

RECREATION AND WATER

Keeping our swimmers safe – SA study investigates water quality of public pools

Everything's under control. It's cool in the pool. Certainly the municipal and holiday resort swimming pools many of us visit are refreshing, but are things quite as they ought to be, water quality-wise? Matthew Hattingh reports on a recently published Water Research Commission (WRC) study on the subject.



So, is the water quality in municipal swimming pools up to scratch? Yes and no, really. The accepted standards are, by-and-large, being met, according to a study commissioned by the WRC, titled, *Chemicals in Recreational Water: Occurrence and Potential Risk in Public Swimming Pools (WRC report no. 2804/1/20)*.

But the study questioned whether the standards themselves were fit for the task. It also suggested that bathers, particularly athletes who spend a lot of time in the pool, should become better informed about the effects of chronic exposure to chemicals. They should be encouraged to shower before as well as after entering the pool and discouraged from widdling in it.

Pool maintenance may need to up their game too. And the

study suggested backwash water, where flow has been reversed to flush a pool filter, should be watched more closely. The study's authors, ecotoxicologists, Prof Rialet Pieters and Dr Suranie Horn, of the North-West University's Unit for Environmental Sciences and Management, focused on the chemicals found in pool water.

They made the point that pool managers rightly work at meeting microbial parameters. But while keeping bacteria at bay and banishing protozoans – single-cell organisms that carry disease – the chemicals found in the same water may escape notice.

These chemicals have three origins:

- From municipal drinking water sources which by law must

- be used to fill public pools;
- Added to the pool as disinfectants, chiefly chlorine-based formulations and the byproducts of these; and
- Off the bodies of bathers (sunblock, cosmetics and other person grooming gunk), or excreted or shed from their persons (metabolised pharmaceuticals in urine, faecal matter and sweat).

All were examined, but it was this third main category that really interested the researchers. Pieters and Horn noted that although the health risks posed by personal care chemicals and cosmetics in general use have been well documented, rather less was known about what happens when these are mixed together with pool disinfectants and sunlight. And, more to the point, whether the watery chemical soup we leap into with hardly a care might be messing with our endocrine systems.

After all, some of the pharmaceuticals we take and lotions and potions we lather ourselves with are known to interfere with these systems. This includes the glands that secrete hormones and the receptors that detect and react to the hormones. At risk then, is the body's chemical messaging and regulating networks, which affect everything from our metabolisms and nervous systems to our tissue function.

"The biggest motivation for this study was to learn the endocrine disruptive effects of swimming pool water, because this is an effect not often considered in monitoring regimes. And the biggest contributor of endocrine disrupting effects by swimming pool water is likely to be pharmaceuticals and personal care products," the authors said. They noted that because of the broad and interwoven role hormones play in the body, disrupting their function can lead to cancer, heart and liver disease, reproductive disorders, learning and behavioural problems, and immune-related health problems.

Care for a dip, anyone?

Ok, so assuming we have made the leap into the water, how do those chemicals enter our bodies? The literature suggests that what with splashing about an adult, on average, swallows between one and two teaspoons of pool water and children may ingest up to five times this volume.

Chemical vapours are found near the surface of the water and bathers will inhale these, with the amounts varying depending on whether the pool is indoors or outdoors. Then, as we all know, the skin is the human body's largest organ, providing plenty of surface area for chemicals to creep in. The extent to which this happens depends on how long you are in the water, its temperature and the chemical compounds and concentrations concerned.

Now for a closer look at some of these chemicals

First up, the disinfectants. When chlorine is added to water it produces what are known as disinfectant byproducts (DBPs). According to 2015 research, at least 700 byproducts have been found in chlorinated water and many of these have been linked to cancer and genetic mutation.

One class of DBPs is trihalomethanes, which can be absorbed relatively easily by the body and stored in its fat, and have been known to cause cancer.

South Africa's drinking water standards (none exist for public pool water – more on this later) lists the maximum permissible levels for four trihalomethane compounds: chloroform, bromoform, dibromochloroform and bromodichloroform. The authors limited themselves to measuring levels of these, the most common DBPs, as well as "total trihalomethanes".

Metals were touched on in the study too. The drinking water standards lists a number of these and sets a level for each to avoid a wide variety of health risks that come with long-term exposure. Five are viewed as very toxic: cadmium, chromium, lead, mercury, and arsenic (not strictly a metal).

Pharmaceuticals and personal care products are commonly found in public pool water, but the researchers focused on those known to disrupt endocrine systems, noting that these, when combined with disinfectant byproducts, can create something more harmful than the products alone.

Parabens (a preservative) are found in sunscreens and other personal care products. Parabens have been found to affect levels of oestrogen, the hormone responsible for the development and regulation of the female reproductive system. Then there are phthalates. Used in beauty products, deodorants, lotions and, for example, to stop nail varnish from going hard, it is a testosterone receptor blocker and has also been shown



Photograph supplied

Children are at greater risk than adults to exposure from chemicals found in pools.

to have a role in the development of obesity and blood-sugar disorders.

Other hormone disruptors washing off bathers and into the pool's chemical soup include synthetic musks, antibacterial and antifungal agents. A veritable medicine chest of pharmaceuticals excreted from the skin or passed out in urine awaits bathers. These include non-steroidal anti-inflammatory drugs known to affect endocrine functions, including the reproductive systems of aquatic vertebrates. And there's no cause for complacency here.

"They are useful examples because if it can happen to fish, it may happen to a human, also a vertebrate," Pieters and Horn explained.

During 2018 and 2019, the researchers collected samples from the surface water of two outdoor, unheated municipal swimming pools in an undisclosed town in the North West Province. And in the same province they drew samples at a holiday resort known for its good pool water maintenance. The resort pools – two outdoor and one indoor, all heated – are filled from a borehole, occasionally topped up with municipal water.

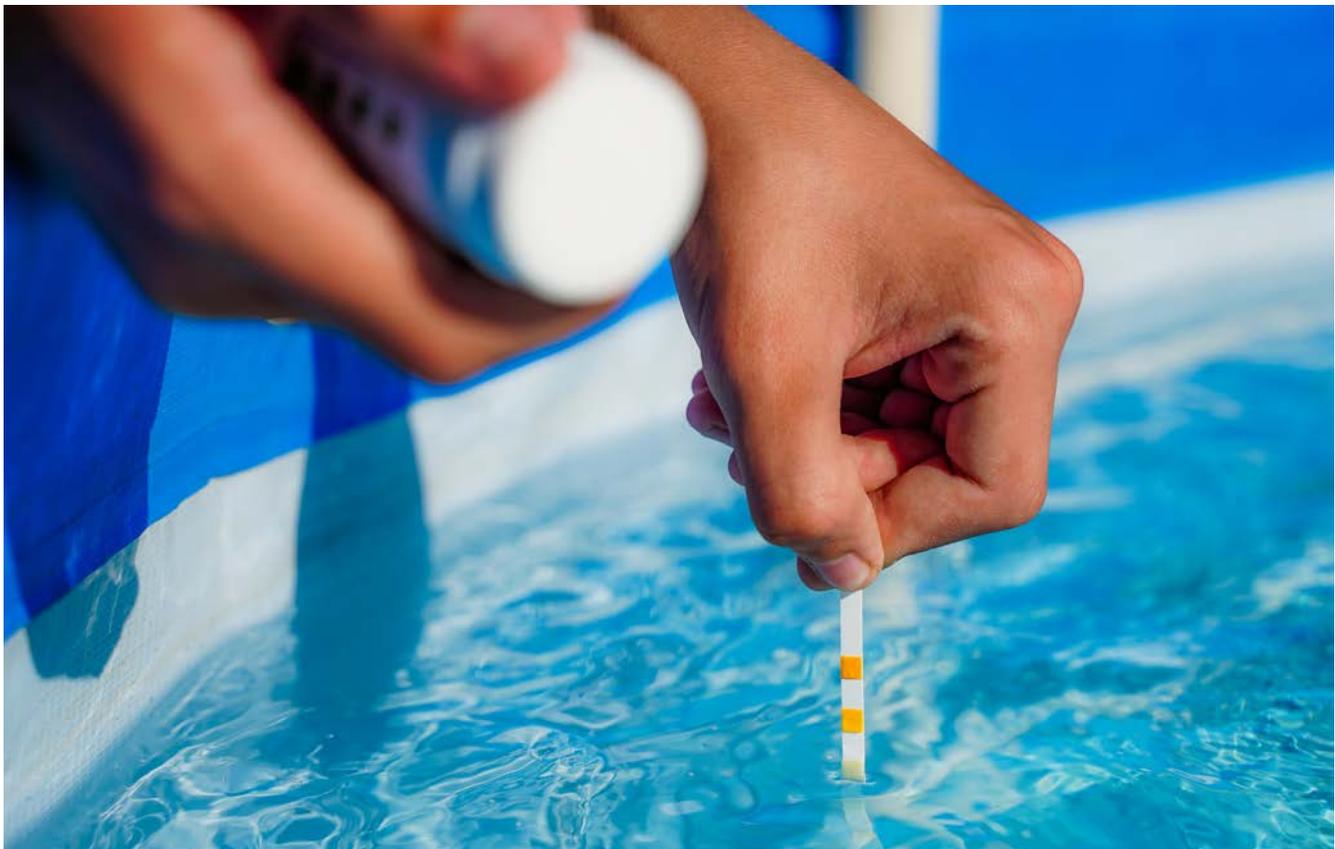
Levels were determined for the four common DBPs and a host of metals; and concentrations of these were recorded from pool samples as well as from source and backwash water. Measures of concentration were done mainly to establish if it differed in the morning (before bathers arrived) from the end of the day. The pools were also investigated for pharmaceuticals and personal care products.

Rand Water's laboratory analysed the samples for disinfectant byproducts, while an in-house lab at the North-West University's Potchefstroom campus handled the metals. The pharmaceuticals and personal care products were extracted for analysis using proprietary systems, with the water sample concentrated 2 000 times to near dryness. Chromatographic analysis (which separates chemical mixtures into their component parts) was used to identify compounds, with the process calibrated to detect endocrine disrupting hormones. This was facilitated by comparison against a database which includes 9 200 compounds – everything from human doping and designer drugs, to veterinary drugs, pesticides, pharmaceuticals, stimulants, benzodiazepines and a whole lot more.

So what were the findings?

None of the metals covered by the drinking water standards for chronic health risks exceeded the permitted levels in any of the pools. Lead levels in the water at the borehole exceeded the limits but, contradictorily, were much lower in the reservoir it feeds. The authors recommended follow-up investigations. The study also found "very high" lead levels in one of its backwash water samples, but this is fed into a pond where no bathing is allowed.

Real danger of these compounds lay in long-term exposure, rather than from a short spell in a pool.



It's important that pH levels are correct to make the most of the chlorine used and so avoid overdosing.

Organic compounds and the trihalomethanes they give rise to were within the drinking water standards, with the exception of an afternoon sample taken at one of the resort pools, which was over the limit for total trihalomethane. A number of the pools sampled, however, were close to or on the limit.

But these findings must be seen in perspective and Pieters and Horn noted that the real danger of these compounds lay in long-term exposure, rather than from a short spell in a pool. The testing for pharmaceutical and personal care products was calibrated to detect steroid hormones, but other compounds were found too. The study presented a shortlist of the 26 most frequently found.

Bumadizone (a non-steroidal anti-inflammatory drug) was topped the list across all pools, followed by citronellal hydrate (a terpenoid that gives citronella oil its distinctive lemon scent) and netilmicin (a semisynthetic antibiotic). Some compounds were detected at municipal pools but not resort pools and vice versa. For example, zoloperone, the sometimes habit-forming anti-anxiety drug, was found only in the resort samples; efavirenz, the HIV/Aids drug (which is not on the frequently-found list), was found only in the municipal samples.

Betamethasone, a steroidal medication, was detected in 64% of the samples. The drug may cause endocrine menstrual irregularities and growth retardation and has also been linked to problems with the vital adrenal and pituitary glands. But these side effects were reported by patients exposed to clinical doses. Topical corticosteroid fluorandrenolone, which was found in 36% of samples, had been linked to growth retardation among children, among other things.

But it's all very well determining the levels of certain metals and chemical compounds in a sample and comparing this with the drinking water standards, quite another predicting whether mixtures of these will affect people, in particular, their endocrine systems.

To get a handle on this, the authors tested samples on live tissue in the lab. These *in vitro* biological assays allowed the authors to evaluate a health risk without necessarily identifying all the compounds involved. "There were definite endocrine disrupting effects, both activating and inhibiting the oestrogen and androgen receptors," the authors said, noting these were evident in the samples collected at the end of the day – after many people spent the day in the pool.

They found that children were at greater risk than adults to exposure and more so through the skin than by swallowing.

The backwash water samples for all three resort pools scored highest on hazard and cancer risk measures. No-one bathes in this water, but it does go into a pond and from there to a river. Metals, probably from the source water, posed the bigger health risk at the time of sampling. But the authors acknowledged the values of some of the variables they used in the formulas, like average time spent in a pool, were selected randomly. They recommended analysing a larger sample of pools over a longer period to confirm their observations.



Photograph supplied

Backwash water samples from a resort's pools in the study scored highest on hazard and cancer risk measures. However, no-one bathes in this water but it does go into a pond and from there to a river.

Dedicated standards were needed for public pools as the drinking water and other standards used at present "do not address mixture effects at all", said the authors. They felt biological assays would be a particularly useful addition to testing.

Pool personnel should be made aware of the dangers of overdosing with disinfectants as well as the importance of maintaining correct pH levels (to make the most of the chlorine used) and of topping up pools to prevent harmful compounds accumulating.

Bathers needed a primer in pool health and etiquette too. They should be made aware of the risks they face, including from the compounds they bring into the water themselves. "Showering before swimming is common in some countries and is advised by the World Health Organisation. The advice... is to frequently shower during the visit to the swimming pool. Bathers should also be dissuaded to urinate in the water."