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The WRC operates in terms of the Water Research Act (Act 34 of 1971) and its mandate is to support water research and development as well as the building of a sustainable water research capacity in South Africa.

Managing the quality of water in public swimming pools and similar recreational water environments

New findings from a research study conducted by the Water Research Commission (WRC) highlights the presence and levels of chemical compounds of concern in swimming pool water, and the subsequent exposure of swimmers to these harmful compounds of concern swimming. There are a number of environmental health regulations that address swimming pool water quality, however, they are fragmented and do not adequately address risks associated with chemical compounds. Considering the fact that swimmers are not expected to be drinking large quantities of water during the activity, reference to SANS 241 (South African drinking water quality standard) as a measure for swimming water quality is inappropriate. Based on this study, the policy recommendation is to integrate the current regulations into a comprehensive risk-based recreational water quality guideline taking into account all the risks in public swimming pools and similar recreational environments from source to use.

Legislative context

The roles and responsibilities of the Department of Health in water quality management is stipulated in the Strategic Framework for Water Services (2003). Chapter 3, Section 21(2) (b)(ii) of the National Health Act, 2003 (Act No. 61 of 2003) as amended, mandates the Director-General of the Department of Health must issue and monitor compliance to National Environmental Health Norms And Standards. In this regard, the National Environmental Health Norms and Standards for premises and acceptable monitoring standards for Environmental Health Practitioners, issued in terms of the National Health Act (Act 61 of 2003) stipulates the need for a water quality risk management approach for managing water quality in recreational environments.

The health related regulatory requirements for monitoring the quality of water in public swimming pools and similar recreational water environments are stipulated in the National Norms and Standards relating to Environmental Health, as published in the South African Government Gazette Notice 943 of 2013. One other important guidance on the quality of public swimming pool water in South Africa stipulated is that the potable water supply serving the swimming pool should comply to the drinking water quality standards (SANS 241). The responsibility for swimming pool

water quality monitoring and ensuring water safety and accessibility in respect of quality (microbiological, physical and chemical) is the responsibility of environmental health practitioners, as prescribed in the Environmental Health Practitioners Health Professions Act (Act No. 56 of 1974).

From this, it is clear that there is a need to harmonise all these regulations in order to streamline compliance enforcement and protect water users from exposure to environmental hazards present in swimming pools and similar recreational water environments.

Current practices in swimming pool water quality risk management

A review of municipal bylaws around the country showed these aspects were covered explicitly, and in the few cases where they were expressed, the regulations were aligned with the National Norms and Standards regulations, considering both SANS 241 and the 2006 World Health Organisation (WHO) guidelines for recreational water environments (volume 2: Swimming pool water and similar recreational environments). From the National Norms and Standards, it is evident that public swimming pools in South Africa are often managed only to protect the bather from microbial pathogens. In terms of chemical parameters, both the WHO guidelines and the National Norms and

Standards state that parameters such as pH, turbidity, residual disinfectant, and microbiological must be frequently monitored. The WHO guidelines further states that no harm should come from the pH or chemicals added to treat the water. However, there is no evidence that a comprehensive water safety planning approach (taking into account all risks from source to use) is currently followed for swimming pool water quality management.

Need for monitoring chemical compounds and mixtures in swimming pool water

Numerous research reports have shown that some of the water treatments chemicals added, or their transformation products and residuals may pose significant human health risk to the users (swimmers). Apart from the addition of water treatment chemicals, the bathers themselves may contribute compounds to swimming pool water that may be harmful to human health. Examples of these are the myriad pharmaceuticals and personal care products that are either excreted into the water (through sweat, urine and small amounts of faecal matter) and/or washed off from the skin during swimming.

Such compounds are not yet regulated, and for some the effects are known and for some, not. Bathers would also be exposed to compounds that originate from the supply, and could include toxic heavy metals other inorganic compounds, as well as traces of organic compounds. The mixture of disinfectants and organic compounds create by-products that may be more toxic than their parent compounds. In comparison, outdoor pool water is likely five times less genotoxic than indoor pools and a possible explanation is the potentially increased volatilisation of chemicals in the open air.

The WRC-funded study, led by North-West University, investigated the occurrence, levels and risks of selected compounds of concern in public (municipal) and private swimming pool waters showed a presence of a variety of chemical compounds in swimming pool water, including the classes stated above. However, the levels of most of the individual chemicals were found to within acceptable limits. None of the disinfection by-products, such trihalomethanes (THMs), for instance, was greater than their respective guideline levels, and the total THMs in only one sample exceeded the guideline levels. However, nitrites almost invariably exceeded the South African drinking water quality standard (SANS 241). Some of the unregulated pharmaceuticals and personal care products detected in the swimming pool water included fluconazole, artocaine, efavirenz and methylene blue which were only

detected at the municipality pools. Zoloperone, detanosal, euprocin, dihyprylone, ampyrimine, indeloxazine and pyridinolcarbamate were unique to the holiday resort pools.

In terms of the toxicity assessments, there was evidence of androgen and oestrogen activity, of both the agonistic and antagonistic type, but none of these responses exceeded any internationally available guidelines. The South African guideline for oestrogen-like responses was exceeded only once and that was for a backwash sample. The human health risk assessment revealed that for both hazard quotient (HQ) and cancer risk (CR) backwash water is the most harmful and if the water is returned to natural sources aquatic biota might be harmed. Exposure through the skin was greater than through the ingestion of swimming pool water and it was the metals that were responsible for the highest HQ and CR compared to the THMs. Chloroform was one of the THMs that contributed to health risk. Children were more at risk than the adults to develop detrimental health effects due to these compounds and elements that occur in public swimming pools.

Recommendations for managing the water quality of swimming pools and similar recreational water environments

Need for integrated regulation on recreational water quality risk management

The National Environmental Health Norms And Standards for premises and acceptable monitoring standards for Environmental Health Practitioners, issued in terms of the National Health Act (Act 61 of 2003) stipulates the need for a water quality risk management approach for managing water quality in recreational environments. However, a combination of literature review and laboratory analysis showed that current practice does not follow a comprehensive risk management approach (ie water quality risk management from source to use). The source water used to keep the water levels in the pool filled, should be monitored to prevent the exposure of bathers to harmful chemicals. In addition, the current regulation does not address all the chemicals that may be of concern to bathers.

These aspects highlighted here are result of the fragmentation, as a weakness in the enforcement of the various current regulatory instruments. In light of the fact that people are not expected to be drinking large quantities of swimming pool water, application of SANS 241 for swimming pool water quality management is not appropriate as it does not adequately consider exposures to both known and emerging chemical compounds of concern through dermal and inhalation (through

aerosolisation), especially where ventilation is poor, should be considered. Integrating all the water quality regulations into one document framed around water safety planning for recreational water environments might help solve this problem and also enable better coordination for monitoring and compliance enforcement.

Strengthening regulation of water treatment chemicals

Studies have shown that the use of water treatment chemicals can contribute to the formation of toxic by-products and metabolites. In particular, while the priority should be on protecting bathers from exposure to microbiological hazards through the addition of disinfectants, necessary precautions must be taken to avoid the formation of disinfection by-products. Care should be taken NOT to return backwashed water into the pool since it contains the highest levels of contaminants. Backwashed water should be treated before being disposed of into the environment.

Adoption of a toxicity screening approach for chemicals risk management

Another issue that needs addressing is the combinatorial effect of all these compounds. The bathers are exposed to the mixture of compounds simultaneously present in the pool. These compounds might cause synergistic effects, enhancing effects seen in single exposures or because of competing for the same cellular receptors, might inhibit each other's effect, lessening the expected harmful effect. The lack of guidance on the effects of chemical mixtures

is not only limited to South Africa, but is a weakness with most current global water quality guidelines and standards. In a country such as South Africa where there is limited capacity to quantify concentrations on a regular basis for known contaminants, it is not a feasible solution to have only maximum concentration levels to protect human health listed in a regulatory document, adoption of a toxicity screening approach for chemicals risk management may be advantageous.

Strengthening water user education

Bathers should be informed about their contribution to the presence and levels of chemical compounds of concern in swimming pool water. For example, the role pharmaceuticals and personal care products may play in contaminating swimming pool water with endocrine disruptors and that making use of the showers (often available at public swimming pools) before entering the pool might help to curb overloading the pool with contaminants. Bathers should also be made aware of the detrimental health effects they may cause other bathers when relieving themselves in the water, not only because of hygienic reasons, but also because partially metabolised pharmaceuticals entering the swimming pool in this manner. These pharmaceuticals may contribute to load of endocrine disruptive compounds. Members of the public should be made aware of the possible risks they expose themselves to when using public swimming pools, especially the more sensitive life stages.

Related report:

Chemicals in Recreational Water: Occurrence and Potential Risk in Public Swimming Pools (WRC report no. 2804/1/20).

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