Implementing Evidence-Based Infection Prevention Strategies in Primary School Environments

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Background

Why Schools?

High-contact settings where respiratory pathogens spread rapidly — young children have **developing immune systems** and limited hygiene autonomy.

⚠ Critical Gap

No standardised, evidence-based IPC protocols tailored to **school operational assistants** — cleaning and support staff who are frontline but often overlooked.

Sources: WHO (2021); CDC (2020)

Child absenteeism

Household transmission

Pressure on primary care

InChildHealth Project

This study is a spin-off of a European research project, “Identifying determinants for indoor air quality and their health impact in environments for children: measures to improve indoor air quality and reduce disease burdens”.

Why Exposure Assessors?

This framework was designed **by and for exposure assessors** working in primary school environments.

Step-by-Step Process

From risk characterisation to management — a practical flowchart that can be applied in the field

Practical Actions

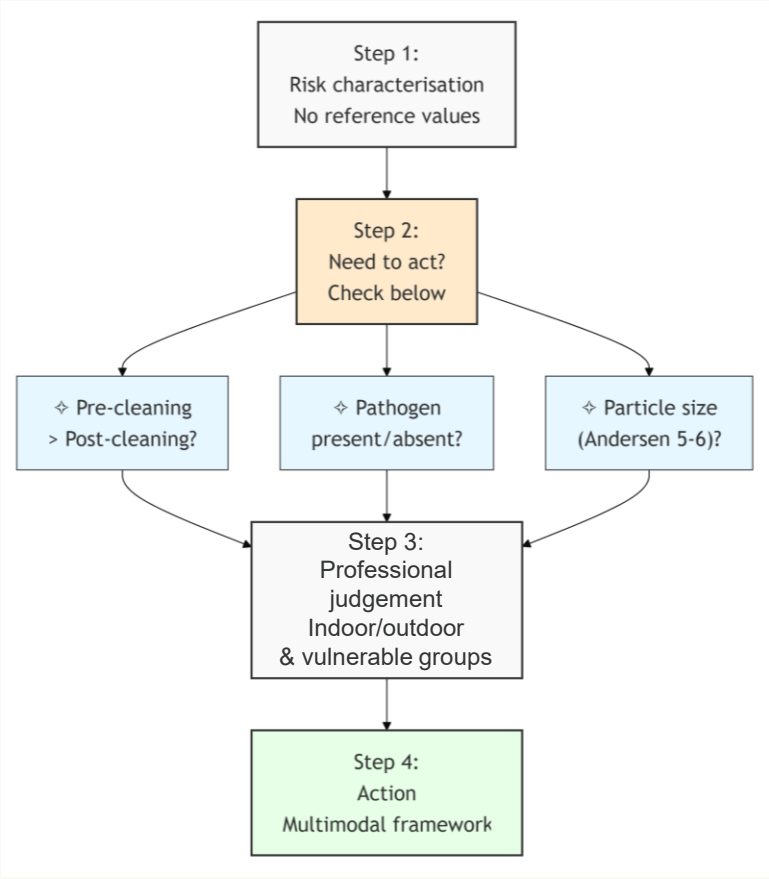
Improve air quality **without needing established reference values**

Open Questions

Identifying the main gaps that the scientific field still needs to address

Adaptable Structure

Insert your **own field data** and decision rules into this framework



References: Whitby et al., 2022 (sampling challenges); Oppliger, 2014 (complexity of microbial exposure)

When Does This Framework Apply?

Criterion	Applicability
Context	Primary schools (ages 6–10), adaptable to early years
Building characteristics	Natural ventilation, mixed heating/cooling, canteen, and toilet facilities
Occupancy	Pupils + teachers + support staff
Climate	Temperate, with hot and humid summers and cold winters
Resources	From low-cost settings to higher-resource contexts

This framework was developed based on WHO (2021) and CDC (2020) guidance for school environments.

INDOOR AIR QUALITY RISK MANAGEMENT FRAMEWORK

From Assessment to Action

STEP 1 – HAZARD IDENTIFICATION & RISK CHARACTERIZATION

- Identify hazards: bacteria, fungi, particle size (Andersen stages)
- Measure concentrations: active (MAS-100, BS) + passive (EDC, mops)
- Compare indoor vs, outdoor, seasonal variations, critical zones
- Note any detection of pathogens or indoor > outdoor

STEP 2 – RISK PRIORITIZATION (qualitative, not quantitative)

- We cannot directly link complex microbial mixtures to specific health effects – so focus on:
  - Presence of known opportunistic pathogens (*Aspergillus fumigatus, Mucor sp., Gram-negative bacteria*)
  - Particle size distribution (Andersen stages 5-6 → deep lung reach)
  - Indoor concentrations consistently higher than outdoor (poor ventilation or indoor sources)
  - Vulnerable groups present (children with asthma, immunocompromised)
- Priority increases when multiple indicators align (e.g., pathogen + respirable size + indoor > outdoor)

STEP 3 – RISK EVALUATION (based on professional judgment)

- NOTE: There are no consensual reference values for microbial exposure in schools. Therefore, risk evaluation relies on qualitative indicators, indoor/outdoor comparisons, and professional judgment.

Risk acceptable?
Continue monitoring

Risk not acceptable
Proceed to risk treatment

RISK TREATMENT (PRACTICAL ACTIONS TO IMPROVE AIR QUALITY)

VENTILATION IMPROVEMENTS

- Natural cross-ventilation schedule: open windows [adjust to local needs]
- Use CO_2 monitors as proxy
- Portable HEPA if feasible
- Mechanical exhaust in bathrooms and kitchen

CLEANING & DISINFECTION

- High-touch surfaces daily
- Use correct disinfectant (0.1% hypochlorite or 70% ethanol)
- Observe contact time
- Clean mops & dry fully
- Differentiate materials by area (no cross-contam)

HUMIDITY CONTROL

- Keep RH < 65% (ideal 30–65%)
- Use dehumidifiers in damp areas
- Fix leaks / condensation
- Improve drainage

BEHAVIOURAL & ADMINISTRATIVE

- Train staff (especially operational assistants)
- Hand hygiene posters
- Staggered schedules if outbreak
- Isolate symptomatic cases

STEP 5 – IMPLEMENT & VERIFY (MONITORING & REVIEW)

- Apply selected interventions
- Re-assess (same methods, same locations, same season if possible)
- Compare post-intervention data to initial findings
- If not improved → adjust actions (e.g., increase ventilation frequency, change disinfectant, repair HVAC, retrain staff)

STEP 6 – DOCUMENT & COMMUNICATE

- Report to school management, public health authorities, staff
- Provide actionable recommendations (checklists, job aids)
- Schedule routine re-assessment (e.g., seasonally or annually)

GOAL: HEALTHIER INDOOR ENVIRONMENTS, INFORMED DECISIONS, AND CONTINUOUS IMPROVEMENT

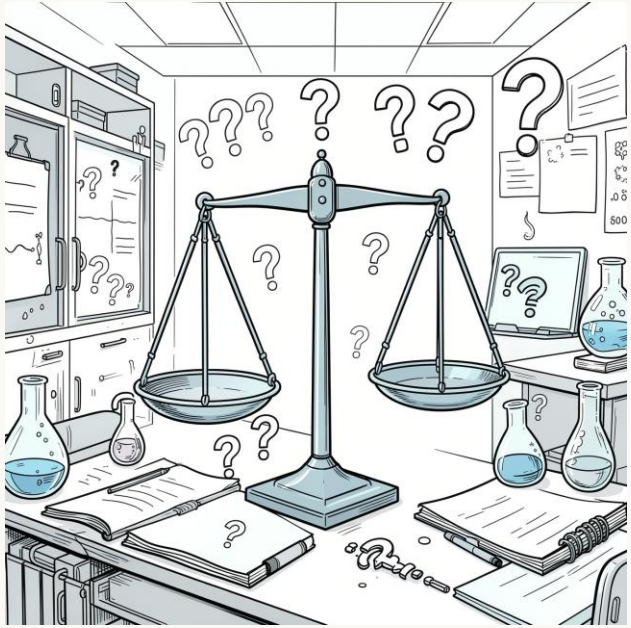
In What Situations Should You Use This Framework?

1. **Routine Assessment**
   Baseline indoor air quality — regular, systematic monitoring
2. **Outbreak Investigation**
   Increased absenteeism due to respiratory or gastrointestinal causes
3. **Post-Renovation or Moisture Event**
   Water damage, visible mould, persistent dampness
4. **Complaint-Driven**
   Allergies, asthma, or infections reported by parents or staff
5. **High-Risk Seasonal Periods**
   Warm, humid months (fungal peak) and cold months (lower ventilation, build-up of fine particles)

References: Mendell & Kumagai, 2016 (moisture and health); Reponen, 2017 (seasonal variation)

The Central Challenge – What Should Trigger Action?

⚠ **There are currently no health-based reference values for complex microbial mixtures in the air in schools.** As exposure assessors, we need to decide when to recommend intervention — but on what basis?



Guiding Principle

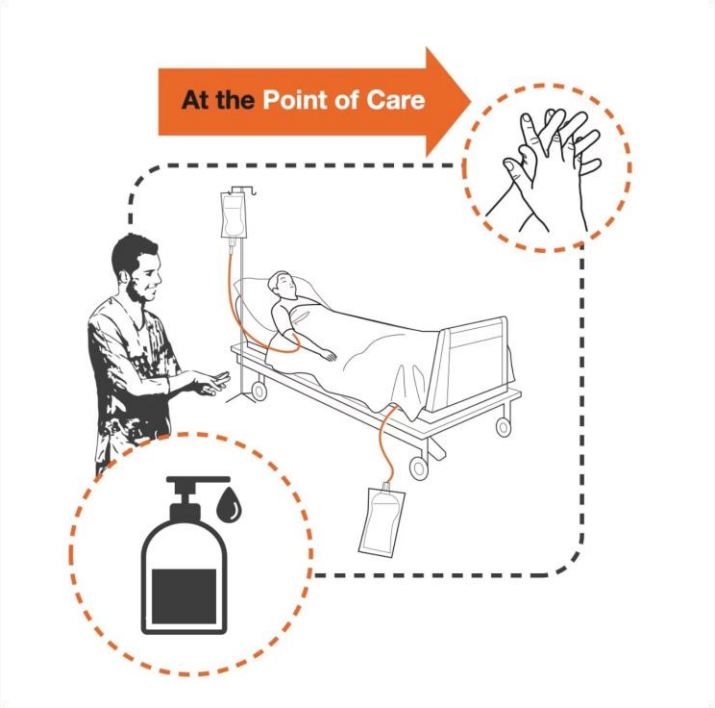
This presentation **does not provide definitive answers** — it suggests a framework for transparent and justifiable decision-making based on the data available.

- The absence of reference values does not prevent action. Professional judgement, comparisons, and the presence of pathogenic agents are valid tools for decision-making.

References: Ferguson et al., 2019; Whitby et al., 2022; Viegas et al., 2021b

The Multimodal IPC Framework – Adapted for Exposure Assessors

This framework supports the actions of Step 4. Adapted from the WHO Multimodal Improvement Strategy.



Pillar	Triggered by	Key Actions
Administrative Controls	Outbreak, high absenteeism	Staggered schedules, cohorting, visitor restrictions, isolation protocols
Environmental Management	Any pathogen detection, indoors > outdoors, humidity >65%	Ventilation, cleaning/disinfection, biofilm prevention
Behavioural Interventions	Observations of poor hygiene, staff knowledge gaps	Hand hygiene, respiratory etiquette, training, and visual reminders

The multimodal approach is more effective than any single intervention — the three pillars should be activated together whenever possible.

References: WHO Multimodal Improvement Strategy (WHO, 2019); CDC (2020, 2021)

Practical Examples – Lessons from Other Contexts

These examples illustrate how contamination patterns inform management actions. The same principles apply in schools.

Fitness Centres

Mops contained ***Aspergillus fumigatus*** **and toxigenic species**; mops spread mycotoxins → Wash and dry thoroughly; use separate mops for each area

Waste Collection

Section *Fumigati* of *Aspergillus* detected in air; **azole resistance observed** → Improve ventilation and respiratory protection; **schools near agricultural areas require enhanced monitoring**

Ambulances

Surfaces were more contaminated after cleaning (ineffective protocol); MRSA and azole-resistant fungi → Review and train cleaning staff; use the correct disinfectant with the proper contact time

Healthcare Centres

HVAC filters accumulated mycotoxins and fungi; **passive sampling (EDC) identified chronic contamination** → Replace filters regularly; use EDC for long-term monitoring

Practical conclusion: Cleaning protocols should ensure **contact time**, **drying of mops** and **separation of materials by area**. Passive methods (EDC, mops) can identify reservoirs that active air sampling does not detect.

References: Fitness centres – Viegas et al., 2022b; Waste collection – Viegas et al., 2018, 2020a; Ambulances – Viegas et al., 2019c; Healthcare centres – Viegas et al., 2020b

Implementation and Adaptability

Scalable

Works in both high- and low-resource settings — adaptable to the local reality

Adaptable

Prioritise actions based on local results: pathogens, indoor/outdoor, vulnerable groups

Practical Tools

Checklists, training modules for operational staff

Multiple Matrices

Air, surfaces, mops, HVAC filters, settled dust (EDC) — each provides different exposure information

Key message for exposure assessors

You do not need reference values to act. Use the **comparison** between results **before and after cleaning**, the **presence or absence of pathogens**, **particle size**, and your **professional judgement**.

The combination of active and passive methods provides a more complete picture of microbial exposure than any single method alone.

References: Viegas et al., 2021b (combination of active/passive methods); Whitby et al., 2022 (practical tools)

Conclusions and Next Steps for Exposure Assessors

Key Conclusions from the Science of Exposure Assessment

- Absolute CFU reference values **do not exist** for complex microbial mixtures — and they may never exist
- Sampling methods (active/passive) answer **different questions** — use a combination
- Legal frameworks based only on CFU/m³ are **insufficient** — multi-approach assessments are needed
- Reference values are not enough. Compare pre- and post-cleaning results. Use indoor/outdoor and pathogen checks. Assess particle size and vulnerable groups.
- The proposed **6-step flowchart** is a practical framework that can be tested in the field

References: Pena et al., 2024; Viegas et al., 2018, 2019c, 2020a, 2022b (multi-matrix assessments); Reponen, 2017 (sampling strategies)

Conclusions and Next Steps for Exposure Assessors

Next Steps – Applying Our Assessment Data

We collected:

- Active samples (MAS-100, Andersen, personal samplers)
- Passive samples (EDC, swabs, vacuum filters)
- Multiple matrices (air, surfaces, cleaning materials)
- Multiple assays (bacterial quantification, fungal identification, Gram-negative detection)

Our next step is to combine the results of this comprehensive characterisation — integrating results across matrices, methods and seasons — and then:

1. Apply the flowchart to our school data
2. Document the decision rules used
3. Share our experiences to help build evidence-based guidance

We invite other exposure assessors to do the same — and to share their cases.
And keep a close look at Biological Agents WG!!

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Thanks

Thanks for your attention and looking forward to hearing your Questions?

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