Effects of Pool Water on Swimmers' Eyes, Ears, Teeth and Hair


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Why do I see rainbows around lights after swimming in a pool? Does too much chlorine in pool water cause eye irritation? What causes my hair to turn green after swimming in some pools? Is it safe to wear contact lenses while swimming? What should I do if I get swimmers' ear?

This paper will attempt to answer these and other compelling questions frequently asked by swimmers of lifeguards, swim instructors and pool operators. It is hoped that those of you who work with the swimming public will then be able to impugn some myths about the dangers of swimming in chlorinated water, and, give a knowledgeable explanation as to how pool water effects swimmers' eyes, ears, teeth, and hair.

EYES

Eye irritation is a major cause of bather discomfort and source of complaints from swimming in pools. Usually, due to a lack of knowledge of pool chemistry, the eye irritation will be attributed to too much chlorine in the water. This of course is incorrect, but there are four major sources of irritation that pool operators can control.

The first is chloramines. In order to understand what chloramines are, it is necessary to first understand what happens when chlorine enters the water. Chlorine reacts with and oxidizes bacteria and other organic matter in the water. Some chlorine added to the water is lost due to evaporation. The chlorine left over, or the chlorine residual, which is free or available to immediately attack future bacteria or organic material not yet introduced into the pool is called free available chlorine (F.A.C.). Some of the residual chlorine combines with other substances, particularly nitrogen and amonia introduced by swimmers, to form combined available chlorines (C.A.C.), also known as chloramines. Although they are present in the water as a residual,
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they are not freely available. They will kill bacteria but at a rate one hundred times slower than F.A.C. They are also undesirable since they are the major cause of eye irritation, itchy skin and mucous membrane irritation, and are responsible for the rather unpleasant odor often attributed to chlorine. To eliminate chloramines from the water superchlorinate whenever the C.A.C. level reaches .3ppm.

A second source of eye irritation is unbalanced water. Water balance is used to ascertain if proper chemical levels are being maintained in the pool. Water temperature, pH, calcium hardness, and total alkalinity all need to work together to balance water and avoid corrosion or calcification problems. To determine if water is balanced, use a test kit and reagents, and the Langlier Saturation Index. If water is unbalanced, the individual components should be chemically adjusted and brought into ideal ranges.

Friction of water and debris against the cornea and disruption of the tear film is another source of irritation. Excessive debris or turbidity of the water may be due to any of the following. The pool filter media or elements are not being cleaned often enough, or the hair and lint trap, or skimmer baskets are not being emptied often enough. Settled debris are not being vacuumed out of the pool frequently enough. Total dissolved solids (T.D.S.) levels are too high. The pool should be emptied and refilled when the T.D.S. level approaches 1500 ppm. Quantities of chemicals are being added to the water too quickly or in too large a concentration. The filter system may be operating without media. D.E. elements may not be precoated with diatomaceous earth. Channeling or mudball development may have occurred in high rate sand filters. The supporting layers of sand and gravel may have been upset in a rapid sand filter. Or, the circulation system and filters may not be sized properly to meet user demand.
Environmental factors, primarily wind and sun reflection, are sometimes overlooked as a source of swimmer eye irritation. Irritated eyes can result from wind blowing debris filled air, smog, pollen or other air pollutants into a swimmer's eyes. Eye burn can result from sun reflection off the water and into the eyes of a swimmer. Prolonged ultraviolet light exposure causes inflammation of the cornea, and may lead to development of cataracts, the cloudiness in the eye lens which can lead to blindness. Swimmers should be encouraged to use eye drops containing antihistamines after swimming, and wear good filter coated goggles while swimming in outdoor pools to lessen the irritation from the wind and sun.

Corneal edema is the accumulation of fluids in the eye. The clear part of the front of the eye becomes swollen and fills with water. Since pool water is less salty than tears, or hypotonic, water from the pool moves by osmotic pressure into the eye, and is the causitive factor in corneal edema.

This causes blurred vision because of the loss of some cells off the surface of the cornea, and photophobia, or sensitivity to light, making the eyes more sensitive to smog, smoke and light. Haag (1983) reported that in chemically balanced pools, sixty-eight percent of swimmers saw halos or rainbows around lights within an average of 13.7 minutes of entering the pool. This sensitivity to light usually disappears within thirty minutes of leaving the pool. To lessen the effects of corneal edema it is recommended that goggles be worn when swimming in chlorinated pools and fresh water lakes.

The question as to whether it is safe to wear contact lenses while swimming in pools due to fear of infection from corneal abrasions or loss of lenses continues to be studied.

Pool and Spa News (1985), reporting the findings of research done at the Indiana School of Optometry, found after one and a half hours of swimming only
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one of twenty-eight lenses, worn by fourteen different swimmers, was lost. Osmotic pressure of pool water forced out the saltier water content of soft lenses. Lenses tended to shrink and fit the cornea more tightly.

Stein (1977) studied the effect of visual acuity, ease of lens removal, and effects after removal of lenses. Stein found that after three to four minutes, the lenses adhered firmly to the cornea due to the hypotonicity caused by the pool water, and adherence became stronger with increased length of exposure to water. There was no change in vision. There was less blinking, but normal blinking returned in about thirty minutes after leaving the pool.

Wearing of hard contacts while swimming was not recommended. Loss of lenses was common with hard lenses in both fresh and salt water, and with soft lenses in ocean water. In eighty-four trials of entering the pool in various ways, only six soft lenses were lost. No contacts were lost at all in one hundred and two trials where pool water was splashed in the eye before entering the pool. There was no damage to the lenses themselves.

Stein found no infection of the eyes from swimming in mildly contaminated water. However, eye infection is possible if lenses become contaminated from water, or if corneal abrasions result from contaminated debris getting under lenses.

Because of the strong adherence of lenses to the eye, swimmers should wait thirty minutes after leaving the pool to remove soft lenses, or use saline solution eye drops to avoid damaging the corneas.

EARS

Swimmer's ear, or otitis externa, is an inflammatory disease of the auricle, the skin of the outer ear. The interaction of four
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Factors—temperature, length of exposure, amount of moisture retained in the ear canal, and the presence of bacteria, lead to the development of external ear infections. Chlorine changes the ear canal lining from slightly acidic to alkaline. Wax and the protective lipid film coating are washed out of the ear by water, and the resulting laceration of the skin encourages bacterial growth. Infection is caused by bacteria or fungi contaminated water entering the ear and growing under these favorable conditions. Pseudomonas aeruginosa, proteus vulgaris, staph and strep infections are most common.

Some people are more susceptible than others to swimmer's ear. Individuals with allergies, and children with their favorable anatomical external ear construction are particularly prone to developing these infections.

The following suggestions may be effective in preventing external ear infections by deterring water from entering or remaining in the ears. Wear a bathing cap and pull it down over your ears. Use earplugs or lambs wool coated in petroleum jelly and inserted into the ear canal. Towel off after swimming and dry the ears thoroughly with a towel or hair dryer. Jump up and down and shake the head to dislodge trapped water.

Initial symptoms of swimmer's ear are: mild to moderate pain, low grade fevers, a discharge from the ear, and itching or throbbing. The ear canal may be swollen, and there may be a light partial hearing loss. Symptoms may not appear for several hours, or even a day or two after exposure.

Dry heat helps relieve pain associated with swimmer's ear. In addition, the application of antibacterial eardrops, a combination of alcohols to reduce moisture, and boric acid or vinegar to help reduce the multiplication of bacterial organisms, will return the ear canal to an acidic state and slow bacterial growth and the spread of infection.
Middle ear infections, or otitis media, are a serious problem requiring medical attention and antibiotics. Middle ear infections develop as a result of viral infections of the nose and throat.

There is an increased possibility of infection from the pressure of exhaling through the nostrils with the mouth closed while swimming. This may push mucous toward sinuses and the middle ear. Water which is inhaled may travel past infected nasal passages to the middle ear from the pharynx via the eustachian tube. Abrasions from wearing incorrectly fitting earplugs may lead to infection. Pressure on the eardrum may be responsible for the development of ear polyps, a mass of swollen tissue in the mucous membrane. Development of ear polyps is common to SCUBA divers, and more common in children than in adults because of the shape of their developing eustachian tube.

Signs of middle ear infections include severe earaches and some loss of hearing caused by the build up of fluids in the ear. The ear drum may perforate resulting in a discharge of pus. Today antibiotics can prevent the spread of infection to the skull cavity, but permanent deafness can still result if ignored.

Although less common that either otitis externa or media, ruptured eardrums are sometimes associated with water activities. Diving from a height and hitting the water too hard on the side of the head, or diving to depths without equalizing pressure are most often the cause. Competitive divers learning twisting dives should be encouraged to wear plastic coated wrestling earguards during practice. Before practicing surface diving or underwater swimming, students should be instructed in the proper methods and importance of clearing their ears in order to equalize pressure to avoid injury to their eardrums.
The widespread belief that frequent swimming in chlorinated swimming pools causes dental enamel erosion, is inaccurate. This misconception can be traced to a single incident reported in Morbidity and Mortality Weekly Reports (1983, July), Dentistry Today (1983, September), and the Harvard Medical School Health Letter (1983, December) as well as being mentioned in numerous other newspaper columns.

A dentist in Charlottesville, Virginia noticed that two of his patients that were swimmers on the same competitive private club team had "general erosion of enamel from the anterior surface of the incisors and premolars" (Dentistry Today, 1983). A questionnaire was sent to all members of the swim club, and it was found that fifteen percent of frequent swimmers and three percent of infrequent swimmers had some symptoms of enamel erosion. Symptoms included rough or gritty feeling teeth, transparent, yellow, or chalky colored teeth, or pain while chewing.

Analysis of a water sample taken from the club pool indicated that the pH was maintained at 2.7. A pH of 2.7 is one hundred thousand times more acidic than the recommended ideal range of 7.4 to 7.6. The media inaccurately reported the problem as resulting from the use of gas chlorine rather than a hypochlorite so as to save money in chlorinating a large pool. The real problem of course was twofold. Improper maintenance and balancing of the pH of a pool where elemental gas chlorine with a pH of 2.9 was being used as the primary bactericide was the immediate cause. Secondly, the problem arose because operation of the pool facility was the responsibility of a pool manager with little or no training in pool chemistry, maintenance or operation.
Regular swimming in chlorinated pools can severely damage hair. Chlorine softens and dissolves the cuticle, the protective outer layer that covers the inner cortex, of each hair shaft. Chlorine bonds with protein in hair, making it dull and brittle, and fading color treated hair. The damage can be cumulative. Damaged and overprocessed hair is even more susceptible to deterioration. Weak hair can be further harmed by regular hair brushing or combing. Breakage and split ends may result.

Some commercially available shampoos contain additives that can help break the chlorine-protein bond. Routine shampooing with sodium thiosulfate, found in UltraSwim shampoo, or, with EDTA (ethylenediamine tetracetic acid) found in products such as Nexus, Finesse, Prell, and Clairol Essence, will help alleviate, or at least reduce the amount of damage.

Damaged hair can be partially repaired by conditioning while swimming. Before beginning a workout, apply conditioner to your hair and cover with a bathing cap. Heat generated from exercise while swimming will provide a heat conditioning treatment.

Try to limit the use of blow dryers, since they further dry out already dull and lifeless hair. Don't brush hair when it's wet. Let it dry naturally, then to lessen breakage, brush only with a wide tooth comb.

Discoloration, or the development of greenish coloration of hair, is another problem common to regular swimmers with blond, gray or white hair. This development is usually attributed, incorrectly, to the presence of too much chlorine in the water.

Copper from source water, or copper introduced as residue from improperly maintained and disintegrating copper pool recirculation pipes, or copper...
sulfate added to the pool as an algaecide, is really the culprit. Copper oxidizes hair, and leaves behind a greenish residue.

There are three generally accepted methods of eliminating the green tint from hair. The use of shampoos containing either sodium thiosulfate or EDTA, in addition to the previously mentioned use, will also break the bond with copper minerals. The color can be removed by bleaching the hair with a three percent peroxide solution, and then applying a chelating compound. A third method is to dissolve six aspirin in twelve ounces of warm water, pour the solution on your hair, let sit and rinse after fifteen minutes.

REFERENCES


While you're having fun this summer, protect your beauty from the elements. (1983, June). Philadelphia Inquirer, p. 8-L.