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H&TRC
Health and Technology Research Center



Bioburden in Indoor SPAs Air

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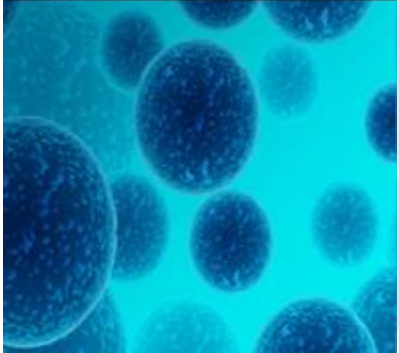
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Introduction

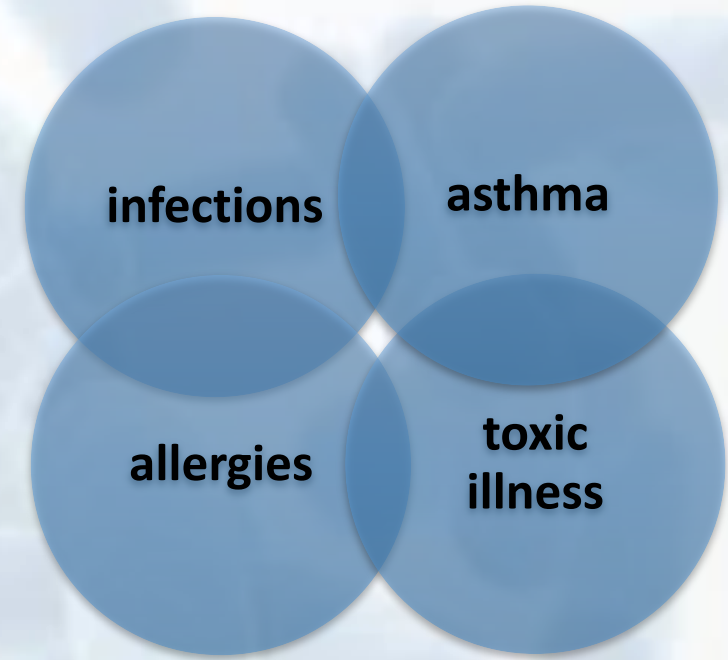
The indoor environment of Portuguese thermal spas can influence the health of users and their attending staff (Klánova & Hollerová, 2003).

These facilities can be a source of microorganism and can constitute a public health concern.



Introduction

Airborne bacteria can constitute risks when the concentration is high enough to create adverse health effects (Mentese & Tasdibi, 2014):



When significant indoor or outdoor airborne bacteria sources do not exist, the most critical factor that contributes to indoor bacteria levels is the human presence (Mentese & Tasdibi, 2014).



Introduction

Airborne fungal contaminants are increasingly gaining importance due to the health hazards caused by their spores or metabolites (Oppliger, 2014).

Fungal contamination indoors, often contributes to building-related diseases (Levetin et al., 2001):



**infectious
diseases**

allergic rhinitis

Asthma

**hypersensitivity
pneumonitis**

Objective

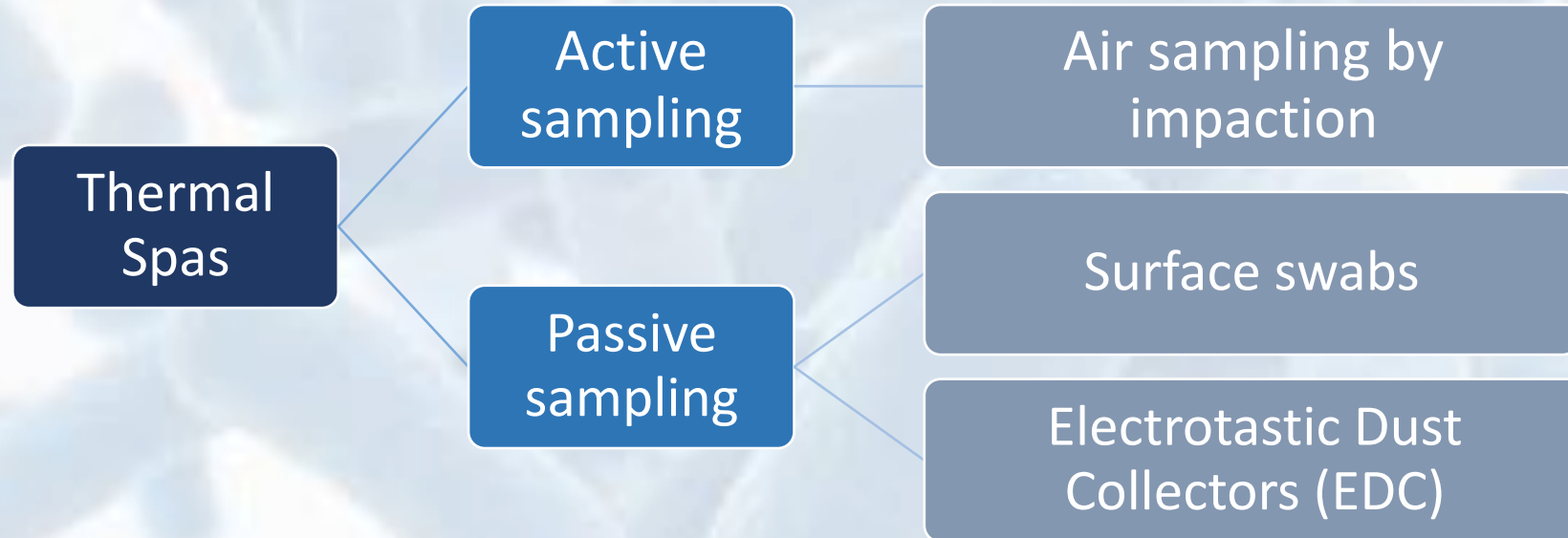
The aim of this study was to assess bioburden in two Portuguese thermal spas and to develop protocols and recommendations for bioburden control.



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Bioburden and Radon in Indoor SPAs Air

Materials and Methods



2 Thermal Spas: Spa A with one building and the Spa B with 2 buildings.
Sampling location: reception, thermal pool, spa pool, bertholet treatment, otolaryngologist treatment, double cab treatment, workers' bathhouse

Sampling
May 2019

Materials and Methods

Bioburden exposure assessment

Bacteria

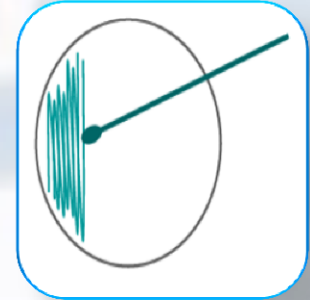
Inoculation in tryptic soy agar (TSA), incubation at 30°C for 7 days

Inoculation in violet red bile agar (VRBA), incubation at 37°C for 7 days

Fungi

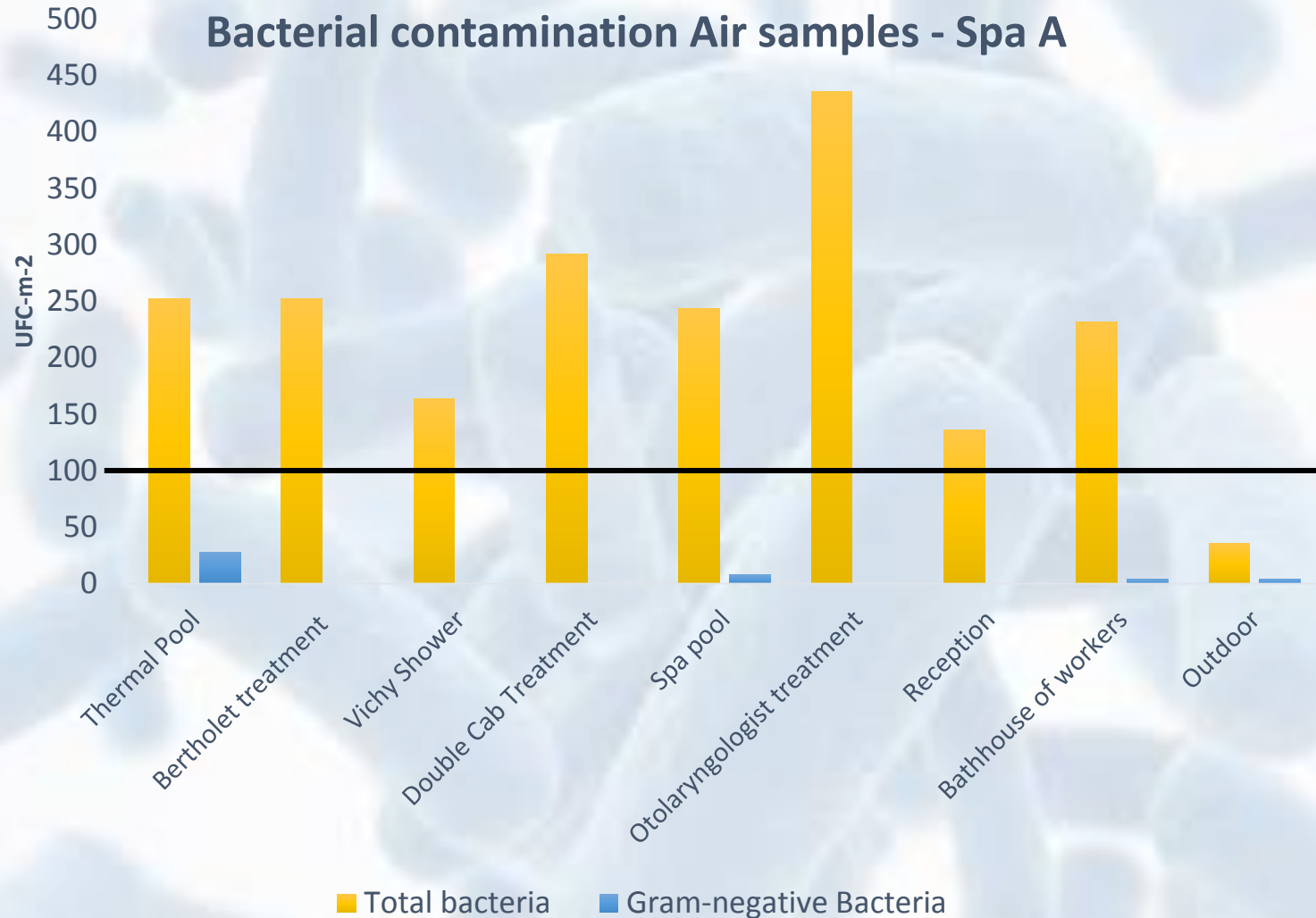
Inoculation in 2% malt extract agar (MEA) with 0.05 g/L chloramphenicol media, incubation at 30°C for 5 to 7 days

Inoculation in dichloran glycerol (DG18) agar-based media, incubation at 30°C for 5 to 7 days



Results

Bacterial contamination Air samples - Spa A



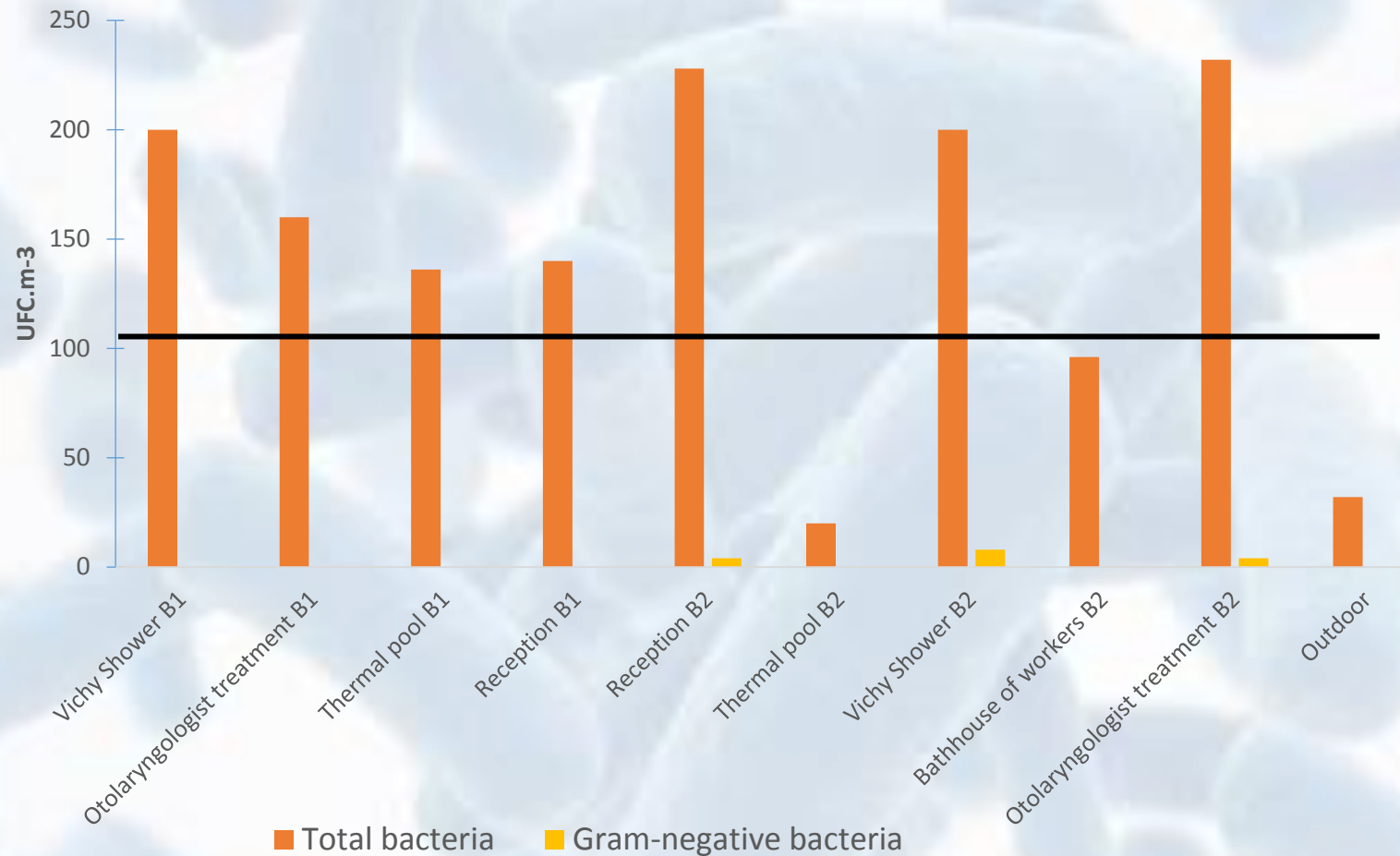
50 CFU/m³ as 'very low' bacterial load,
50–100 CFU/m³ as 'low', 100–500 CFU/m³ as 'intermediate' 500–2000 CFU/m³ as 'high' above 2000 CFU/m³ as 'very high' load

(Sanitary Standards for Non-industrial Premises (CEC, 1993))

In spa A, the total bacterial air load ranged from 140 (reception) to 440 CFU.m⁻³ (otolaryngologist treatment). Coliform load in indoor air ranged from 4 (workers locker room) to 24 CFU.m⁻³ (thermal pool).

Results

Bacterial contamination Air samples - Spa B



50 CFU/m³ as 'very low' bacterial load,
50–100 CFU/m³ as 'low', 100–500 CFU/m³ as 'intermediate'
500–2000 CFU/m³ as 'high'
above 2000 CFU/m³ as 'very high' load

(Sanitary Standards for Non-industrial Premises (CEC, 1993))

In spa B the total bacterial air load ranged from 20 (thermal pool- building 2 - B2) to 230 CFU.m⁻³ (otolaryngologist treatment - B2) and coliforms counts ranged from 4 (otolaryngologist treatment and reception – B2) to 8 CFU.m⁻³ (Vichy Shower treatment – B2).

Results — Bacterial contamination - Surface samples

Surface samples – SPA A		
sample	Total bacteria UFC/m ²	Gram-negative bacteria UFC/m ²
Thermal Pool	8 000	0
Bertholet treatment	6 000	0
Vichy Shower	1 000 000	35 000
Double Cab Treatment	1 000	0
Spa pool	33 000	0
Otolaryngologist treatment	9 000	0
Reception	0	0
Workers locker room	312 000	0

SPA A - Surface samples showed a range of total mesophilic bacteria counts between 1×10^3 (double cab treatment) and 1×10^7 CFU.m⁻² (Vichy shower treatment). Coliforms in surface samples were only found in Vichy shower treatment with a load of 35×10^3 CFU.m⁻².

Results - Bacterial contamination - Surface samples

Surface samples – SPA B

Sample	Total bacteria CFU.m-2	Gram-negative bacteria CFU.m-2
Vichy Shower treatment B1	476 000	95 000
Otolaryngologist treatment B1	10 000	0
Thermal pool B1	0	0
Reception B1	1 000	0
Reception B2	11 000	0
Thermal pool B2	2 000	0
Vichy Shower treatment B2	61 000	0
Workers locker room B2	6 000	0
Otolaryngologist treatment B2	1 000	0

SPA B - For surface samples, the total bacterial concentration ranged from 1 000 (reception - building 1 and otolaryngologist treatment – building 2) to 476 000 CFU.m⁻² (Vichy Shower - building 1) and coliforms were only detected in Vichy shower – building 1 at a concentration of 95 000 cfu.m⁻².

Results - Bacterial contamination - EDC

EDC – SPA A

sample	Total Bacteria
Thermal Pool	2 866
Bertholet treatment	212
Vichy Shower	106
Double Cab Treatment	106
Spa pool	0
Otolaryngologist treatment	3503
Reception	0
workers locker room	13 057

SPA A - Total bacteria count in EDC ranged from 106 CFU.m⁻² (Double Cab and Vichy shower treatment) to 13 057 CFU.m⁻² (workers locker room). Coliforms in EDC samples were not found.

EDC – SPA B

sample	Total bacteria CFU.m-3	Gram-negative bacteria CFU.m-3
Vichy Shower B1	212	0
Otolaryngologist treatment B1	106	
Thermal pool B1	5 626	0
Reception B1	106 157	0
Reception B2	0	0
Thermal pool B2	106	0
Vichy Shower B2	106 157	0
workers locker room B2	4 352	743
Otolaryngologist treatment B2	212	0

SPA B - Total bacteria count in EDC ranged from 106 CFU.m⁻² (Otolaryngologist treatment B1 and Thermal pool B2) to 106157 CFU.m⁻² (reception B1 an vichy shower B2). Coliforms in EDC samples only were found in workers locker room .


Results - Fungi contamination – Air samples

Fungal air load in the **Spa A** ranged from 12 (in the double cabinet treatment) to 5.4×10^2 CFU.m⁻³ (in the reception) on MEA, and from 4 CFU.m⁻³ (in the Vichy shower) to 88 CFU.m⁻³ (in the thermal pool) on DG18.

Fungal air load from **Spa B**, ranged from 4 (in the thermal pool of building 2) to 1.2×10^3 CFU.m⁻³ (in the thermal pool of building 1) on MEA, and from 12 (in the thermal pool of building 2) to 1.13×10^3 CFU.m⁻³ (in the workers locker room in building 2) on DG18.



Results – Fungi contamination – Surface samples




SPA A - The swab samples showed a major contamination $20,5 \times 10^3$ CFU.m⁻² in the Vichy shower on MEA, and 5×10^6 CFU.m⁻² in the otolaryngologist treatment on DG18.

Fungi in surface samples were not found in the Otolaryngologist treatment, in the Bertholet treatment, in the Spa pool and in Double Cab Treatment on MEA and in the thermal pool, in Double Cab Treatment and in the workers locker room on DG18.

SPA B - The swab samples presented a major contamination 5×10^6 CFU.m⁻² in the workers locker room in building 2 on MEA, and 5.15×10^6 CFU.m⁻² in the Vichy shower in building 2 on DG18.

Fungi in surface samples were not found in Otolaryngologist treatment B1 and B2, in the thermal pool B1 and in the workers locker room in B2 on MEA.

Results – Fungi contamination – EDC



SPA A - The EDC samples showed major contamination 1.1×10^5 CFU.m⁻² in the double cabinet treatment on MEA and 1.1×10^5 CFU.m⁻² in the SPA pool on DG18.

Fungi in EDC samples only were not found in the Vichy shower on DG18.

SPA B - The EDC samples presented a major contamination $5,5 \times 10^4$ CFU.m⁻² (in the workers locker room in building 2) on MEA, and 5.15×10^6 CFU.m⁻² (in the Vichy shower in building 2) on DG18.

Fungi in EDC samples were not found in the Vichy shower in the building 2, on both culture medium.

Conclusion

The results highlighted the need of intervention since immunocompromised patients/users can be present in this environment.

- A multi-approach in the sampling methods (active and passive) and analyses applied should be the trend.
- Molecular methods must be utilized in order to confirm the results



will be important to
**more refined risk
characterization for:**

Staff

Users



Suitable risk control measures to reduce patients and workers health outcomes.





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