



ESCOLA SUPERIOR DE
TECNOLOGIA DA SAÚDE
DE LISBOA
INSTITUTO POLITÉCNICO DE LISBOA

Indoor Air Quality in Portuguese Healthcare Facilities

A Correlational Study on Environmental
Parameters and
Cytotoxic and Pro-inflammatory Effects

Instituto Politécnico de Lisboa – Escola Superior de Tecnologia da Saúde de Lisboa

I Webinar de Investigação Aplicada em Farmácia

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Prof.^a Liliana Aranha Caetano e Prof.^a Elisabete Carolino

Our Study

Main project: EXPOsE – Establishing protocols to assess occupational exposure to microbiota in clinical settings;

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Our Study

A petri dish containing several bacterial cultures on a light-colored agar surface. The cultures show various morphologies, including circular, irregular, and filamentous shapes, with some appearing more dense and others more sparse. The background is a soft, out-of-focus light blue.

Correlational analysis of the relationship between variables

“Does the air quality of healthcare facilities influences biological responses?”

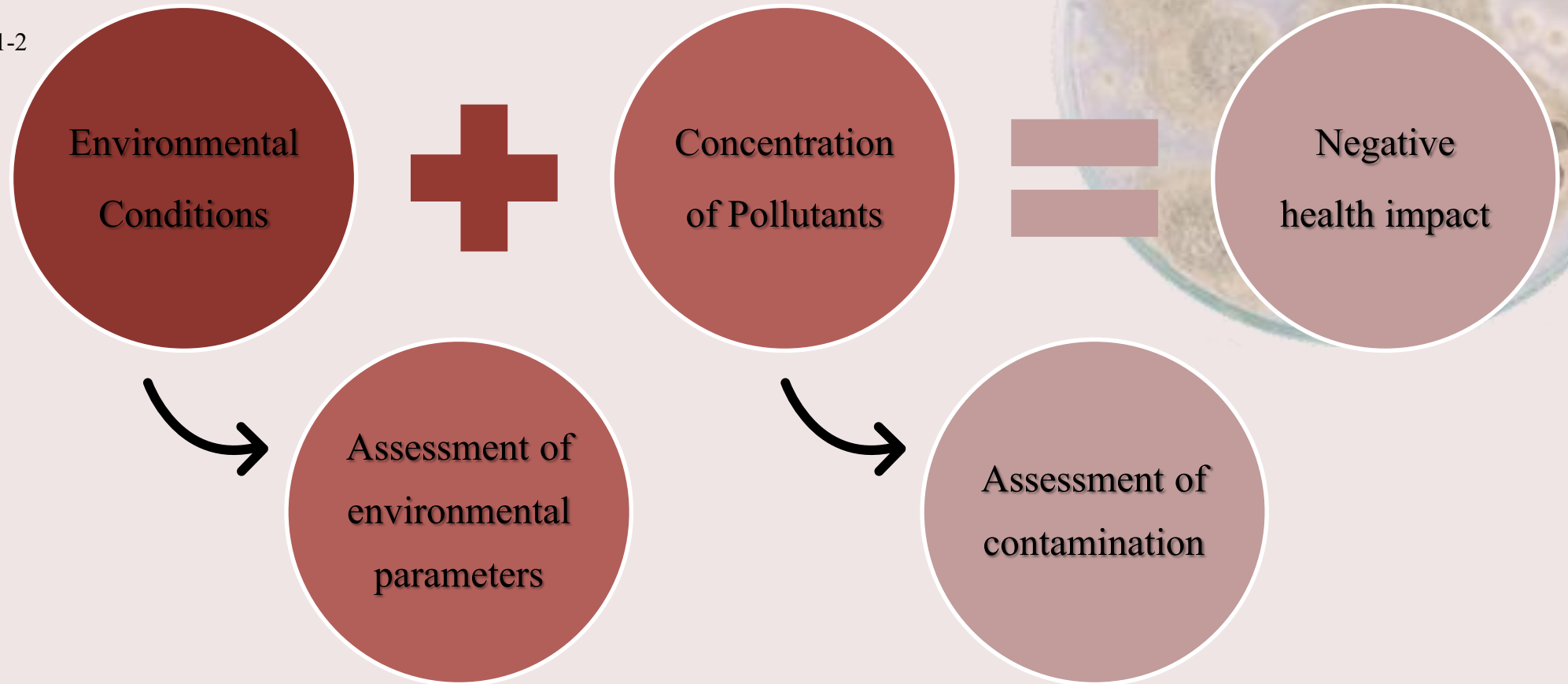
“Indoor Air Quality”, “Bioaerosols”, “Nosocomial Infections” and “Assessment Methods of Environmental Contamination”

Healthcare facilities display an important role in the transmission of airborne infections

→ Risk assessment to promote patients and professionals safety

Indoor Air Quality

1-2



1. Kubba S. Butterworth-Heinemann; 2017

2. Soreanu G. Elsevier; 2016

Bioaerosols and Nosocomial Infections

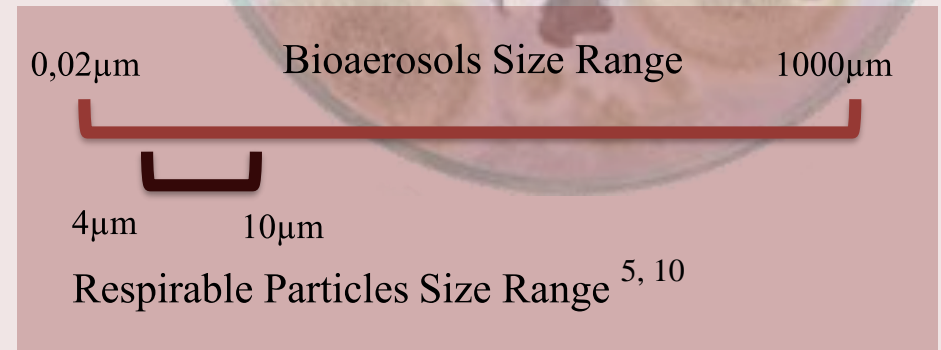
Bioaerosols are particles with biological origins

→ Infections, irritations and allergies

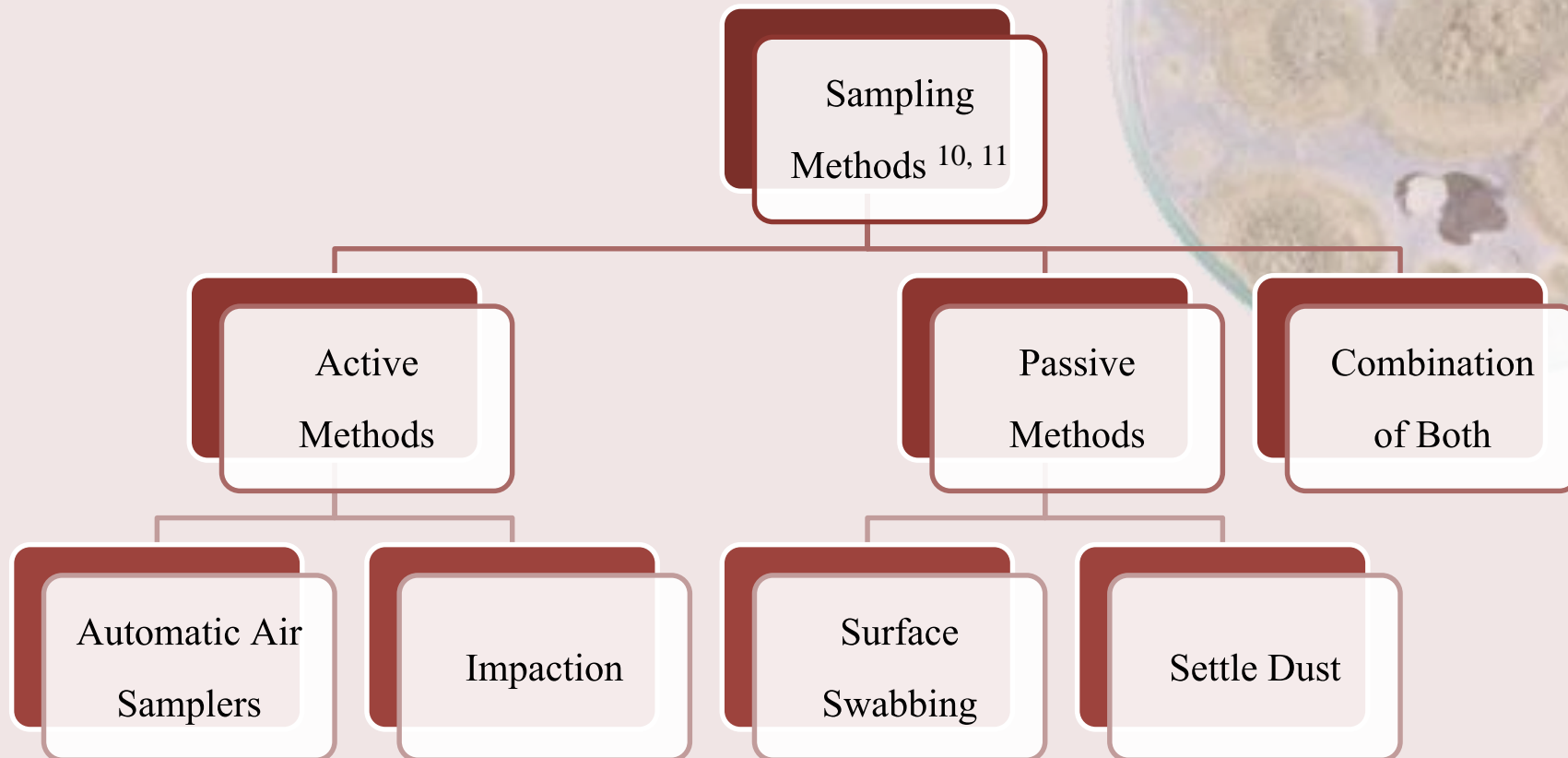
→ Nosocomial infections ²⁻⁹



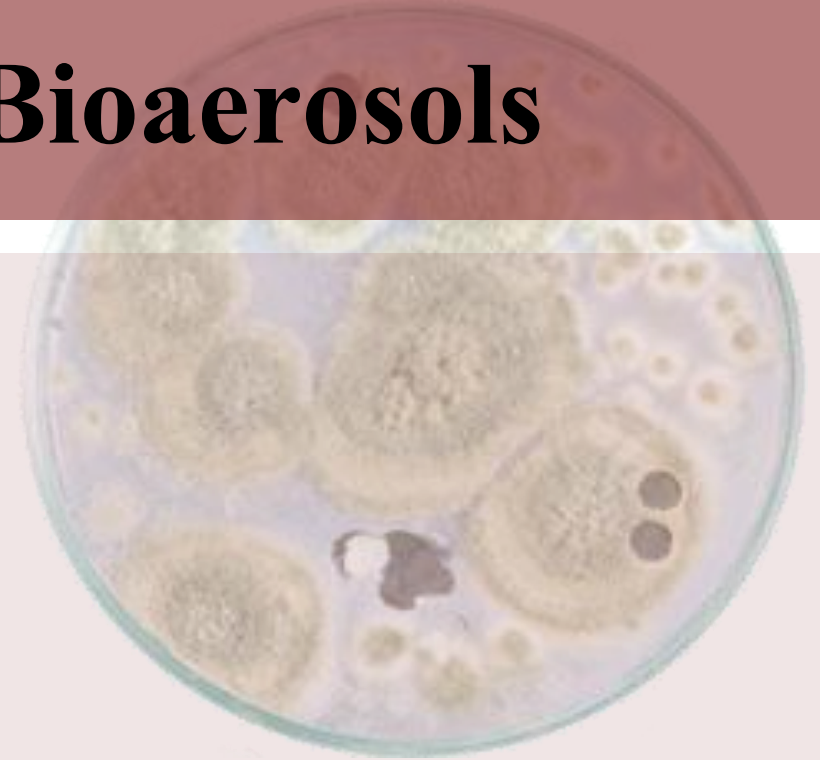
⚠ Methods for controlling airborne pathogens



Methods of Assessing Environmental Contamination



Biological Response to Bioaerosols



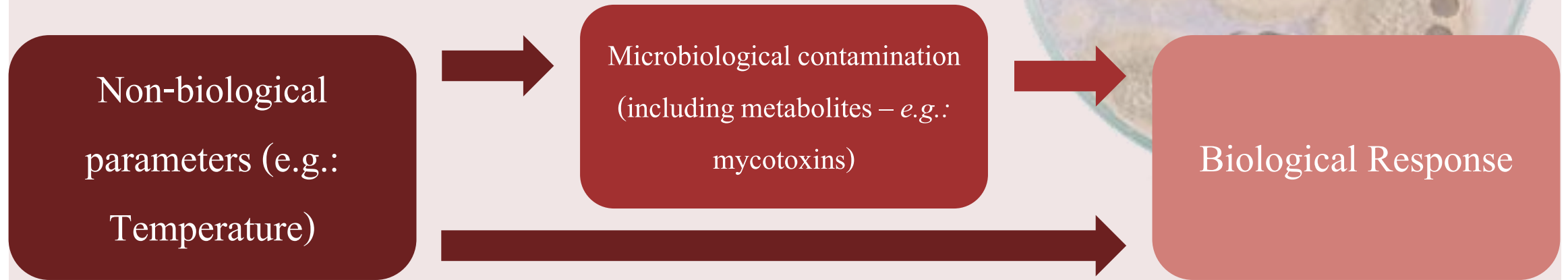
Measured using:

‡ Cytotoxic effects on THP-1 cells ^{12, 13};

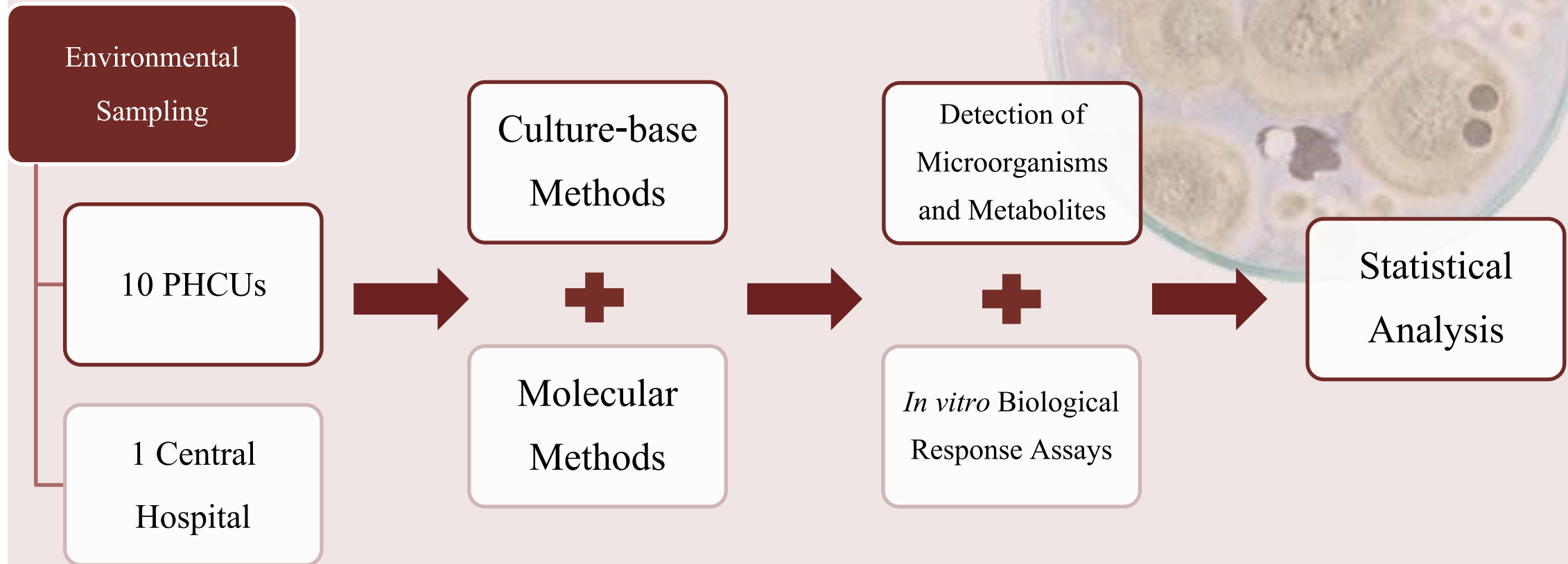
‡ Cytotoxic effects on Calu-3 cells ¹⁴;

‡ Pro-inflammatory effects of cytokines IL-1 β and TNF- α (from THP-1 cells) ^{12, 13}

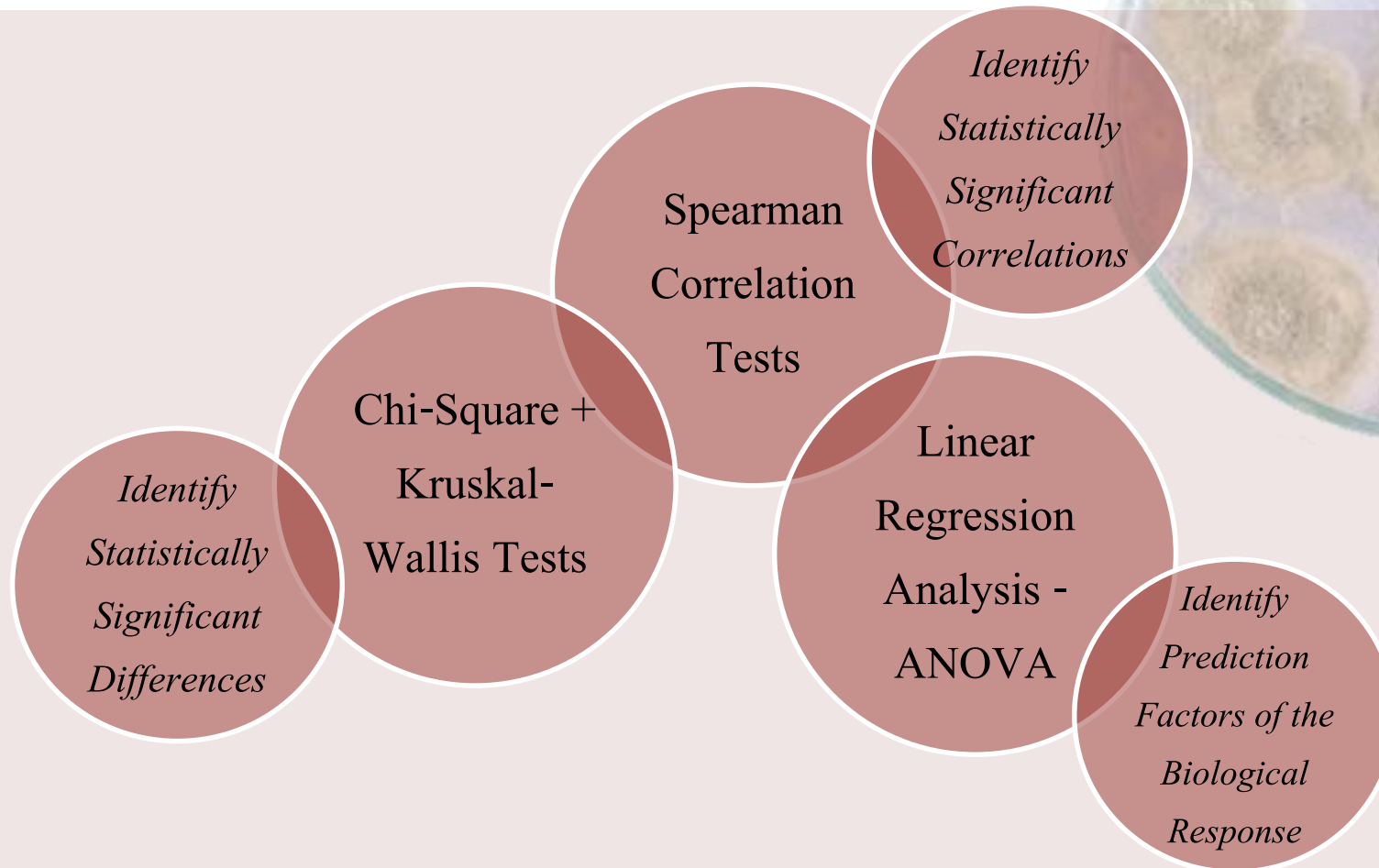
Objectives



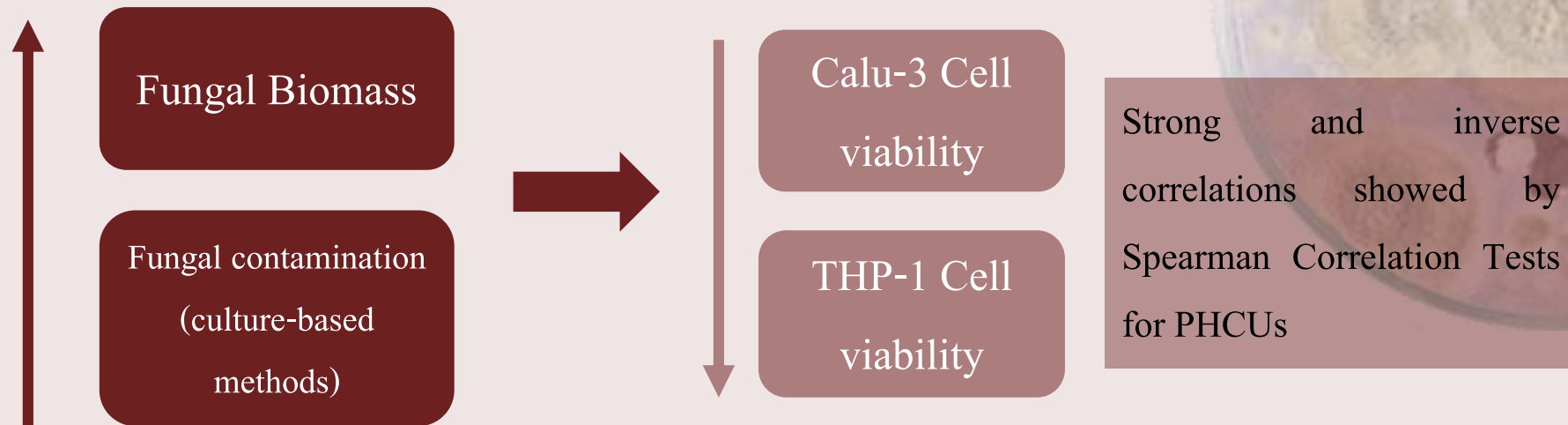
Materials and Methods



Statistical Analysis



Main Results



Previous study with THP-1 cells' response to air quality

→ pro-inflammatory effects (of cytokines $TNF-\alpha$ and $IL-1\beta$) + cytotoxic effect on all air samples collected¹²

Main Results

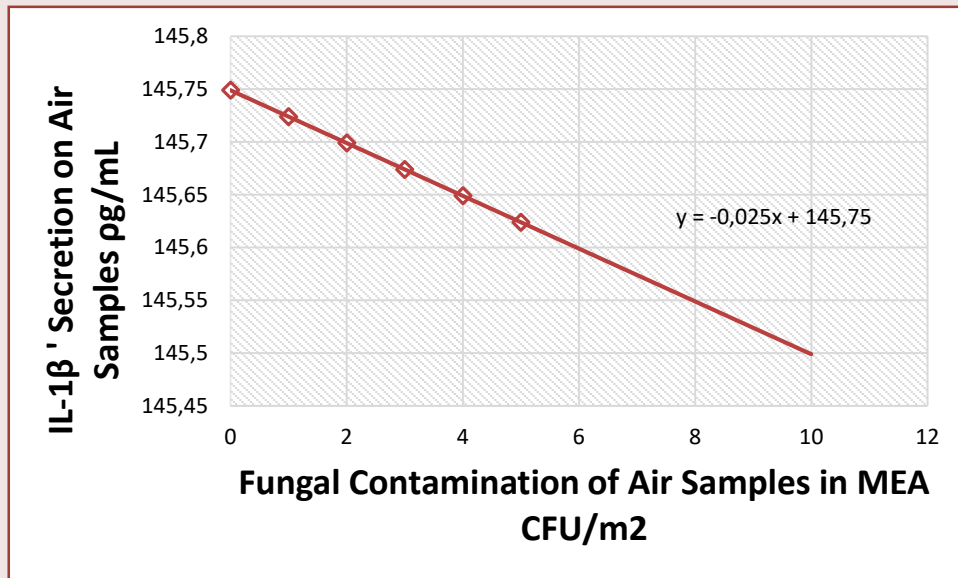


Figure 1 - Linear Regression Analysis (ANOVA Test), model 1

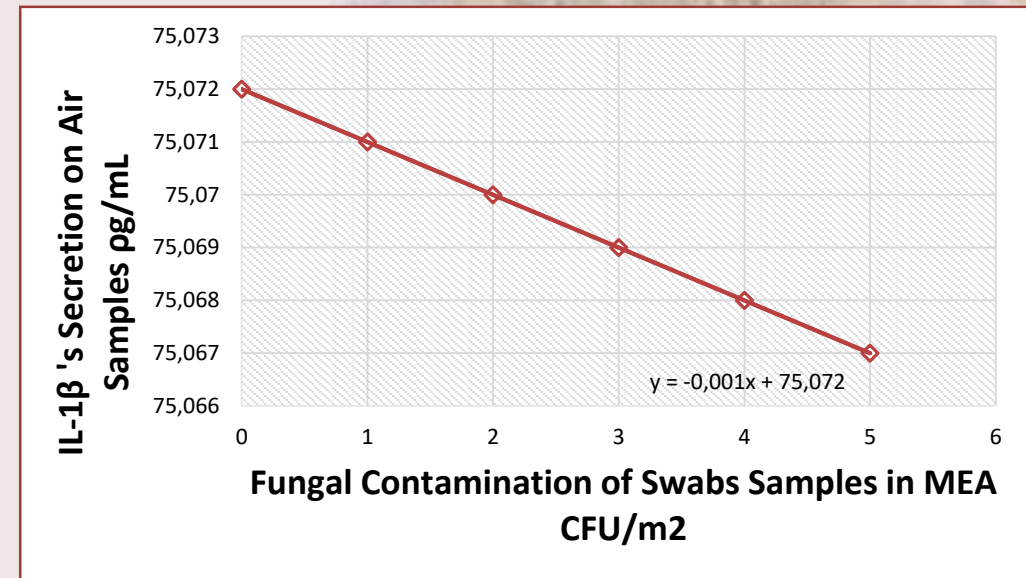


Figure 2 - Linear Regression Analysis (ANOVA Test), model 4

Fungal contamination decreases IL-1β' secretion

Main Results

Variables (air contamination CFU/m ²)	Influence over dependent variable (THP-1 cells' relative viability %)
VRBA (Gram (-) bacterial contamination)	-0.272
MEA (fungal contamination)	-0.18
DG18 (fungal contamination)	0.06

Figure 3 - Linear Regression Analysis (ANOVA Test), model 2

Fungal

contamination with Gram (-) bacteria was mainly associated with decreased cell viability in THP-1 cells in air samples

Variables (air contamination CFU/m ²)	Influence over dependent variable (Calu-3 cells' relative viability %)
Total TSA (bacterial contamination)	-0.065
VRBA (Gram (-) bacterial contamination)	-4.183

Figure 4 - Linear Regression Analysis (ANOVA Test), model 3

Gram (-) bacteria combined with total bacterial contamination (on TSA), on air samples, decreases cell viability of Calu-3

Main Results

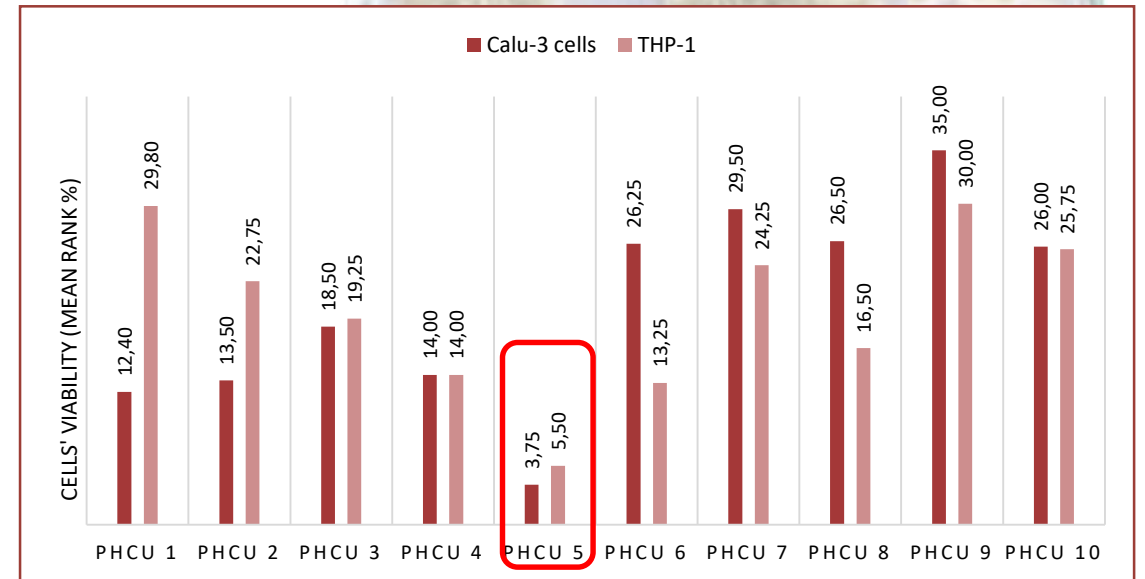
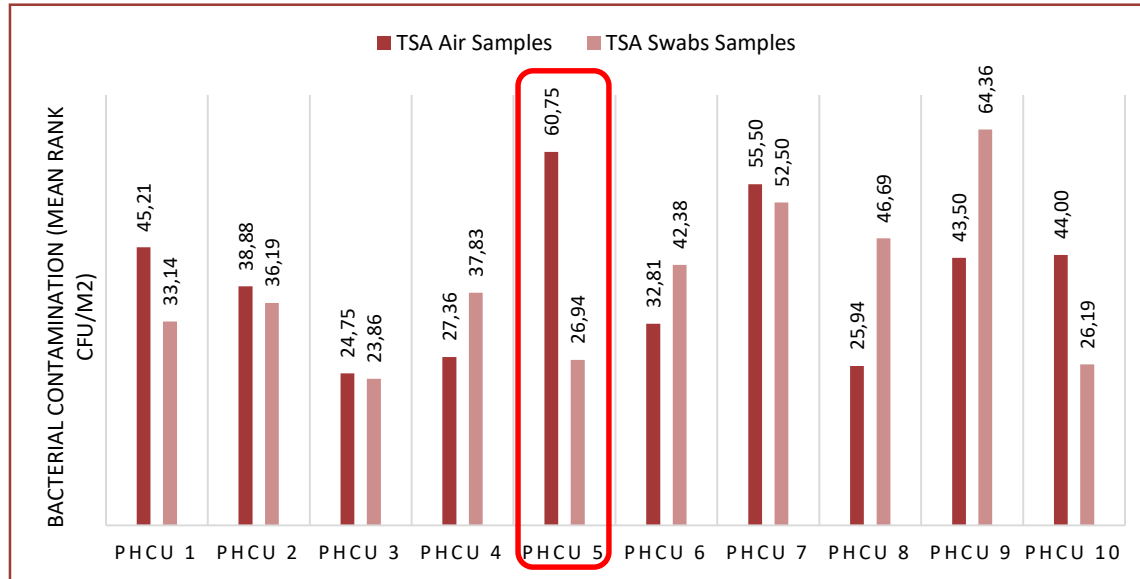


Figure 5 - Mean Ranks (results of Kruskal-Wallis test) to compare bacterial counts between PHCUs

Figure 6 - Mean Ranks (results of Kruskal-Wallis test) to compare biological responses of both cell lines between PHCUs

PHCU 5, which had the highest count of bacterial contamination (on TSA) also had the lowest count of Calu-3 and THP-1 viabilities.

Main Results

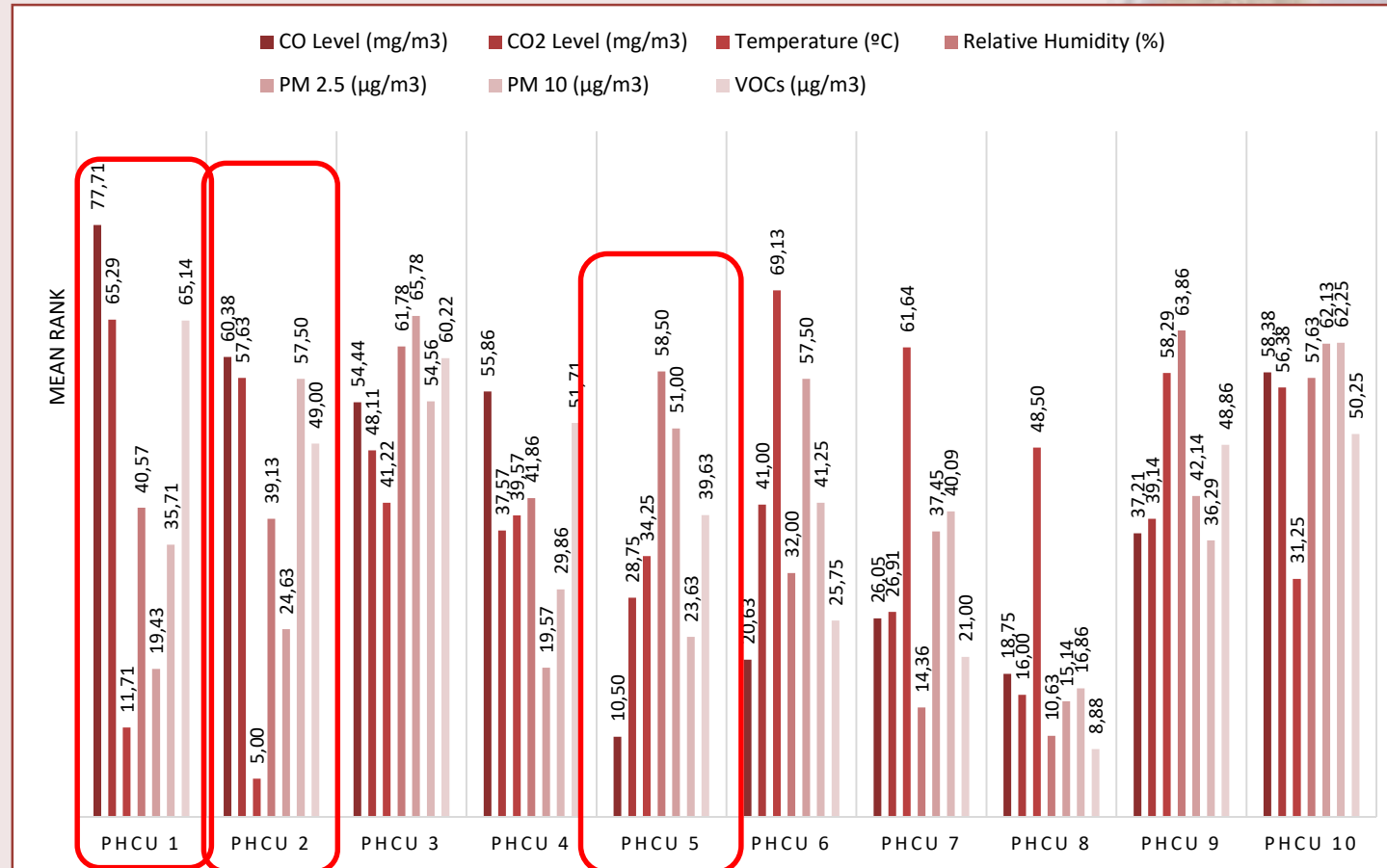


Figure 8 - Mean Ranks (results of Kruskal-Wallis test) to compare environmental parameters between PHCUs

Main Results

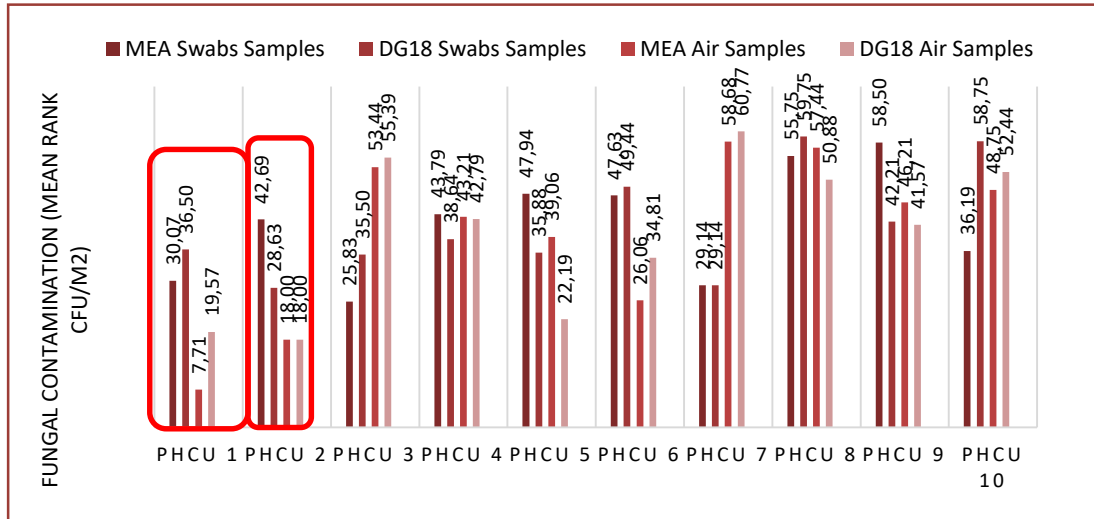
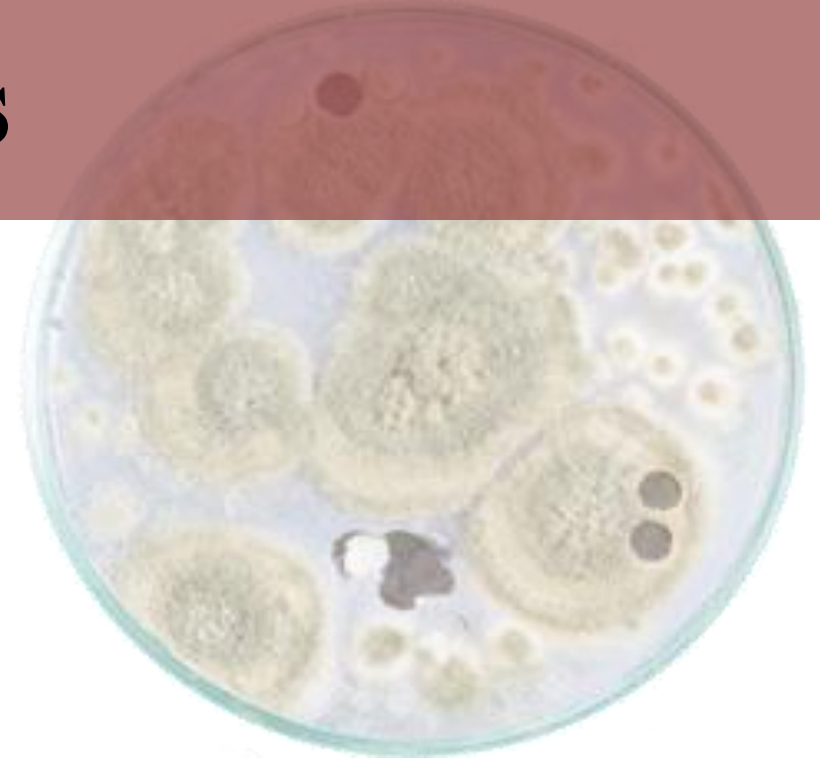


Figure 9 Mean Ranks (results of Kruskal-Wallis test) to compare fungal counts between PHCUs

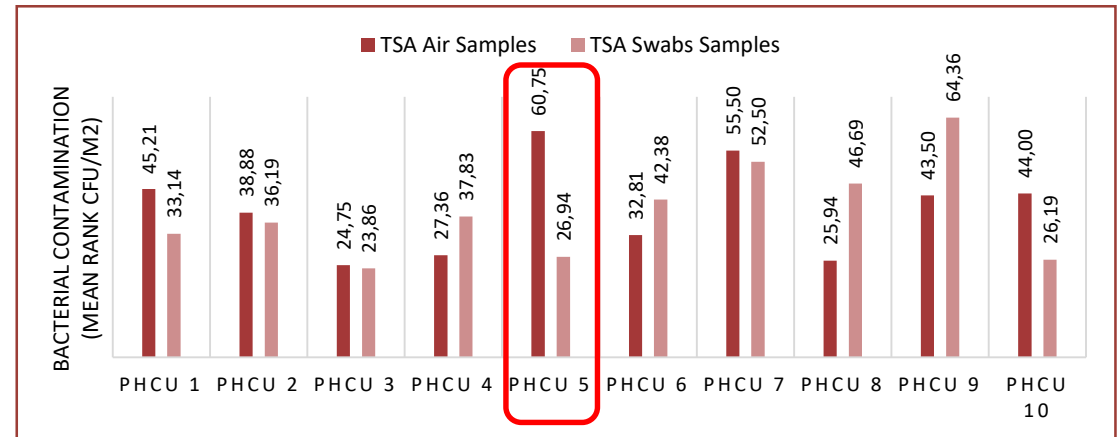


Figure 10 - Mean Ranks (results of Kruskal-Wallis test) to compare bacterial counts between PHCUs

Main Results

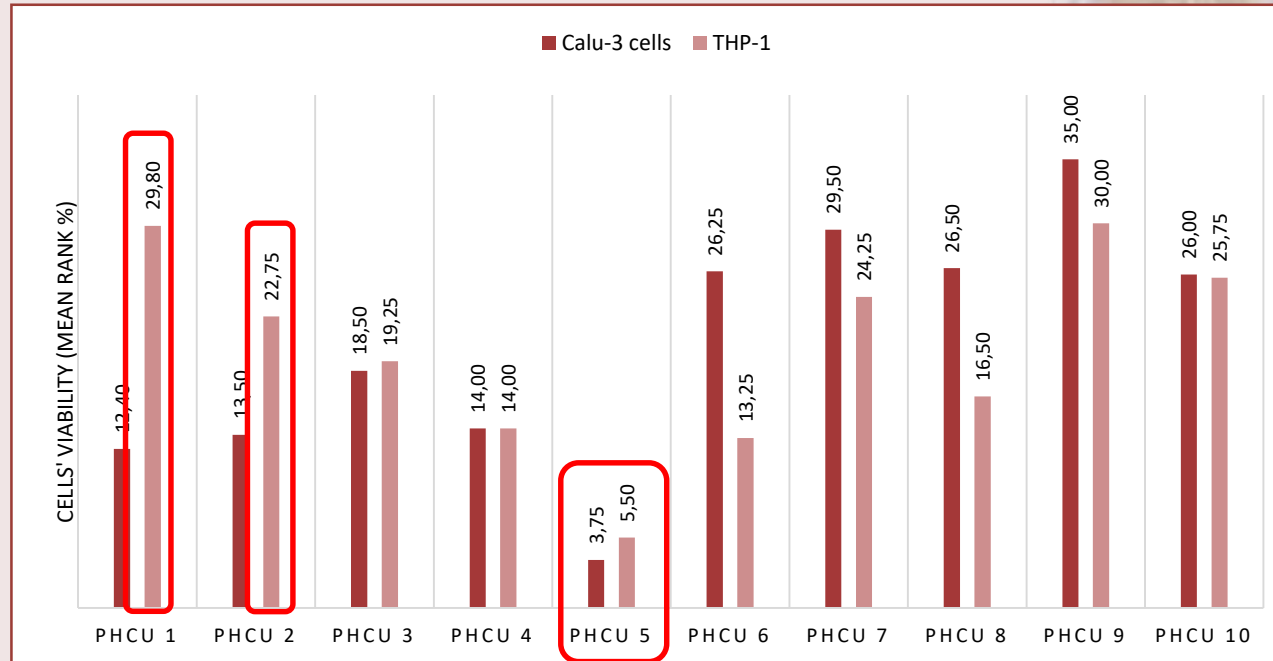


Figure 11 - Mean Ranks (results of Kruskal-Wallis test) to compare biological responses of both cell lines between PHCUs

Higher levels of carbon monoxide and dioxide may reduce viable fungal and bacterial air contaminants and allow higher viability of THP-1 and Calu-3 cells.

Main Results

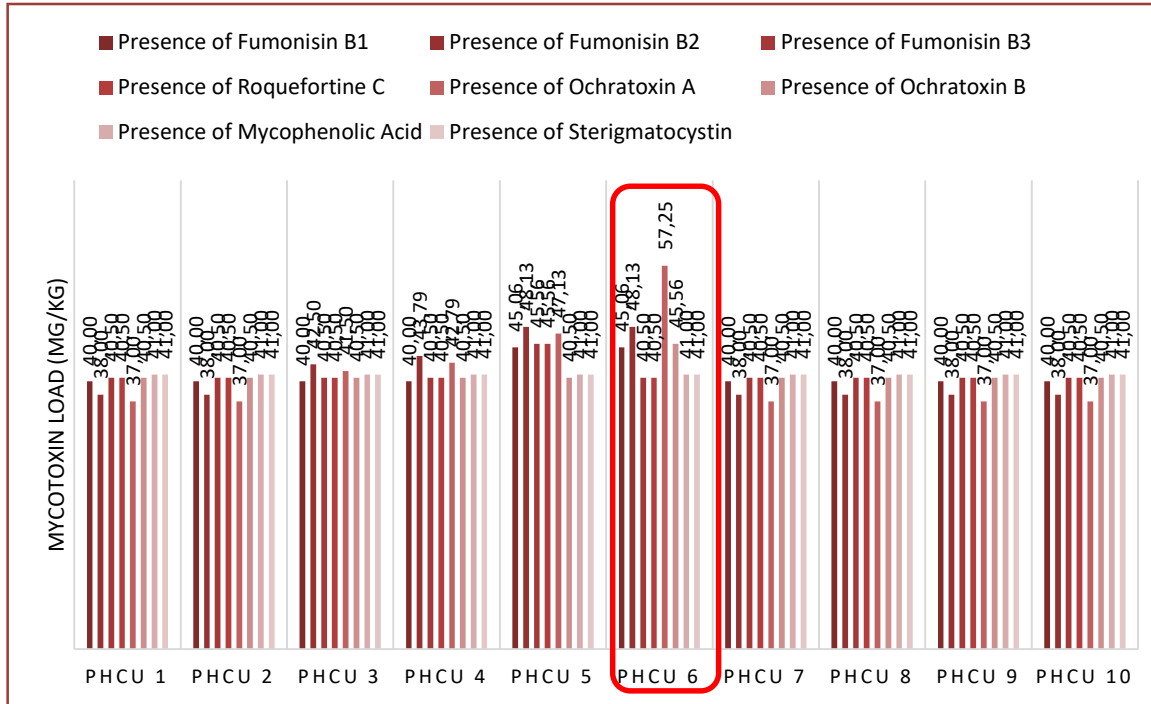


Figure 13 - Mean Ranks (results of Kruskal-Wallis test) to compare mycotoxin counts between PHCUs8

Ochratoxin A has been associated with decrease in metabolic activity, cell proliferation, differentiation, phagocytic behavior and other effects over THP-1 cells and Fumonisin 1 with decreased cell viability also in THP-1 cells^{17, 18}

17. Müller G; Toxicology. 2003, 18. Smith M-C; Cell Biol Toxicol. 2018

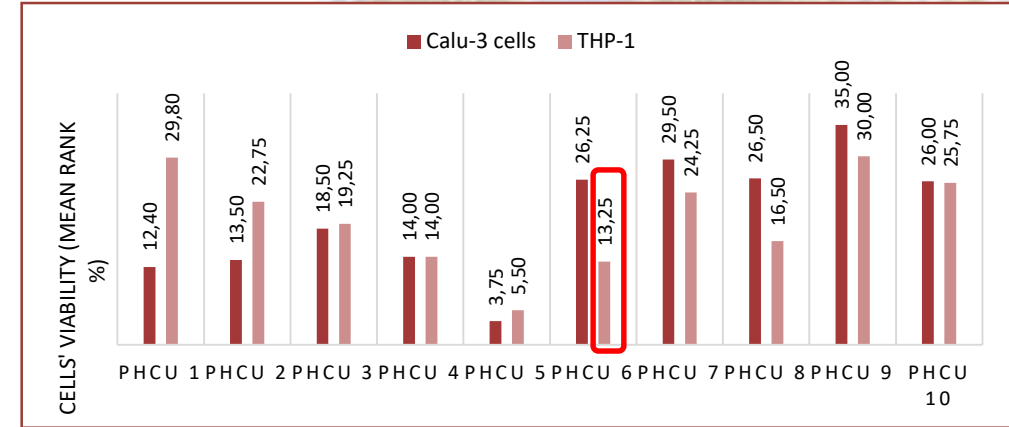


Figure 14 - Mean Ranks (results of Kruskal-Wallis test) to compare biological responses of both cell lines between PHCUs

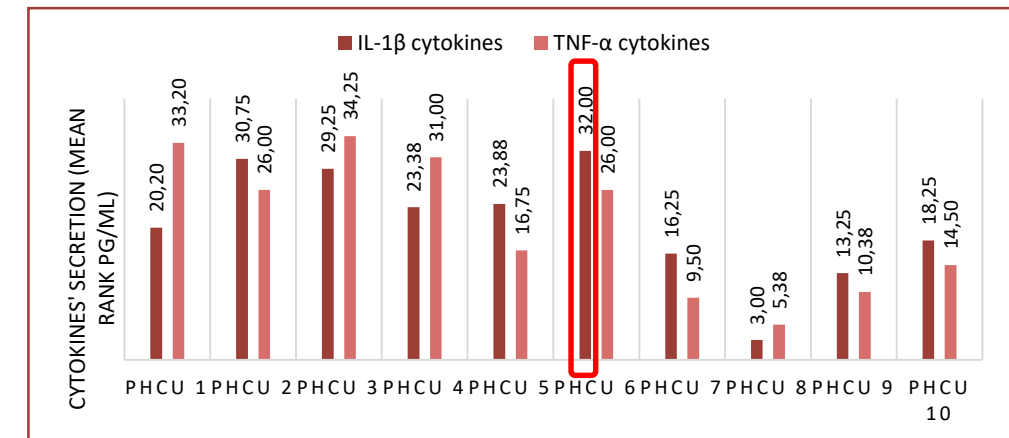
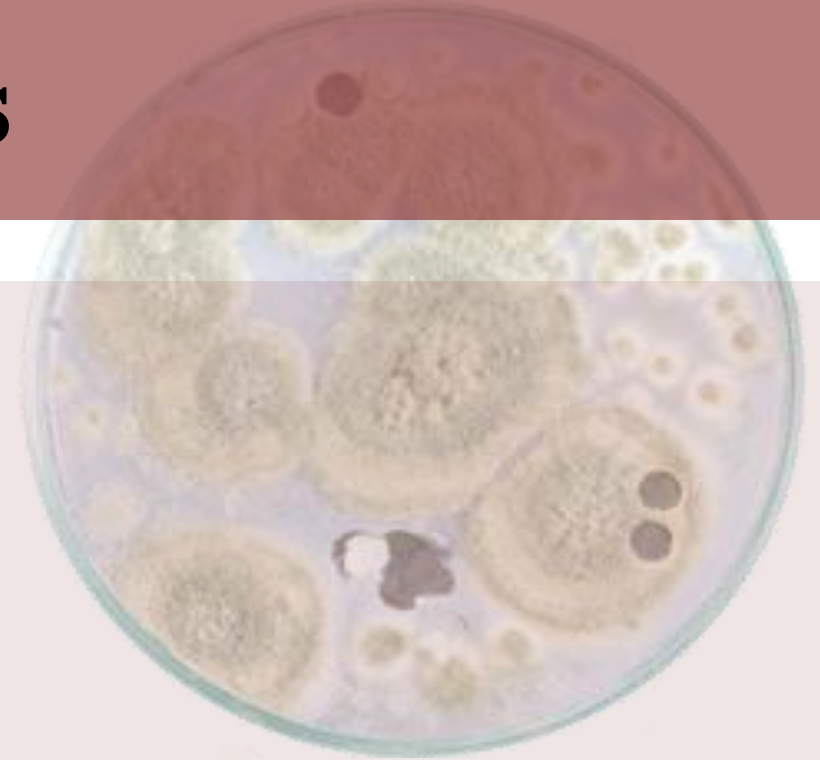
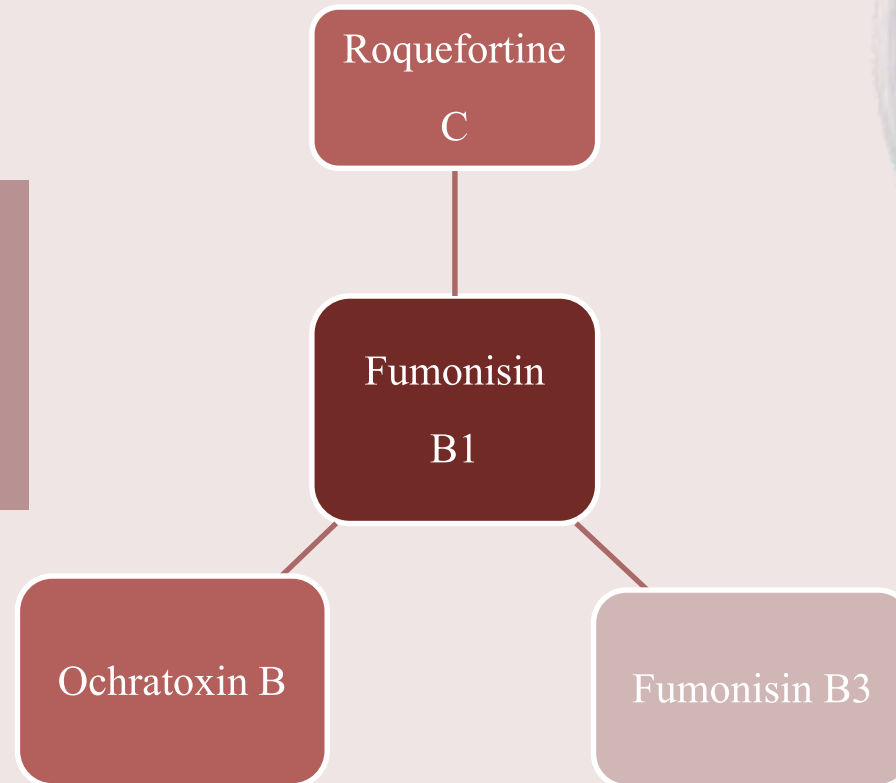


Figure 15 - Mean Ranks (results of Kruskal-Wallis test) to compare biological responses of both cytokines between PHCUs

Main Results



Strong and direct correlations showed by Spearman Correlation Tests for PHCUs



Trichothecene mycotoxins and aflatoxins can be efficiently inactivated with common cleaning products, such as sodium hypochlorite^{19, 20}

19. Wilson, SC; J Occup Environ Hyg. 2004;

20. Yang, CY; Appl Microbiol. 1972;

Main Results

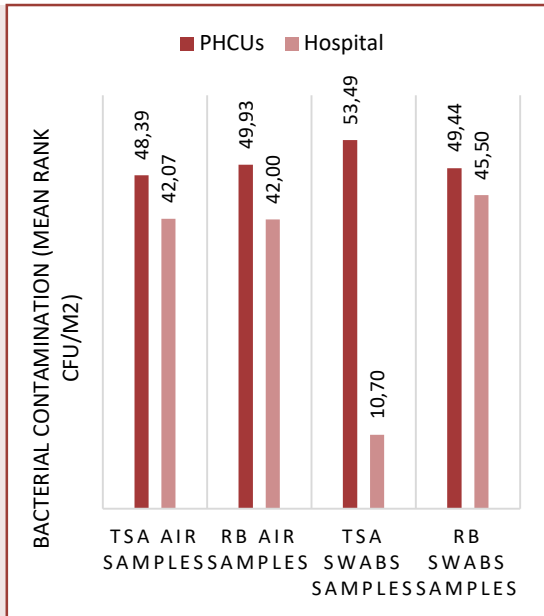


Figure 16 - Mean Ranks (results of Kruskal-Wallis test) to compare bacterial counts between all PHCUs and the Hospital

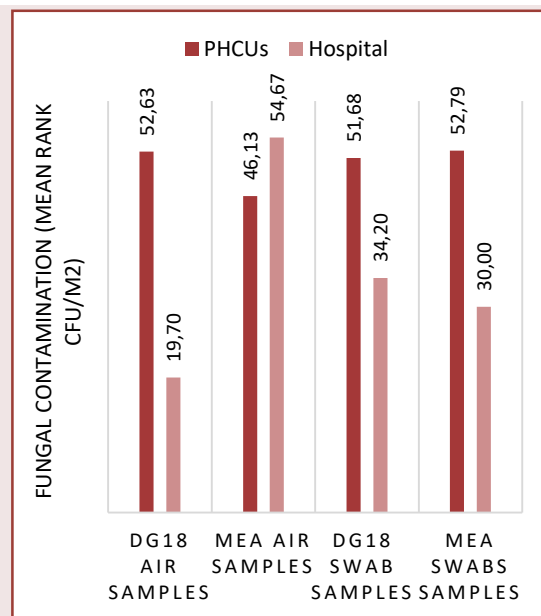


Figure 17 - Mean Ranks (results of Kruskal-Wallis test) to compare fungal counts between all PHCUs and the Hospital

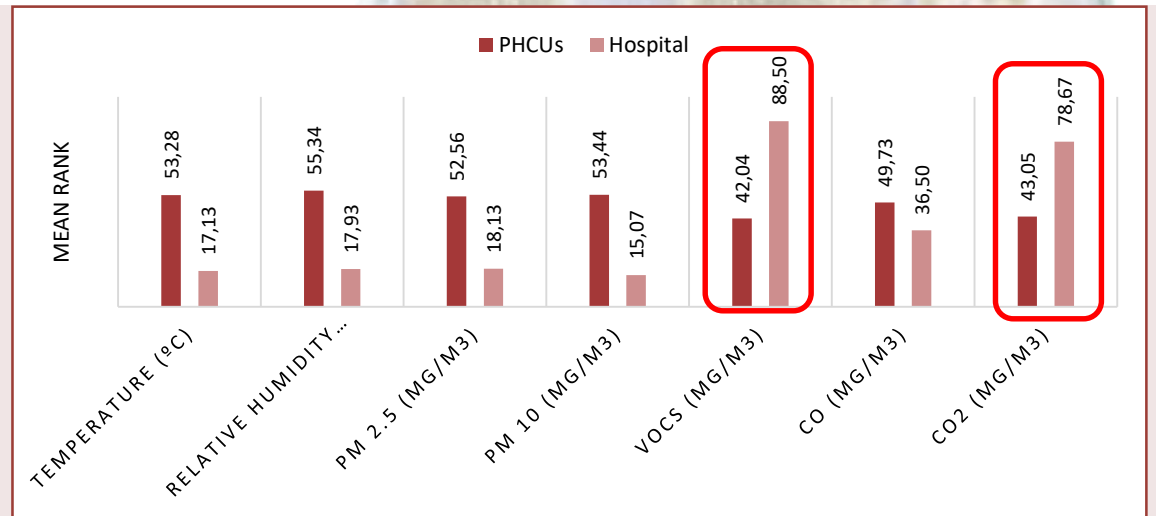
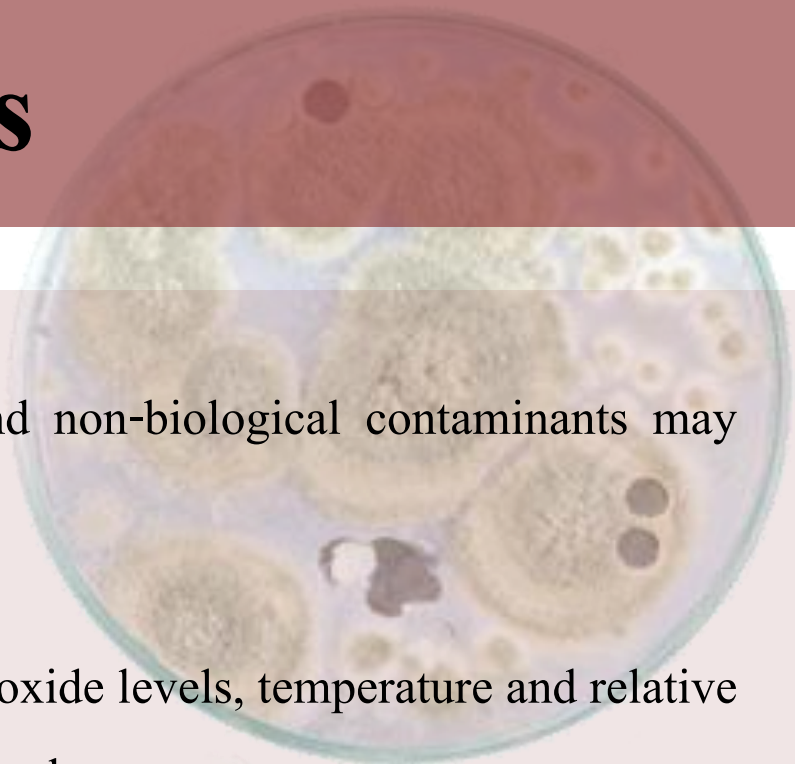


Figure 18 - Mean Ranks (results of Kruskal-Wallis test) to compare non-biological parameters between all PHCUs and the Hospital

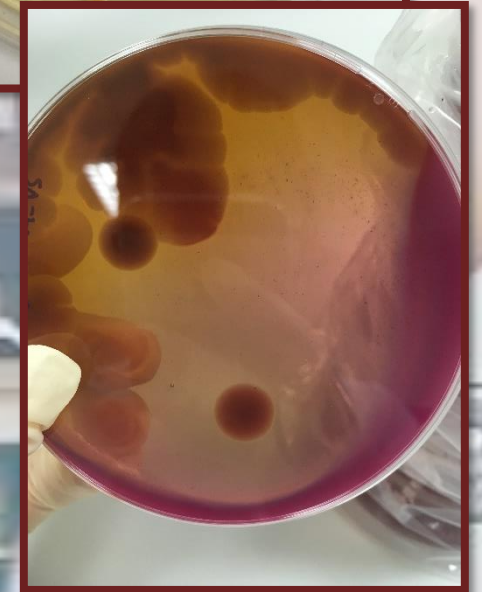
Lower contamination of fungi and bacteria + higher carbon dioxide and VOCs

Main Findings

- 
- A petri dish containing a culture medium with several distinct colonies of varying sizes and colors, including yellow, white, and brown, indicating microbial growth.
- 🔑 Indoor air quality parameters associated with microbiological and non-biological contaminants may influence the biological response in Calu-3 and TPH-1 cells;
 - 🔑 Fungal and bacterial (namely gram (-) specimens) load, carbon monoxide levels, temperature and relative humidity proved to be statistically significant influencers of the biological response;
 - 🔑 Correlations between the presence of different mycotoxins in air samples may suggest improper practices and/or inefficient cleaning and disinfecting methods.

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Thank you



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