

Background & Objectives

- Indoor swimming pools create a suitable environment for mold growth as they are intentionally humid and warm¹
- Although there are no established occupational exposure limits for airborne mold spores, their presence has been associated with adverse health effects such as asthma, upper respiratory tract symptoms, bronchitis and respiratory infections¹
- If deemed necessary, preventive and corrective measures for mold growth are possible during the design stages of an indoor swimming pool facility or as part of the maintenance²
- The objective of this pilot study is to observe the occurrence of airborne mold within indoor swimming pools

Methods

- Indoor swimming pools (n=6) across the Greater Toronto Area were assessed for presence of airborne mold spores during winter season
- A Surface Air System (SAS) microbial air sampler was used with the following parameters:
 - Rose Bengal Agar plate with Chloramphenicol to isolate for fungal growth
 - 100L/min sampling speed
 - 400L total sampling volume
- Multiple viable air samples were collected on pool deck with 1-2 non-pool samples for comparison at each location
- Samples cultured to quantify and identify airborne mold spores using microscopy
- Relative humidity and temperature were monitored in duplicate at each site using an indoor air quality monitor and an air velocity meter
- Facility conditions, pool chemistry and number of bathers were recorded during site visits

Results

Table 1: Summary of number of bathers, pool chemistry and facility conditions at each indoor swimming pool location (n=6) sampled for airborne mold spores. Ranges account for variability in number of bathers, relative humidity and temperature during sampling period.

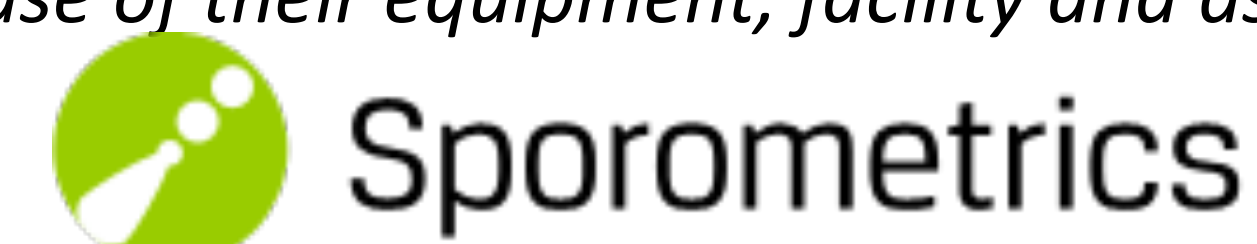
	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6
Number of adults [Range during visit]	10 - 22	5 - 19	3 - 35	4 - 34	15 - 18	11 - 18
Number of kids [Range during visit]	12 - 41	11 - 29	37 - 49	0 - 8	0	0 - 13
Total pool water volume (gallons)	196,400	86,200	997,000	167,858	25,000	252,000
Mean Temperature (°C) [Range]	25.2 [17.4 - 25.6]	27.9 [25.5 - 28.9]	25.1 [19.1 - 25.7]	24.6 [21.9 - 24.8]	26.9 [24.2 - 28.5]	25.6 [21.5 - 27.1]
Mean Relative Humidity (%) [Range]	56.4 [52.4 - 78.9]	36.1 [31 - 47.2]	51.6 [42.7 - 84.6]	45.5 [39.3 - 55.9]	61.7 [46.9 - 64.7]	61.1 [57.5 - 83.2]
Mean water pH	7.5	7.5	7.5	7.5	7.5	7.5
Mean water combined chlorine (ppm)	0.4	0.3	0.1	0.2	0.2	0.3
Mean water temperature (°F)	91	88	80	89	83.7	85

Table 2: Overview of mold counts in air samples from indoor swimming pools. Additionally, indication of fungi with known negative health effects isolated from samples at certain sites.

	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6
Mold counts (CFU/m³)						
Non-Pool Air Sample 1	18	21	6	6	6	33
Non-Pool Air Sample 2	-	-	9	-	0	-
Pool Air Sample 1	9	33	0	0	9	33
Pool Air Sample 2	6	0	0	3	0	9
Pool Air Sample 3	6	3	9	0	0	21
Pool Air Sample 4	0	9	6	0	3	3
Pool Air Sample 5	3	3	0	6	6	9
Pool Air Sample 6	6	3	9	9	0	0
Pool Air Sample 7	0	6	6	-	6	6
Fungi group with known negative health effects isolated at site (CFU/M³)						
Alternaria	0	0	0	0	3	15
Nigrospora	0	0	3	0	0	0
Rhizomucor	0	0	0	3	3	0
Aspergillus niger	6	0	0	0	0	0
Aspergillus fumigatus	0	6	3	0	0	3
Aspergillus versicolor	0	0	0	0	0	9

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Discussion

- There was no consistent correlation between site relative humidity and temperature and site mold count (Table 1 and 2)
- Although mold counts were lower than expected in the humid and warm environment, the counts were consistent with literature for viable mold counts inside indoor swimming pools when assessed with a Surface Air System sampler³
- The lower than expected mold counts may be attributed to sampling method as fungal airborne concentrations are dependent on the method used for assessment⁴
- A biodiverse fungal profile was found at most sites, some of which included fungal groups with known negative health effects in humans such as *Alternaria* spp., *Nigrospora* spp., *Rhizomucor* spp., and *Aspergillus* spp.
 - All of which are known allergens and are associated with respiratory tract diseases^{5, 6}
- Due to experimental method limitations, further research is required to determine whether preventive and/or corrective measures are required
- It is recommended that mold counts inside indoor swimming pools be collected once more using a non-viable sampling method, potentially with a different agar and that mold species be identified using a sequencing analysis method rather than microscopy

References

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