

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

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Board of Scientific Counselors Meeting
April 2017



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

IOM Report (2004) and WHO Guidelines (2009)

- 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.

Background

- 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
 - Cox-Ganser et al. 2009, *Indoor Air*; 19:280-290

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.

U.S. School Conditions

- 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 for Schools Use one form per room. Draft

Date: 1/12/13 Observer: John Doe District: Southeast Site: Miller Elementary School

Building: Main Type: Elementary Wing: A Floor: 2 Room: 23

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

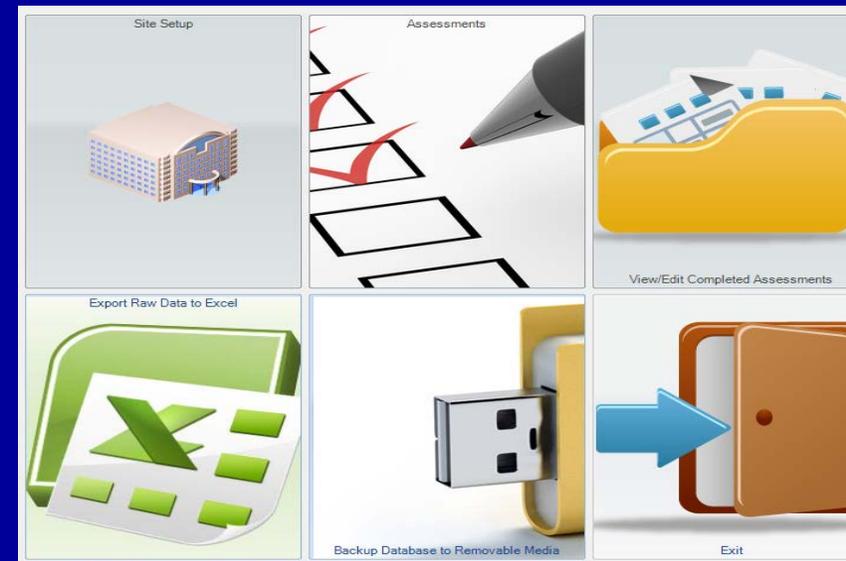
Auditorium Cafeteria Conference room Gym Library Mechanical room Pipe chase/shaft Other
 Bathroom Classroom Custodial closet Hallway Locker room Music room Stairwell
 Boiler room Computer room Entrance area Kitchen Lounge Office Storage area

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

Check if component is in the room/area (✓)	Nothing found (✓)	DAMAGE or STAINS				VISIBLE MOLD				WET or DAMP				Row Totals	NOTES
		0	1	2	3	0	1	2	3	0	1	2	3		
✓ Ceiling			●	○	○	●	○	○	○	○	○	○	○	2	
✓ Walls		○	○	○	●	●	○	○	○	○	○	○	○	5	
✓ Floor		○	○	○	●	●	○	○	○	○	○	○	○	6	
✓ Windows	✓	○	○	○	○	○	○	○	○	○	○	○	○		
✓ Furnishings		○	○	○	○	○	○	○	●	○	○	○	○	3	
✓ HVAC systems	✓	○	○	○	○	○	○	○	○	○	○	○	○		
✓ Supplies & Materials		○	○	○	○	○	○	○	○	○	○	○	○	2	
✓ Pipes	✓	○	○	○	○	○	○	○	○	○	○	○	○		
Other _____		○	○	○	○	○	○	○	○	○	○	○	○		
Column Totals		8				3				7				18	
Column Averages		1.0				0.375				0.25				0.375	

Size based scores: 0=None 1=the size of this form or smaller 2=between the size of this form and the size of a standard interior door 3=equal to or larger than the size of an interior door



NIOSH Dampness and Mold Assessment Form (Use one form per room.)

Start Date: _____ Time: ____ Observer: _____ District: _____ School/Site: _____

Building/Element: _____ Wing: ____ Floor: _____ Room: _____

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

- | | | | | | |
|------------------------------------|-----------------------------------|--|-------------------------------|-------------------------------------|--------------------------------------|
| <input type="radio"/> Auditorium | <input type="radio"/> Boiler Rm | <input type="radio"/> Conference Rm | <input type="radio"/> Gym | <input type="radio"/> Locker Rm | <input type="radio"/> Office |
| <input type="radio"/> Bathroom (M) | <input type="radio"/> Cafeteria | <input type="radio"/> Custodial Closet | <input type="radio"/> Hallway | <input type="radio"/> Lounge | <input type="radio"/> Pipe Chase |
| <input type="radio"/> Bathroom (F) | <input type="radio"/> Classroom | <input type="radio"/> Elevator | <input type="radio"/> Kitchen | <input type="radio"/> Mechanical Rm | <input type="radio"/> Stairwell |
| <input type="radio"/> Bathroom (U) | <input type="radio"/> Computer Rm | <input type="radio"/> Entrance Area | <input type="radio"/> Library | <input type="radio"/> Music Rm | <input type="radio"/> Storage/Closet |
| | | | | | <input type="radio"/> 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

		Check if Nothing Found	Damage or Stains	Visible Mold	Wet or Damp	Flakey Paint	NOTES
(✓)	Check if Component is in the room/area	(✓)	0 1 2 3	0 1 2 3	0 1 2 3	(✓)	
✓	Ceiling		① ① ② ③	① ① ② ③	① ① ② ③		Ceiling Tile Plaster Concrete Sheetrock
✓	Walls		① ① ② ③	① ① ② ③	① ① ② ③		Plaster Sheetrock Concrete Brick Block
✓	Floor		① ① ② ③	① ① ② ③	① ① ② ③		Carpet Wood Ceramic Vinyl Concrete
	Windows		① ① ② ③	① ① ② ③	① ① ② ③		
	Furnishings		① ① ② ③	① ① ② ③	① ① ② ③		
	HVAC systems		① ① ② ③	① ① ② ③	① ① ② ③		
	Supplies & Materials		① ① ② ③	① ① ② ③	① ① ② ③		
	Pipes		① ① ② ③	① ① ② ③	① ① ② ③		
	Other _____		① ① ② ③	① ① ② ③	① ① ② ③		

Scoring: ① = none; ② < or = the size of a sheet of paper; ③ > than a sheet of paper to the size of a standard door; ④ > 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.

NIOSH Dampness and Mold Assessment Form (Use one form per room.)

Start Date: _____ Time: _____ Observer: _____ District: _____ School/Site: _____
Building/Element: _____ Wing: _____ Floor: _____ Room: _____

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 Order: 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 MOULD ODOR? Source Unknown

Check if Component is in the room/area	Check if staining found	Damage or Stains				Visible Mold				Wet or Damp				Mold Order	NOTES
		0	1	2	3	0	1	2	3	0	1	2	3		
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	0	1	2	3	0	1	2	3	0	1	2	3		Celling: Plaster Concrete Sheetrock
<input checked="" type="checkbox"/>		0	1	2	3	0	1	2	3	0	1	2	3		Plaster Sheetrock Concrete Brick Block
<input checked="" type="checkbox"/>		0	1	2	3	0	1	2	3	0	1	2	3		Carpet Wood Ceramic Vinyl Concrete
		0	1	2	3	0	1	2	3	0	1	2	3		
		0	1	2	3	0	1	2	3	0	1	2	3		
		0	1	2	3	0	1	2	3	0	1	2	3		
		0	1	2	3	0	1	2	3	0	1	2	3		
		0	1	2	3	0	1	2	3	0	1	2	3		
		0	1	2	3	0	1	2	3	0	1	2	3		
		0	1	2	3	0	1	2	3	0	1	2	3		
		0	1	2	3	0	1	2	3	0	1	2	3		
		0	1	2	3	0	1	2	3	0	1	2	3		

Scoring: 0 = none; 1 = or the size of a sheet of paper; 2 = than a sheet of paper to the size of a standard door; 3 = than the size of a standard door



Dampness and Mold Assessment Tool

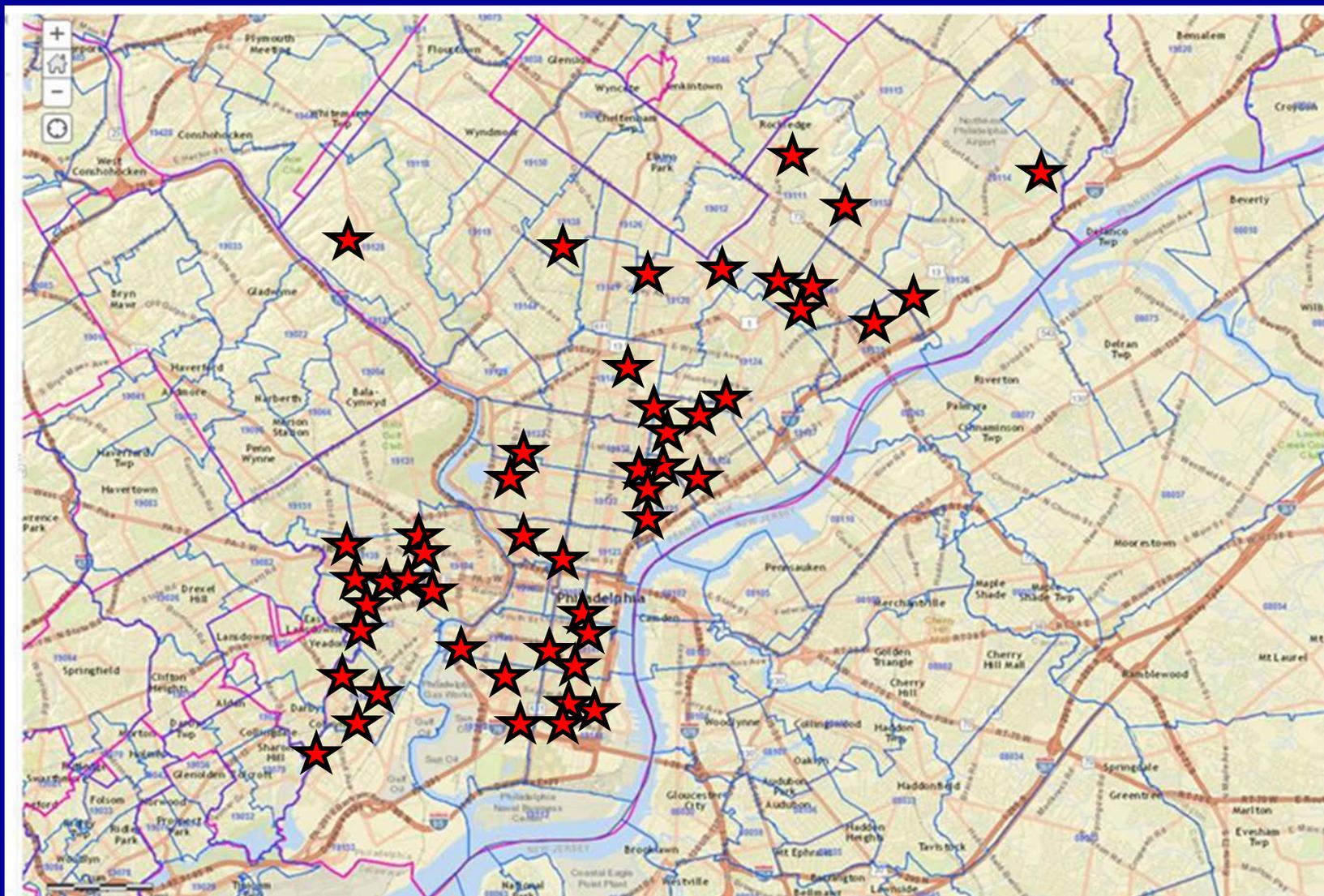
- Between 2011 and 2014 developed and tested in collaboration Philadelphia School District and the Philadelphia Teachers Health and Welfare Fund & Union.
- ±100 planned assessments conducted
- Assessment for damage from Hurricane Sandy on 61 schools

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
- CO₂, 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

Health Condition	Teachers	PA Adults 2015*
Asthma ever	21.7%	15.0%
Asthma current	15.6%	10.2%
Post-hire onset asthma	9.5%	---

* 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

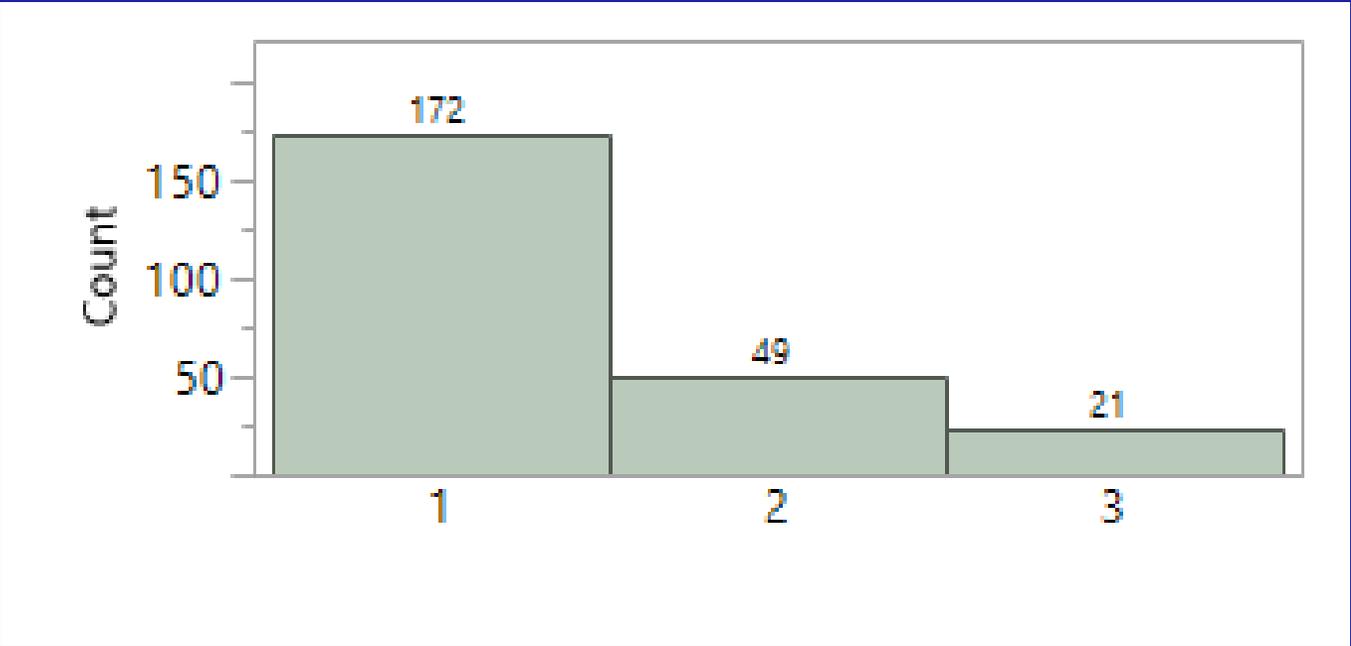
- Five NIOSH teams of 2
 - Evaluated all accessible rooms/areas for two weeks
- Total
 - 6,492 rooms/areas
 - 1665 classrooms
 - 559 offices
 - 50 libraries
 - 158 mechanical rooms
 - 1722 storage areas
 - 2338 other rooms/areas

Signs of Dampness and Mold in 6492 Rooms/Areas

Sign	Count	Percent
Mold odor	242	3.7
Visible mold	282	4.3
Wet/Damp	363	5.6
Water damage/Stains	4896	75.4

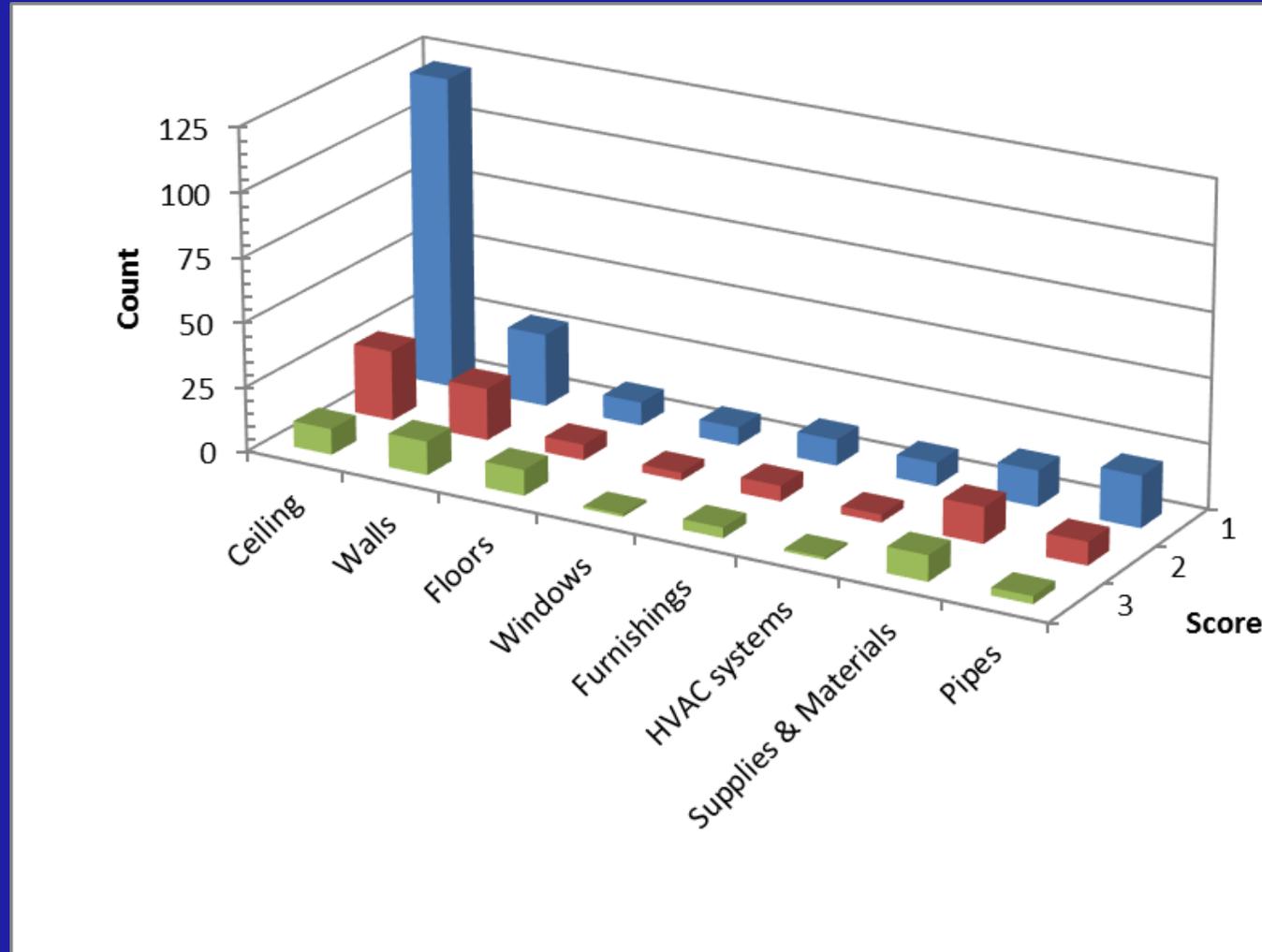
Dampness and Mold Assessment Results

Mold Odor



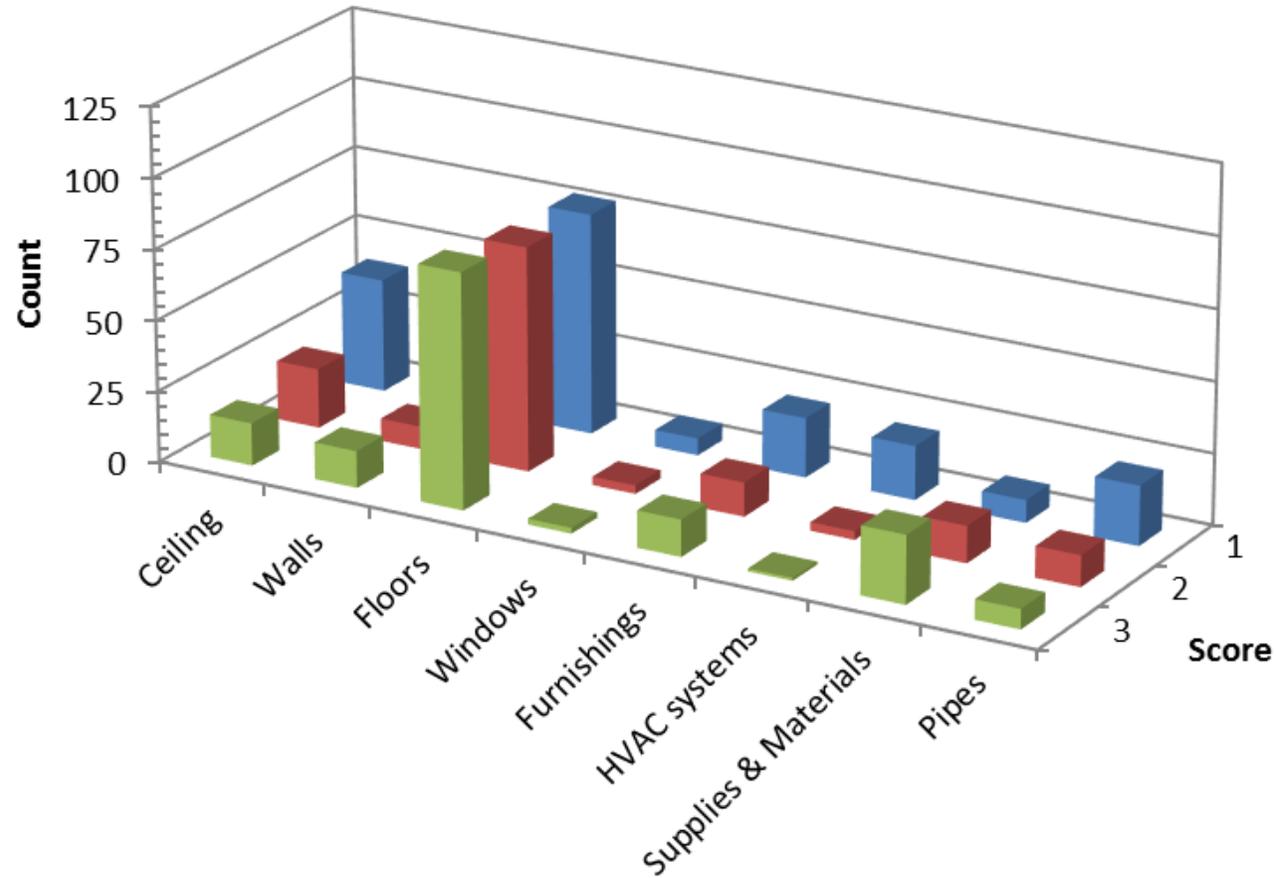
Dampness and Mold Assessment Results

Visible Mold



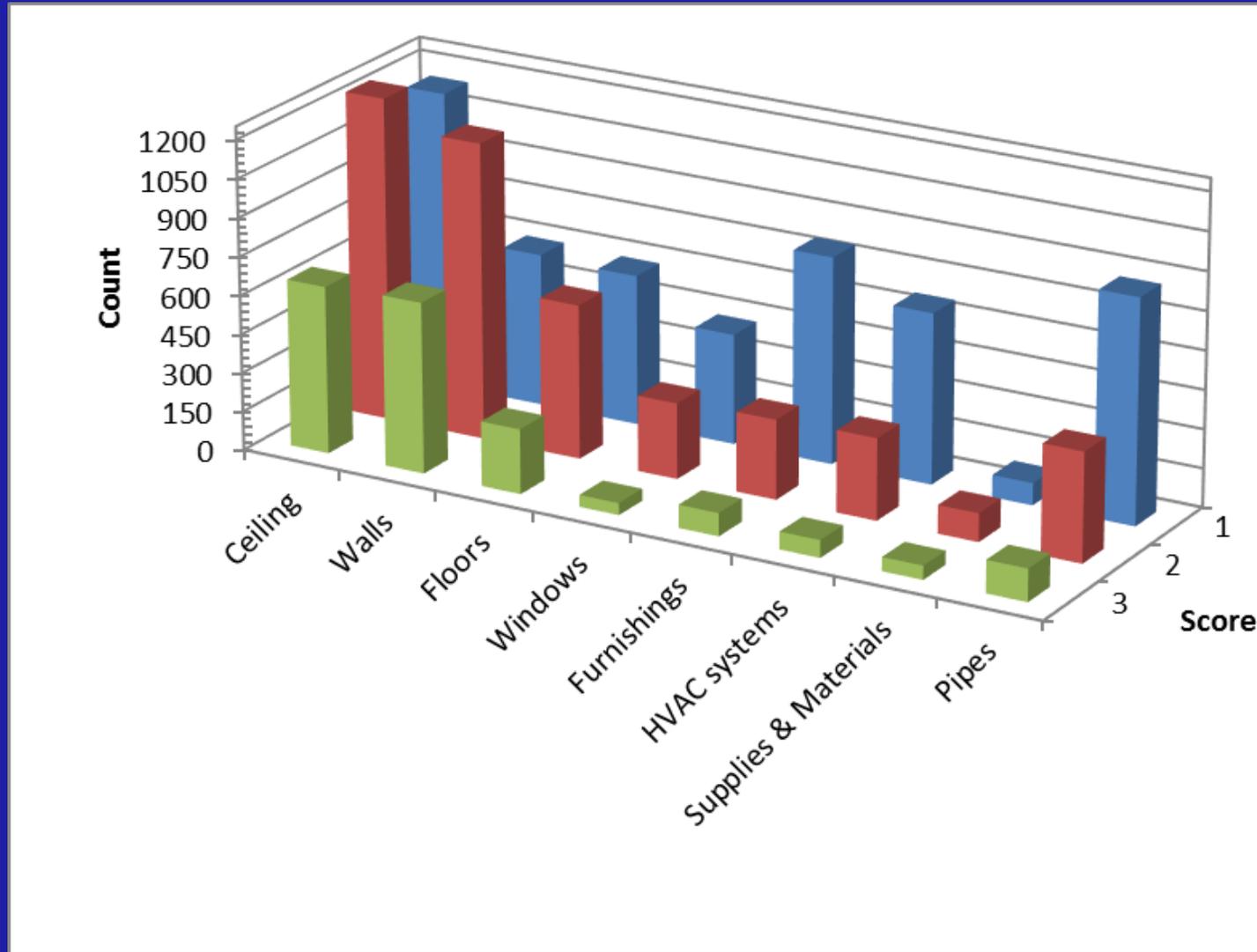
Dampness and Mold Assessment Results

Wet/Damp



Dampness and Mold Assessment Results

Water damage/Stains



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?