air particles. They bind to dust particles, bacteria, micro-organisms and other air pollutants and cause them to clump together. As a result, the particles become heavier than air and settle. This removes harmful substances from the silently drawn in air.

Negative ions have a positive effect on human health and well-being. The air in nature, such as by the sea, in the forest or in the mountains, is charged with negative ions. Charged plastic surfaces, house dust and electrical appliances take away ions and can therefore cause complaints such as a dry throat, a stuffy nose, a flu-like feeling, fatigue, sleeping problems and headaches. These complaints are countered bythe negative ion generator.The air purifier combats complaints associated with Sick Building Sy[redacted]sures fresh air and a healthy working and living environment.

Extra powerful cleaning thanks to photocatalytic air filter

The photocatalytic nano-filter uses Titanium Dioxide. When exposed to UV light, it secretes hydrogen peroxide (H_2 $O_2$and hydroxyl radicals (OH). These substances are able to break down odours and eliminate bacteria and viruses.Partly because of this, the air purifierhelpsprevent colds, allergic reactions [redacted]ission of viruses through the air. The photocatalytic nano-filter works in combination with a UV lamp with a bactericidal and virucidal effect. This is an internationally recognised technology, which also cleans swimming and drinking water, for example.

Manufacturer C

The positive impact of negative ions
Negative ions have a great impact on human well-being and can be very effective in combating physical complaints.Increase the indoor well-being of you or your family members by placing the [redacted] in your living room, bedroom, children's room or office. A higher concentration of negative ions has been shown to be effective in increasing human resistance and wellbeing.

Negative ions not only have a positive effect on human health and mood, but also have a strong air-purifying effect, the negative ions bind to dust particles, bacteria, micro-organisms and other air pollutants and cause them to clump together. As a result, the particles become heavier than air and precipitate. With thisthe [redacted] removesdust particles, pollen, cigarette smoke, unpleasant odours, and is effective ag[redacted]eactions to dust mites and eliminates bacteria.

Manufacturer D

Ionisation
Ionisation is the most promising form of air purification. An air purifier that ionises produces positively and negatively charged ions and disperses them in the room. These ions surround the bad substances, so to speak, after which a chemical reaction renders them harmless.
Negative ions attach themselves to pollen, mould, cigarette smoke and dust, among others, and neutralise their harmful effect. In this way, air pollution by culprits such as bacteria and germs is countered. Ionisation can counteract pollutants as small as 0.01 micrometres in diameter.
Researchers have scientifically proven that negatively charged air ions are important for a healthy and clean air climate. Naturally, negative ions are common in the air near mountains, after thunderstorms and near the sea.

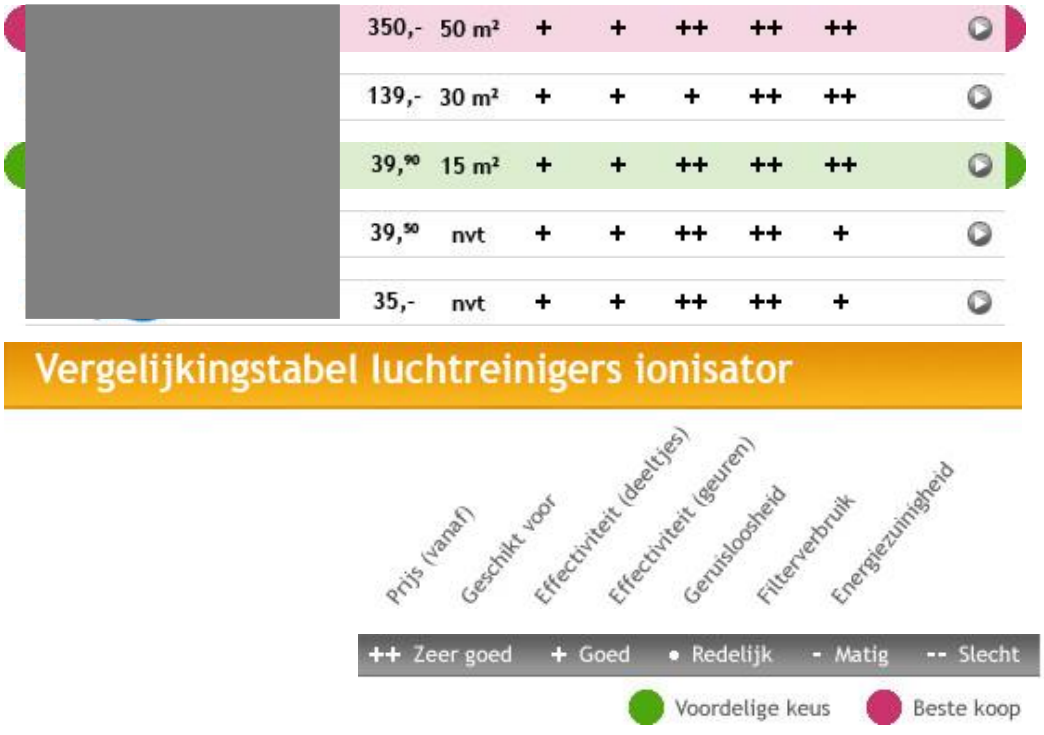
Operation of ionisation

Manufactur er E

Air cleaners ionisers

- Removes dirt particles from the air
- No filter required

Ionisers are inexpensive, simple air purifiers. An ioniser introduces a large amount of electrons into the air that attach themselves to oxygen molecules. The charged molecules then attach themselves to dirt particles in the air. These now carry an electrical charge, causing them to precipitate in the environment. In this way, the particles thus disappear from the air. Ionisers require no filter material and use little electricity.
We have placed the features in a comparison table. Click on the product of your choice for more information or to order the product.



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Manufacturer F

Why an ioniser?

Ionising the air around us is a perfectly safe and healthy way to keep the atmosphere in your immediate environment optimally healthy.During the ionisation process, the air purifier at filters the air to fight pollution ar[redacted]stances. These can be house dust mites and pollen, for example. But dirty tobacco smoke or unpleasant odoursfrom your pet alsodisappear. Ionisation combined with the air purifier creates permanently clean and pure air. In your living room, bedroom, office. But also in the cellar or hobby room

Functioning air cleaning with ioniser, ionising air.

The technology of an ioniser is simple and reliable. Ionisers use a small amount of electricity to ionise the air. In that process, an electric charge is applied to airborne particles. The ioniser releases as many as 20,000 to 200,000 ions per second into the atmosphere. This process is completely safe. As these then become heavier, they fall to the ground. To put it more simply, the ionised dust swirls down and is thus rendered harmless. The atmosphere in the room where the air cleaner with ioniser does its work is thus cleaned very effectively. So you can[redacted]

Where ionisation works

Our environment is becoming increasingly crowded. And that means our atmosphere is also becoming increasingly polluted. The signs are clear. More and more people develop respiratory diseases and fresh, clean air has long since ceased to be a matter of cou[redacted] Therefore, air cleaners with ionisers are an effective and safe solution. In urbanenvironments, but also near busy (fast) roads and industrial estates, offersa solution. But also fo[redacted] in rural areas or near parks. After all, a lot of pollen andpollenfloat aroundthere.Here, too, air cleaners with ionisation technolog[redacted]t for people with symptoms of hay fever or allergic diseases.

Clean air for optimum performance

No matter how clean your home seems and how often you vacuum, micron-sized dusts will always remain suspended in the air. And this is why ionisation is important, even when it comes to bacteria in the atmosphere. By ionising with negatively charged ions, the air becomes clean and you can take in oxygen more easily. Breathing becomes easier because less histamine is released into the airway. This bodily substance is part of our body's defence system.
Histamine causes coughing which is a protective response. The cleaner the air, the less coughing. Moreover, a positive effect is that the amount of serotonin, which affects your mood, remains stable in your brain. So you are also more balanced and in terms of mood

When will you benefit from ionisation of the air

In the following situations, users benefit greatly from [redacted] air purifierswith ionisers:

- Allergic reactions to hay fever, house dust mites, tobacco smoke, fungi.
- Shortness of breath due to bronchitis, asthma, tobacco smoke and allergies.
- People with birds, dogs and cats.
- Fatigue and stress complaints.
- Migraine.

- People living or working next to busy roads.
- The desire to always breathe healthy pure air at home

The ionisation process in detail

[redacted] The air cleaner with ionisation disperses electrons in the room. Inside the device, a negative high voltage is applied to a needle. The electrons then jump off the needle and bind to oxygen molecules including dust, germs and bacteria. The charged oxygen molecules then attach themselves to harmful (positively charged) dust particles in the air and neutralise them. These can be tobacco smoke, pollen, and mould, but also harmful gases such as formaldehyde, sulphur dioxide and hydrocarbon compounds. So with artificial ionisation, you create a restoration of the natural concentration of negative ions. The voltage on the needle is high, but the power is low. The process is therefore safe

Correct operation of the ioniser

If you want optimal effect from[redacted] with ioniser, make sure the room is well ventilated.An ambient temperature of 20°C and a relative humidity of between 45 and 60% are highly recommended. [redacted] also offers efficient humidifiers. Ask about the possibilities!

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Annex 2: Method of literature review

Question

What is the effectiveness of using an ioniser on health problems?

Type of investigation and procedure

Systematic literature review
After performing the search strategy, titles and abstracts were selected for relevance to the question, inclusion criteria and the presence of an English-language abstract if the language of the article was other than English, German, Dutch or South African. From the selected abstracts and in case of doubt about inclusion, articles were reviewed.

Databases

Medline (1966-2009), Embase (1974-2009), Cochrane Central.

Search strategy

Research design and population
Since this is an efficacy study, the condition for inclusion was the comparison of an intervention group with an ioniser and a control group without an ioniser. No further specification was made to the control condition such as placebo. Also, no criteria were set on how an individual was assigned to the intervention or control group: randomised or not. Table 1 shows the selection criteria of study design and population.

Table 1. Selection criteria regarding research design and

populationResearch design	Population
Clinical Trial Meta-Analysis Randomised Controlled Trial Comparative Study Controlled clinical trial	Humans

Search terms

All search terms were entered as MeSH term and as `text word`. The search strategy was carried out in two rounds. In the first round, the search strategy consisted of the relationship between ´ioniser´ and
´health´. Based on the results, a second round was conducted for three sub-areas of health, namely ´asthma´, ´depression´ and ´attention - learning difficulties´. Table 2 shows the search terms.

Table 2. Search terms ioniser &health Round

1: 'Ioniser' and 'health'			
	ioniser* *or*		well-being *or*
	ioniser* *or*		quality of life *or*
	electrostatic* *or*	AND	health *or*
	ion generat* *or*		sympt* *or*
	aeriontherapy *or*		disorder *or*
	ionised air *or*		ill *or*
	ionised air		illness
Round 2A: 'Ioniser' and 'asthma'			
	ioniser* *or*		asthma *or*
	ioniser* *or*		wheeze *or*
	electrostatic* *or*	AND	cough *or*
	ion generat* *or*		lung function *or*
	aeriontherapy *or*		spiromet* *or*
	ionised air *or*		peak expiratory flow *or*
	ionised air		PEF *or*
			forced expiratory volume *or*
			FEV1 *or*
			hyperresponsive* *or*
			hyperreactive* *or*
			BHR *or*
			AHR
Round 2B: 'Ioniser' and 'mood/depression'			
	ioniser* *or*		affective* *or*
	ioniser* *or*		depression* *or*
	electrostatic* *or*	AND	mood*
	ion generat* *or*		
	aeriontherapy *or*		
	ionised air *or*		
	ionised air		
Round 2C: 'Ioniser' and 'attention/learning issues'			
	ioniser* *or*		attention* *or*
	ioniser* *or*		learning* *or*
	electrostatic* *or*	AND	task performance*
	ion generat* *or*		
	aeriontherapy *or*		
	ionised air *or*		
	ionised air		

Results

Title selection yielded 40 hits for selection of abstracts and/or articles for evaluation of health effects of ionisers (see table 3).

Table 3. Results of article selection; details of selection in brackets

Asthma	
Inclusion	
1. Mitchell EA, Elliott RB. Controlled trial of an electrostatic precipitator in childhood asthma. The Lancet 1980;13:559-61.	
2. Nogrady SG, Furnass SB. Ionisers in the management of asthma. Thorax 1983;38:919-22	
3. Ben-Dov I, Amirav I, Sochina M, Amitai I, Bar-Yishay E, Godfrey S. Effect of negative ionisation of inspired air on the response of asthmatic children to exercise and inhaled histamine. Thorax 1983;38:584-8.	
4. Lipin I, Gur I, Amitai Y, Amirav I, Godfrey S. Effect of positive ionisation of inspired air on the response of asthmatic children to exercise. Thorax 1984;39:594-6.	
5. Bowler SD, Mitchell CA, Miles J. House dust control and asthma: a placebo-control trial of cleaning air filtration. Ann Allergy 1985;55(3):498-500	
6. Warner JA, Marchant JL, Warner JO. Double blind trial of ionisers in children with asthma sensitive to the house dust mite. Thorax 1993;48:330-3	
7. Larsen KR, Olsen OT, Jarnvig IL, Svendsen UG. Ion generators and bronchial asthma. A double-blind placebo controlled study. Ugeskr Laeger 1994;156(41):6025-7	
8. Skulberg KR, Skyberg K, Kruse K, Eduard W, Levy F, Kongerud J, Djupesland P. The effects of intervention with local electrostatic air cleaners on airborne dust and the health of office employees. Indoor Air 2005;14:152-9.	
ExclusionRationale for exclusion	
9. Jones DP, O'Connor SA, Collins JV, Watson BW. Effect of long-term ionized air treatment on patients with bronchial asthma. Thorax 1976;31:428-32.	no control group
10. Sovijärvi AR, Rosset S, Hyvärinen J, Franssila A, Graeffe G, Lehtimäki M. Effect of air ionisation on heart rate and perceived exertion during a bicycle exercise test. A double-blind cross-over study. Eur J Appl Physiol Occup Physiol 1979;41(4):285-91.	no health effect
11. Taudorf E, Fosse L, Kjaergaard B, Munch E, Weeke B. Electrostatic filter in the treatment of bronchial asthma. Ugeskr Laeger 1982;144(40):2941-5.	Danish, no English abstract available
12. Dantzler BS, Martin BG, Nelson HS. The effect of positive and negative air ions on bronchial asthma. Ann Allergy 1983;51(3):362-6.	no control group
13. Nogrady S, Furnass B, Stevens D. Air ionisation: its effects in bronchial asthma. Aus NZ J Med 1983;13(5):547.	double publication
14. Kirkham AJ, Hawkins L. The effect of air ionisation on lung function in chronic asthmatics. Clin Sci 1984;67(suppl 9):62-3P.	abstract symposium
15. Daugbjerg P, Brenso E, Henriksen E, Ibsen KK. Ion generator and asthmatic bronchitis/bronchial asthma. Evaluation of an ion generator in the treatment of recurrent asthmatic bronchitis and bronchial asthma. Ugeskr Laeger 1988;150(2):90-4.	Danish, no English abstract available
16. Wickman M, Sandvik L, Aas K. Ion generators are not a complement to asthma treatment in children. Lakartidningen 1989;86(20):1889-90.	Swedish, no English abstract
17. Larsen RK, Olsen OT, Svendsen OG. Ionization of the air as therapy in patients with bronchial asthma. A negative double blind, placebo-controlled study. Eur Respir J 1994;7(suppl 18):15s.	abstract symposium
18. Pomorenko GN, Ponomareva EV, Sereda VP. BiocontrolledRussian	, no english

aeriontherapy - a new method of treatment in patients with bronchial asthma. Vopr Kurortol Fizioter Lech Fiz Kult 2003;(5):17-9.	abstract

Mood/depression

Inclusion

19. Skatsche R, Kobinger W, Fischer G. The influence of artificially produced negative small air ions on the psycho-physical activities of office-clerks. Zentralbl Arbeitsmed Arbeidssch Prophyl Ergonomie 1988;38(11):358-63.
20. Terman M, Terman JS. Treatment of seasonal affective disorder with a high-output negative ionizer. The J of Alternative Complement Med 1995;1:87-92.
21. Terman M, Terman JS, Ross DC. A controlled trial of timed bright light and negative air ionization for treatment of winter depression. Arc Gen Psychiatry 1998;55:875-82.
22. Goel N, Terman M, TErman SU, Macci MM, Stewart JW. Controlled trial of bright light and negative air ions for chronic depression. Psychol Med 2005;35:945-55.
23. Goel N, Etwaroo GR. Bright light, negative air ions and auditory stimuli prouce rapid mood changes in a student population: a placebo-controlled study. Psychol Med 2006;36:1253-63.
24. Terman M, Terman SU. Controlled trial of naturalistic dawn simulation and negative air ionization for seasonal affective disorder. Am J Psychiatry 2006;163:2126-33.

Exclusion

25. Delenanu M, Stamatiu C. Influence of aerionotherapy on some psychiatric symptoms. Int J Biometereol 1985;29:91-6.	no control group double
26. Partonen T. Bright light and high-density negative air ionization reduces symptoms of seasonal affective disorder. West J Med 1999;171(5-6):315-6.	publication

Attention and imprinting

Inclusion

27. Buckalew LW, Rizzuto AP. Negative air ion effects on human performance and physiological condition. Aviation Space & Environ Med 1984;55(8)731-4.
28. Morton LL, Kershner JR. Negative air ionization improves memory and attention in learning-disabled and mentally retarded children. J Abnormal Child Psychol 1984;12(2):353-66.
29. Yates A, Gray F, Beutler LA, Sherman DE, Segerstrom EM. Effect of air ionization on hyperactive and autistic children. Am J Phys Med 1987;66(5):264-8.
30. Skatsche R, Kobinger W, Fischer G. The influence of artificially produced negative small air ions on the psycho-physical activities of office-clerks. Zentralbl Arbeitsmed Arbeidssch Prophyl Ergonomie 1988;38(11):358-63.
31. Morton LL, Kershner JR. Differntial negative air ion effects on learning disabled and normal-achieving children. Int J Biometereol 1990;34:35-41.
32. Nakane H, Asami O, Yamada Y, Ohira H. Effect of negativeair ions on computer operation, anxiety and salivary chromogranin A-like immunoreactivity. Int J Psychophysiol 2002;46:85-92.

Exclusion

33. Morton LL, Kershner JR. Negative ion effects on hemispheric processing and selective attention in the mentally retarded. J Ment Defic Res 1987;31:169-80.	no health effect
34. Kozená L, Frantik E, Lajcíková A. Articificial air ionization doesn't compensate for deleterious effects of monotony. Act Nerv Super (Praha) 1988;30(4):255-8.	Czech

Other health effects	
Inclusion	
35. Rosén KG, Richardson G. Would removing indoor air particulates in children's environments reduce rate of absenteeism - A hypothesis. Sci Total Environ 1999;234:87-93.	
36. Daniell W, Camp J, Horstman S. Trial of negative ion generator device in remediating problems related to indoor air quality. J Occup Med 1991;33(6);681-7.	
Exclusion	
37. Marin V, Moretti G, Rassu M. Effects of ionization of the air on some bacterial strains. Ann Ig 1989;1(6):1491-500.	no health effect no health
38. Livanova LM, Elbakidze MG, Aïrapetiants MG. Effect of the short-term exposure to negative air ions on individuals with vegetative disorders. Zh Vyssh Nerv Deiat Im I P Pavlova 1999;49(5):760-7. [abstract only, article Russian].	effect
39. Richardson LJ, Hofacre CL, Mitchell BW, Wilson JL. Effect of electrostatic space charge on reduction of airborne transmission of Salmonella and other bacteria in broiler breeders in production and their progeny. Avian Dis 2003;47(4):1352-61.	no health effect
40. Gus'kov AS, Ingel' FI, Gubernskii IuD, Malyshev AG, Bezzubov AA, Rastionnikov EG. Aeronification and its impact on workers' functional status and health. Gig Sanit 2005;(4):32-4.	Russian

Additional literature on hypothesised mechanisms

Table 4 shows the two exploratory search strategies followed established for background articles on hypothesised mechanisms of ionisers. Based on titles and abstracts obtained, a number of articles were selected to describe hypothesised mechanisms and effectiveness of ionisers.

Table 4. Search terms ioniser &mechanism

'Ioniser' and 'indoor air'			
	ioniser* *or* ioniser* *or* electrostatic* *or* ion generat* *or* aeriontherapy *or* ionised air *or* ionised air	AND	indoor air* *or* indoor environment *or* tobacco *or* volatile* *or* VOC
'Ioniser' and '(neuro-)physiology'			
	ioniser* *or* ioniser* *or* electrostatic* *or* ion generat* *or* aeriontherapy *or* ionised air *or* ionised air	AND	serotonin* *or* tryptamin* *or* 5-HT