Evaluation of Indoor Environmental Quality and Teachers’ Health in an Urban School District

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The findings and conclusions in this presentation are those of the authors and do not necessarily represent the views of the National Institute for Occupational Safety and Health.
Health Effects Associated with Damp Indoor Environments

- Development and exacerbation of asthma
- Hypersensitivity pneumonitis
- Respiratory infections
- Lower (cough, wheeze, and dyspnea) and upper respiratory symptoms (runny nose, eye irritation, and sore throat)
- Bronchitis
- Eczema
- Allergic rhinitis
Persistent dampness and microbial growth should be prevented since they may produce adverse health effects.

If they occur, dampness and mold should be remediated to minimize exposure to microbial agents.
Our Indoor Environmental Quality team in Morgantown has developed a standardized approach to conduct observational assessments for dampness and mold.

Our earlier research indicated that dampness and mold scores positively associated with respiratory health effects.

- Park et al. 2004, Indoor Air; 14:425-433
Background

• 2016 review of 22 studies that used observation-based dampness and mold metrics in homes:
  - The presence of D/M in homes, indicated by sight or smell is consistently linked with significantly increased risk of multiple respiratory health effects.
  - Among these indicators, mold odor had the strongest correlations with specific health effects.
• Currently the underlying dampness-related causal agents are not understood.

• 1995 U.S. General Accounting Office
  - 33% of schools nationwide need extensive repair or replacement to plumbing, roofs, exterior walls, finishes, windows, or doors,
  - 40% of schools have unsatisfactory indoor environmental conditions


Approach to Dampness and Mold Assessment

- Observational inspection method
  - Olfactory assessment for mold odor
  - Visual inspection of rooms for water-damage related factors
    - Water damage or stains, visible mold, obvious dampness, or dripping/standing water
NIOSH Dampness and Mold Assessment Tool

Two Components

Form

Software
# NIOSH Dampness and Mold Assessment Form

(Use one form per room.)

<table>
<thead>
<tr>
<th>Start Date:</th>
<th>Time:</th>
<th>Observer:</th>
<th>District:</th>
<th>School/Site:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Building/Element:</td>
<td>Wing:</td>
<td>Floor:</td>
<td>Room:</td>
<td></td>
</tr>
</tbody>
</table>

## Room Type: Fill in the bubble for the type of room you are assessing.

- Auditorium
- Boiler Rm
- Conference Rm
- Gym
- Locker Rm
- Office
- Bathroom (M)
- Cafeteria
- Custodial Closet
- Hallway
- Lounge
- Pipe Chase
- Bathroom (F)
- Classroom
- Elevator
- Kitchen
- Mechanical Rm
- Stairwell
- Bathroom (U)
- Computer Rm
- Entrance Area
- Library
- Music Rm
- Storage/Closet
- Other: _______________________

## Mold Odor: Be sure to smell for mold odor when you first walk into the room/area. Fill in the appropriate bubble.

- NONE
- MILD
- MODERATE
- STRONG

Source of MOLD ODOR? ____________________________  
- Source Unknown

<table>
<thead>
<tr>
<th>Check if Component is in the room/area</th>
<th>Check if Nothing Found</th>
<th>Damage or Stains</th>
<th>Visible Mold</th>
<th>Wet or Damp</th>
<th>Flaky Paint</th>
<th>NOTES</th>
</tr>
</thead>
<tbody>
<tr>
<td>(✓)</td>
<td>(✓)</td>
<td>0 1 2 3</td>
<td>0 1 2 3</td>
<td>0 1 2 3</td>
<td>(✓)</td>
<td></td>
</tr>
</tbody>
</table>

- Ceiling:  
  - Ceiling Tile
  - Plaster
  - Concrete
  - Sheetrock

- Walls:  
  - Plaster
  - Sheetrock
  - Concrete
  - Brick

- Floor:  
  - Carpet
  - Wood
  - Ceramic
  - Vinyl
  - Concrete

- Windows:  
  - Glass
  - Plastic

- Furnishings:  
  - Fabric
  - Leather
  - Wood

- HVAC systems:  
  - Ducts
  - Fans

- Supplies & Materials:  
  - Paper
  - Plastic

- Pipes:  
  - Metal
  - Plastic

- Other:  
  - Other materials

Scoring:  ✓ = none;  o = less than the size of a sheet of paper; ♦ = the size of a sheet of paper to the size of a standard door; ➤ = greater than the size of a standard door.
Scoring

0 = None

1 = The total size of the area or areas that are approximately the size of a 8x11 piece of paper or smaller.

2 = The total size of the area or areas that are between the size of a piece of paper and the size of a standard interior door.

3 = The total size of the area or areas that are larger than the size of an interior door.
Dampness and Mold Assessment Tool


• +100 planned assessments conducted
• Assessment for damage from Hurricane Sandy on 61 schools
Philadelphia School Study

- Partnered with the School District and the Union to conduct a study on the association of dampness and mold in schools with health effects among staff

- The evaluations took place in 2015/2016
Philadelphia School Study

- Fifty elementary schools with > 350 students
Philadelphia School Study

- Web-based health questionnaire
- Dampness and mold assessments
- Floor dust samples from each school – total of 500 classrooms
  - to be analyzed for markers of microbial exposure
- CO$_2$, temperature, humidity measurements in the 500 classrooms
Web-base Questionnaire

• Overall participation 46.7% (1536/3291)
• Teacher participation 65.9% (1239/1881)

• Teachers
  ➢ 85.7% female
  ➢ 96.6% non-Hispanic
  ➢ 71.8% white
  ➢ 79.0% never-smokers
  ➢ mean age of 44
Comparison of Physician-diagnosed Asthma Study Teachers and Pennsylvania Adults in 2015

<table>
<thead>
<tr>
<th>Health Condition</th>
<th>Teachers</th>
<th>PA Adults 2015*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asthma ever</td>
<td>21.7%</td>
<td>15.0%</td>
</tr>
<tr>
<td>Asthma current</td>
<td>15.6%</td>
<td>10.2%</td>
</tr>
<tr>
<td>Post-hire onset asthma</td>
<td>9.5%</td>
<td>---</td>
</tr>
</tbody>
</table>

* Data from CDC Behavioral Risk Factor Surveillance System
Respiratory Symptoms in the Past 12 Months

- Teachers
  - 44.0% wheeze
  - 39.7% chest-tightness
  - 34.8% attacks shortness of breath
  - 62.3% attacks of cough
Associations Between Health and Dampness/Mold

• Logistic models adjusted for gender, race, ethnicity, age, smoking, hay-fever, mold in the home:
  ➢ Higher school dampness/mold associated with more wheeze, chest-tightness, and attacks of shortness of breath in the past 12 months (Odds ratios = 1.32-1.61).
Dampness and Mold Assessment

• Five NIOSH teams of 2
  ➢ Evaluated all accessible rooms/areas for two weeks
• Total
  ➢ 6,492 rooms/areas
    ▪ 1665 classrooms
    ▪ 559 offices
    ▪ 50 libraries
    ▪ 158 mechanical rooms
    ▪ 1722 storage areas
    ▪ 2338 other rooms/areas
# Signs of Dampness and Mold in 6492 Rooms/Areas

<table>
<thead>
<tr>
<th>Sign</th>
<th>Count</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mold odor</td>
<td>242</td>
<td>3.7</td>
</tr>
<tr>
<td>Visible mold</td>
<td>282</td>
<td>4.3</td>
</tr>
<tr>
<td>Wet/Damp</td>
<td>363</td>
<td>5.6</td>
</tr>
<tr>
<td>Water damage/Stains</td>
<td>4896</td>
<td>75.4</td>
</tr>
</tbody>
</table>
Dampness and Mold Assessment Results

Mold Odor

![Mold Odor Graph]
Dampness and Mold Assessment Results

Visible Mold

- **Ceiling**: 0
- **Walls**: 25
- **Floors**: 125
- **Windows**: 25
- **Furnishings**: 0
- **HVAC systems**: 10
- **Supplies & Materials**: 25
- **Pipes**: 25

Score

Count
Dampness and Mold Assessment Results

Wet/Damp

![Bar chart showing the count of dampness and mold assessment results across different locations: Ceiling, Walls, Floors, Windows, Furnishings, HVAC systems, Supplies & Materials, and Pipes. The chart indicates the severity levels on a score of 1 to 3.]
Dampness and Mold Assessment Results

Water damage/Stains

![Bar Chart showing the count of water damage/stains by category]

- Ceiling
- Walls
- Floors
- Windows
- Furnishings
- HVAC systems
- Supplies & Materials
- Pipes

Score: 0, 1, 2, 3

Count: 0, 150, 300, 450, 600, 750, 900, 1050, 1200
Outputs/Outcomes

• In 2016, reports on the dampness and mold assessments for each of the 50 schools provided to the School District and the Union
  ➢ School District reported that assessments used to aid in repair and remediation

• Poster “Asthma and Asthma Symptoms in Teachers in 50 Elementary Schools In a Large City.” accepted for presentation at the American Thoracic Society Conference in May 2017.
Future Plans

• Analyze associations between health and environmental measures
• Analyze associations between dampness and mold assessments and floor dust measures
• Report findings
• Make the Dampness and Mold Assessment software available online
Discussion Points

• Where do we take this research to next?
• How do we further investigate the importance of mold odors?
• What other areas of Indoor Environmental Quality and what other occupational groups should be explored?

• How can we promote the use of the Dampness and Mold Assessment Tool more broadly?
• Should we adapt the tool for different building types – such as offices, public buildings, hospitals, homes?