

Microbial load in indoor sport environments: new quality issues by molecular biology

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Abstract

The quality of hygiene found in sporting environments represents an emergent requirement in societies of industrialised countries. Besides safety issues, the microbial load of indoor air, water and surfaces affects comfort and performance. Recent studies have identified fungi as the quantitatively most important component, of unhealthy indoor air. Few studies have been carried out regarding indoor sport, recreational and rehabilitative facilities, such as swimming pools, saunas and spas. The aim of our study is to determine the extent of fungal and microbial contamination in indoor swimming pool environments, by means of both morphological and molecular typing of isolated species. Establishment of appropriate standardised monitoring procedures prevents infections and improves quality.

Introduction

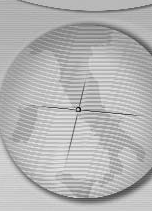
Quality assessment of environments for sport activities includes the evaluation of microbial contamination levels. In recent years, fungi have been identified as quantitatively the most important component of unhealthy indoor air. Fungi commonly isolated in indoor environments include species of *Alternaria*, *Aspergillus*, *Aureobasidium*, *Cladosporium*, *Epicoccum* and *Penicillium*. Species of *Mucor* and *Rhizopus*, both zygomycetes are also frequently isolated in air.[1] Fungi exposure has been reported to cause several types of human health problems, primarily: irritation, infections, allergies, and pneumonia. It has also been suggested that toxigenic fungi are the cause of additional adverse health effects such as organic dust toxic syndrome.[2-5]

Fungi can be found both indoors and outdoors. Many thousands of species of fungi exist, although the overall exact number is not known. The kingdom of Fungi includes common molds that grow best in warm, damp, and humid conditions all year round. Molds are multicellular eukaryotic organisms that spread and reproduce by spores. Spores can survive harsh environmental conditions, such as dry conditions, that do not support normal growth. Yeasts are unicellular fungi belonging to the phylum of *Ascomycota*. The yeast *Candida* can be found on skin or mucous membranes and may be responsible for infections in humans. A variety of manifestations of *Candida albicans* infections are

associated with the formation of biofilms on the surface of biomaterials. Studies demonstrated an increased resistance to antifungal treatments, of the sessile forms of the cells with respect to their planktonic counterparts. It has been reported that the allergy threshold level for common molds, including *Alternaria* species, is 100 CFU/m³. The percentage of the population allergic to molds varies from 2% to 18%, while approximately 80% of asthmatics are reportedly allergic to molds.[1]

Description of the Project

Sick Building Syndrome (SBS), although probably not due to any single cause, has been increasingly associated with fungal contamination in buildings.[6] The risk of illness or infection associated with indoor environments is linked to microbiological indoor air and water quality and can also be associated with the inhalation, or contact with the surface of, objects or materials contaminated with pathogenic fungi. Important factors directly affecting the airborne fungal population are the availability of nutrients and water, both favouring fungal growth as well as the means by which spore dispersal takes place.[1-4] Legionnaire's disease represents an emergent risk due to an ubiquitous bacterium that can be released in the indoor air through showers or other aerosol creating devices. Several other bacteria play a role in indicating microclimate conditions and air quality. Detection and typing by molecular methods is an advanced approach



related to simple, sensitive, specific and time saving procedures.[7-10] Probe techniques, restriction endonuclease analysis, karyotyping, and DNA and polymerase chain reaction fingerprinting methods are available to detect and identify significant bacteria and fungi in the indoor air environment. The objective of our investigation is to determine the extent of microbial contamination in indoor swimming pool environments by morphological and molecular typing. The final aim is to implement appropriate hygienic control procedures. In addition to safety issues, microbial load evaluation represents a quality marker related to Heat Vacuum Air Conditioning System maintenance as well as to management of hygienic parameters.

Conclusions

Indoor swimming facilities have high levels of humidity and elevated temperatures, favouring the colonization of detrimental species such as fungi and bacteria. Mechanical ventilation systems are often implicated in the dispersal of fungal spores because these can amplify and spread airborne fungal fragments present in either contaminated air entering the system or directly from microbial populations growing in the system itself.[5]

Mold growth has been associated with water condensation on walls, in air ducts, and under carpets, tiles and flooring [2]. In buildings, water-damaged materials or the presence of substrates rich in organic materials, may constitute reservoirs for fungi such as *Asperillus fumigatus*, *A. flavus* and *A. niger*. [1] Indoor fungal spore levels are generally higher in winter and in unhealthy, enclosed environments rather than outdoors.[6]

Although "Tinea pedis", or "athlete's foot", can be transmitted by direct person-to-person contact, in swimming pools it is frequently transmitted by physical contact with surfaces, such as floors in public showers, changing rooms, etc., which are contaminated with infected skin fragments.[11-13] Various species of fungi of the *Trichophyton* genera and *Epidermophyton floccosum* are responsible for superficial fungal infections of the scalp, fingernails, feet "Tinea pedis" and skin. Several atopic reactions have been related to fungi. Independently from disease prevention, microorganisms represent environmental quality indicators.

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