Assessment of Indoor Air Quality (IAQ) and Noise in Public Swimming Pools

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Ryerson and LSS-Ont Partnership

- Collaborated together on pilot research projects over the past few years
  - Admission Standards in Class A pools (child: guardian ratios)
  - IAQ in indoor pools
  - Noise in indoor pools
- Provide evidence-based findings that help to promote health and safety for staff and visitors of aquatic facilities

Lead investigators - IAQ

- The three undergraduate students who collected, analyzed and interpreted IAQ data as part of the Research Project (ENH066) course while attending Ryerson University (2015/2016):
  - Milena Agababova
  - Shivangi Patel
  - Kelly White

Lead investigators - Noise

- The two undergraduate students who collected, analyzed and interpreted the noise data as part of the Research Project (ENH066) course while attending Ryerson University (2016/2017):
  - Jana Lowry
  - Annie Zhan

Agenda

- Indoor Air Quality
  - Airborne chemicals
  - Mold
  - Perspectives
- Noise
  - Staff (occupational)
  - Public
  - Perspectives
- Q + A

Indoor Air Quality:
Airborne Chemicals and Mold

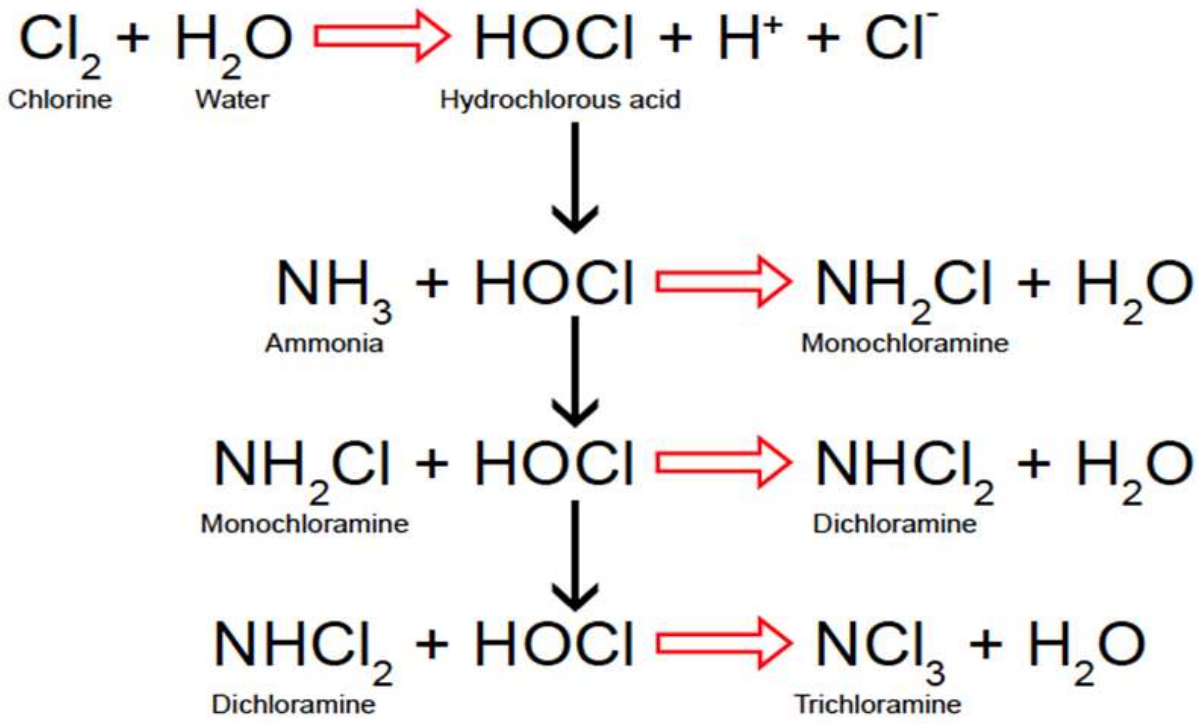
R.R.O. 1990, Reg. 565: PUBLIC POOLS

under *Health Protection and Promotion Act, R.S.O. 1990, c. H.7*

- Sec. 7(7) Every owner and every operator shall ensure that the pool water is treated with chlorine, a chlorine compound or a bromine compound by means of an adjustable dosing device

https://www.ontario.ca/laws/regulation/900565

Chemical reaction



Chemical formation of chloramines

Image courtesy of Google Images

Background – Chlorine products

- Several studies have shown a relationship between high levels of trichloramine and an increase in the frequency of respiratory symptoms and irritation amongst pool employees
- Hery et al. (1995) assessed exposure of swim instructors who complained of eye and lung irritation at work
  - Developed method to sample trichloramine
  - Proposed an occupational exposure level of 0.5 mg/m^3 for trichloramine

Background – Chlorine products

- A study in Netherlands concluded that pool workers experienced a higher prevalence of respiratory symptoms than the average Dutch person (Jacobs et al., 2007)
- Massin et al (1998) found that there was an increase in the incidence of eye and throat irritation as the concentration of trichloramine increased.
  - Lent support to the proposed occupational exposure level of 0.5 mg/m^3 for trichloramine

Background – Chlorine products

- Exposure to indoor pool environments is related to respiratory symptoms including asthma among lifeguards (Bureau et al., 2017)
- Besides trichloramines, exposures to high levels of chlorine gas can lead to chronic respiratory disorders (Kim et al, 2014)
- Studies have shown that inhalation of 10 ppm of hydrogen chloride in an occupational setting can lead to irritation (NRC, 2004)

Background - Mold

- Indoor swimming pools create a suitable environment for mold growth - warm and humid
- Presence of airborne mold spores has been associated with adverse health effects such as asthma, upper respiratory tract symptoms, bronchitis and respiratory infections (Palaty et al., 2012)

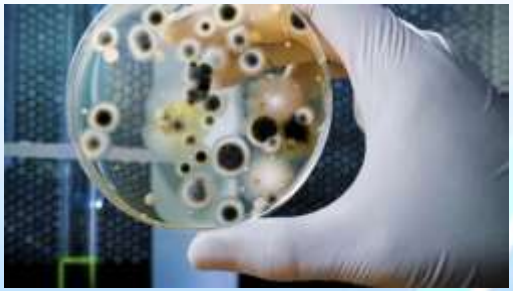


Image retrieved from https://www.analizmarketi.com/294-kuf-maya-analizi.html

Rationale

- To our knowledge, no study has examined airborne levels of trichloramine, chlorine or hydrogen chloride in indoor pools in Canada
- To our knowledge, no study has examined the indoor air quality in Canadian pools including mold (type and amount present)

Study Objective

- To determine the indoor air quality in Class A pools via
  - Airborne measurements of chlorine, hydrogen chloride and trichloramine
  - Assessing levels of temperature and relative humidity
  - Collection of airborne mold samples

Methods

- Airborne chemicals:
  - Area measurements of chlorine, hydrogen chloride and trichloramine
  - Analyzed in an analytical laboratory

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Image courtesy of Google Images

Methods

- Relative humidity and temperature were measured using an indoor air quality monitor and an air velocity meter
- Facility conditions, pool chemistry and number of bathers were recorded during site visits

Image courtesy of Google Images

Air sampling equipment set up

Image courtesy of S. Patel

Methods

- A Surface Air System (SAS) microbial air sampler was used with the following parameters:
  - Rose Bengal Agar plate with Chloramphenicol to isolate for fungal growth
  - 100L/min sample rate
  - 400L total sampling volume

Image courtesy of M. Agababova

Methods

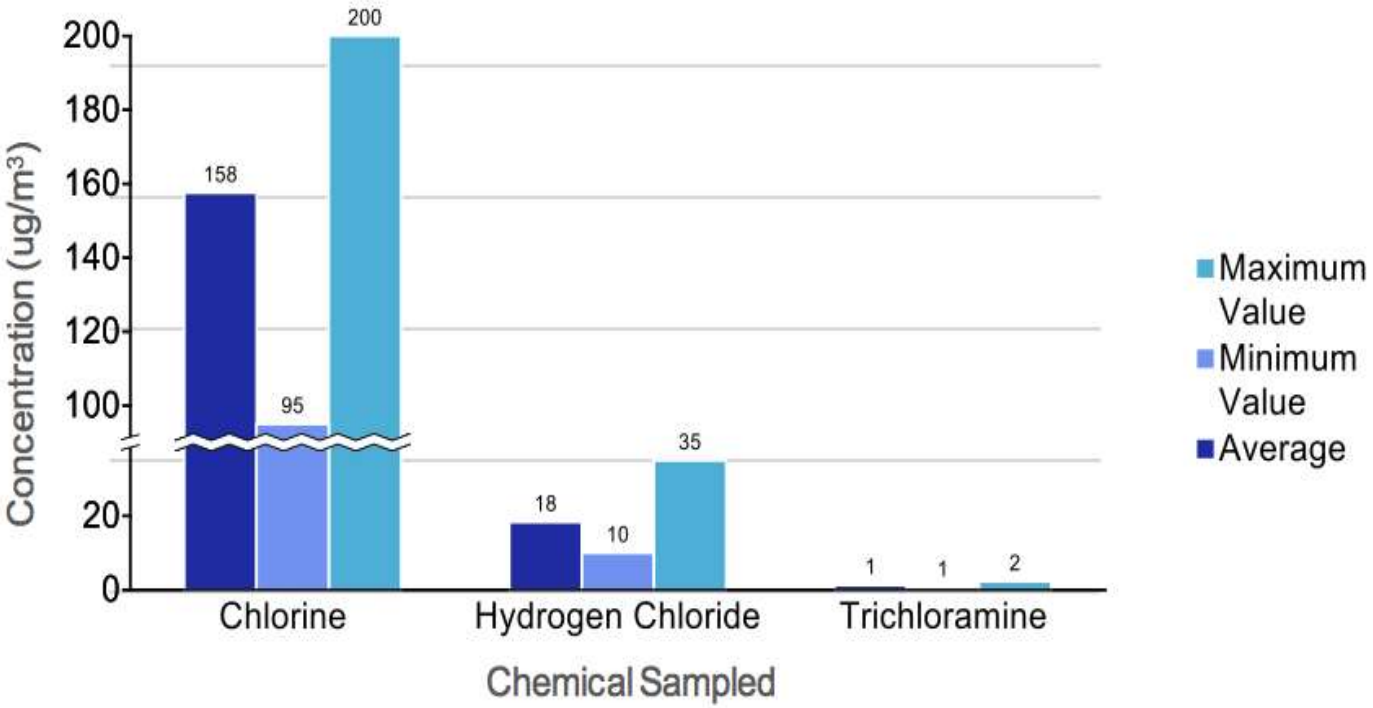
- Multiple viable air samples were collected on pool deck with 1-2 non-pool samples for comparison at each location
- Samples cultured to quantify and identify airborne mold spores using microscopy

Image courtesy of M. Agababova

Results – Site characteristics, temp and RH

	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6
Number of adults [Range during visit]	10 - 22	5 - 19	3 - 35	4 - 34	15 - 18	11 - 18
Number of kids [Range during visit]	12 - 41	11 - 29	37 – 49	0 - 8	0	0 - 13
Total pool water volume (gallons)	196,400	86,200	997,000	167,858	25,000	252,000
Mean Temperature (◦C) [Range]	25.2 [17.4 – 25.6]	27.9 [25.5 – 28.9]	25.1 [19.1 – 25.7]	24.6 [21.9 – 24.8]	26.9 [24.2 – 28.5]	25.6 [21.5 – 27.1]
Mean Relative Humidity (%) [Range]	56.4 [52.4 – 78.9]	36.1 [31 – 47.2]	51.6 [42.7 – 84.6]	45.5 [39.3 – 55.9]	61.7 [46.9 – 64.7]	61.1 [57.5 – 83.2]
Mean water pH	7.5	7.5	7.5	7.5	7.5	7.5
Mean water combined chlorine (ppm)	0.4	0.3	0.1	0.2	0.2	0.3
Mean water temperature (◦F)	91	88	80	89	83.7	85

Results – Chemical levels



Average measured concentrations of chlorine, hydrogen chloride and trichloramine across the six pool sites surveyed.

Results – mold counts

	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6
Mold counts (CFU/m^3)						
Non-Pool Air Sample 1	18	21	6	6	6	33
Non-Pool Air Sample 2	-	-	9	-	0	-
Pool Air Sample 1	9	33	0	0	9	33
Pool Air Sample 2	6	0	0	3	0	9
Pool Air Sample 3	6	3	9	0	0	21
Pool Air Sample 4	0	9	6	0	3	3
Pool Air Sample 5	3	3	0	6	6	9
Pool Air Sample 6	6	3	9	9	0	0
Pool Air Sample 7	0	6	6	-	6	6

Results – toxic mold counts

	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6
Fungi group with known negative health effects isolated at site (CFU/M^3)						
Alternaria	-	-	-	-	3	15
Nigrospora	-	-	3	-	-	-
Rhizomucor	-	-	-	3	3	-
Aspergillus niger	6	-	-	-	-	-
Aspergillus fumigatus	-	6	3	-	-	3
Aspergillus versicolor	-	-	-	-	-	9

Discussion

Chlorine

- Previous study found that concentration must **be 0.2 ppm** for humans to be able to smell it (Kim et al, 2014)
- Our study found an average chlorine concentration of **0.05 ppm**.

Hydrogen Chloride

- Study found that inhalation exposures at **10 ppm** resulted in irritation amongst employees (NRC, 2004)
- Our study found an average concentration of **0.01 ppm**

Discussion

Trichloramine

- Average concentration across the six sites was found to be **1.26 µg/m³**
- Significantly lower than a majority of other studies and lower than the proposed acceptable limit of **500 µg/m³**

Supported by:

- Consistently neutral pH
- Lack of “chlorine” scent

Discussion - mold counts

- There was no consistent correlation between a site's relative humidity and temperature and mold count (see next slide)
- The counts were consistent with literature for viable mold counts inside indoor swimming pools when assessed with a SAS sampler (Brandi et al., 2007)

Discussion - fungal groups

- A biodiverse fungal profile was found at most sites, some of which included fungal groups with known negative health effects in humans such as *Alternaria* species, *Nigrospora* species, *Rhizomucor* species, and *Aspergillus* species.
  - These species are known allergens and are associated with respiratory tract diseases (Knutsen et al., 2012; Goldstein et al., 1992)

Conclusion

- The results show that the existing ventilation systems at each site are effective in maintaining airborne contaminants at low levels
- Also, confirms that pool sites are most likely following correct protocols with respect to site maintenance

Perception of Indoor Air Quality: Workers and Public

Rationale

- To our knowledge, no study in Canada has examined airborne levels of trichloramine, chlorine or hydrogen chloride in indoor pools and compared them to pool worker's or pool visitor's perception of the indoor air quality within the pool

Study Objective

- To determine workers' and the public's perceptions of indoor air quality in Class A pools and comparing their responses to various indoor air quality measurements

Methods

- Ethics approved
- Recruitment:
  - Convenience sampling
  - For all individuals in the facility 18 yrs or older who can read English
  - Self administered
- Target of four staff members and eight visitors per site

Methods

- The survey included questions on: 1) demographics, 2) overall air quality (temperature, humidity, chlorine and mold odor), and 3) common ocular and respiratory symptoms
- Air quality, temperature, humidity and odour were rated on a Likert scale for both the day of the visit and at perceived worst
- Health effects identified by participants were counted and correlated with the number of hours spent per week at the pool

Example questions

Rate your feelings on the air quality at this facility *today:*

Very comfortable (5)	Somewhat comfortable (4)	Neutral (3)	Somewhat uncomfortable (2)	Very uncomfortable (1)

Example questions

Indicate using a check mark in the table below if you currently have any of the following symptoms and rate the severity. Only check one box per symptom.

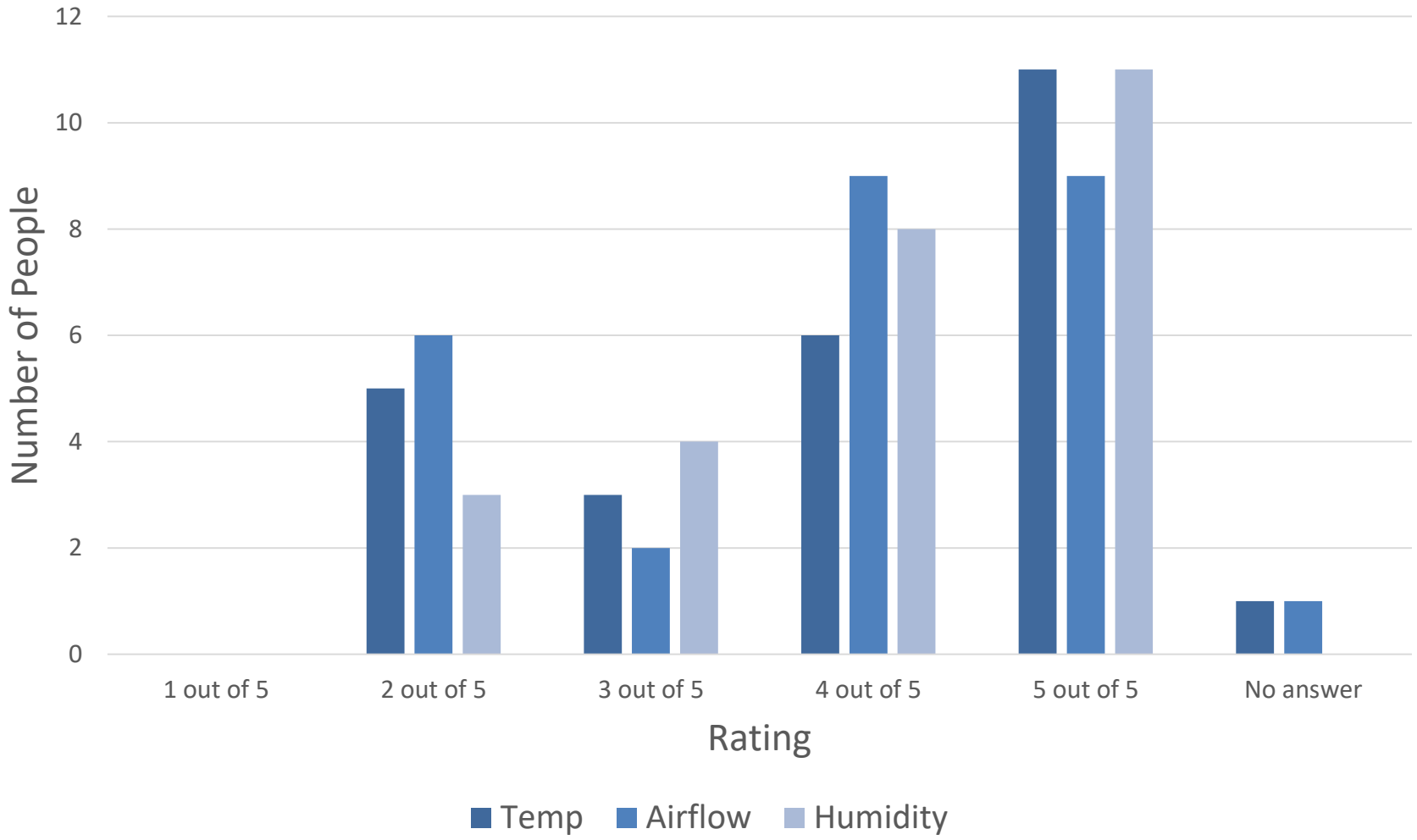
Please rate from 0 (no symptoms) to 5 (extremely bad symptoms)						
Symptom	0	1	2	3	4	5
Red eyes						
Itchy eyes						
Watery eyes						
Runny nose						
Blocked or stuffy nose						
Cold						
Voice loss						
Cough						
Wheeze						
Shortness of breath						

Results – Participant characteristics (W)

Gender (n=26)	
Male	20
Female	6
Age (n= 25)	
18-24	14
25+	11
Years at current location (n=26)	
Less than 1	4
1-5 years	17
6 years or more	5
Hours worked per week (n= 26)	
Less than 12	11
12-19	8
20 or more	7

Results – Participant job titles (W)

Job title (n= 25)	
Pool Attendant	1
Swim Instructor	3
Combination of first two	3
Cleaner	4
Receptionist	3
Other	11
Shift/Aquatic supervisor	8
Coach	2
Facility operator	1



Workers' response regarding temperature, air quality and humidity on a day to day basis . 1 = very poor and 5 = very good

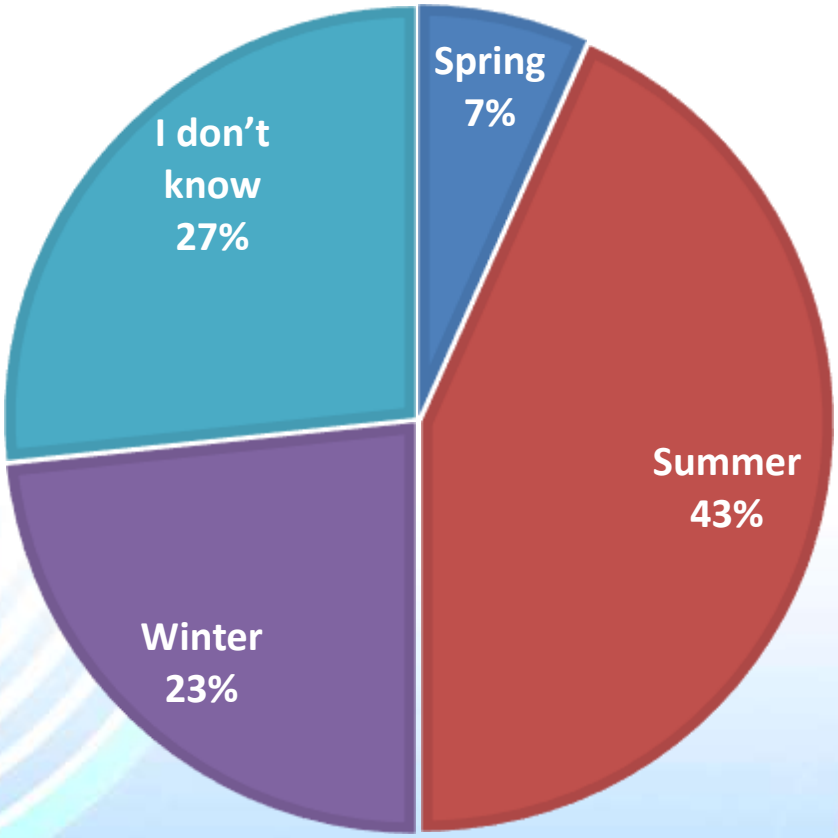
Results - Most prevalent reported symptoms by workers

Itchy eyes

Headache

Image courtesy of Google Images

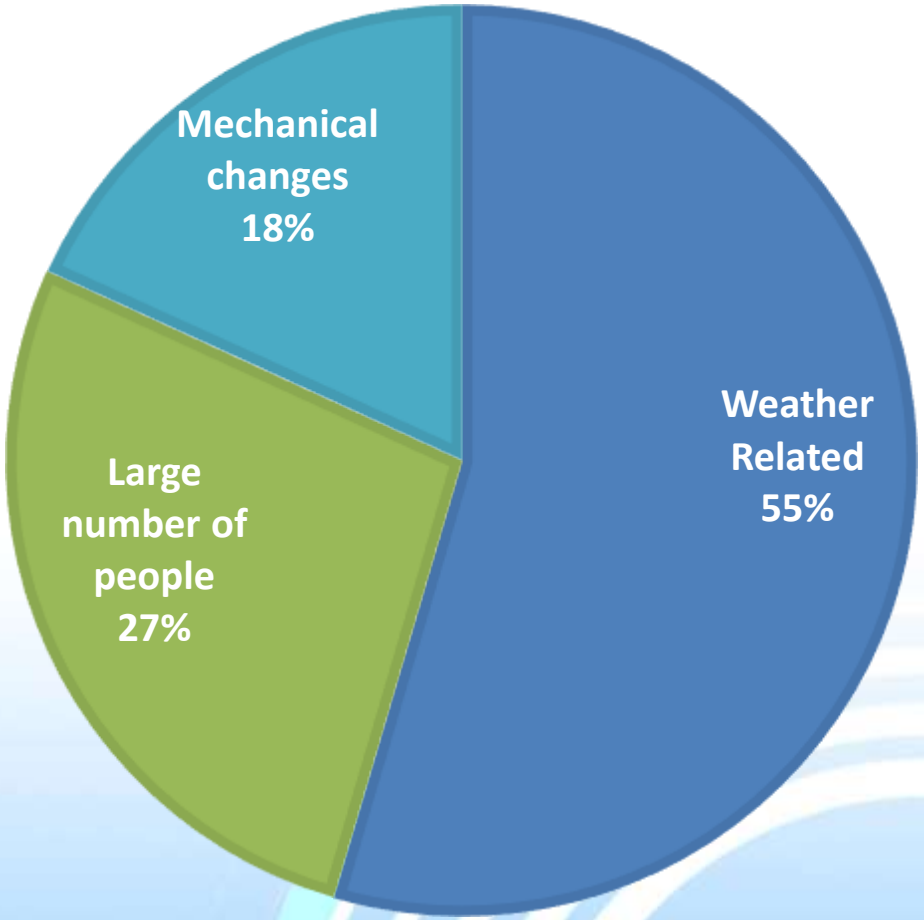
Results - Workers



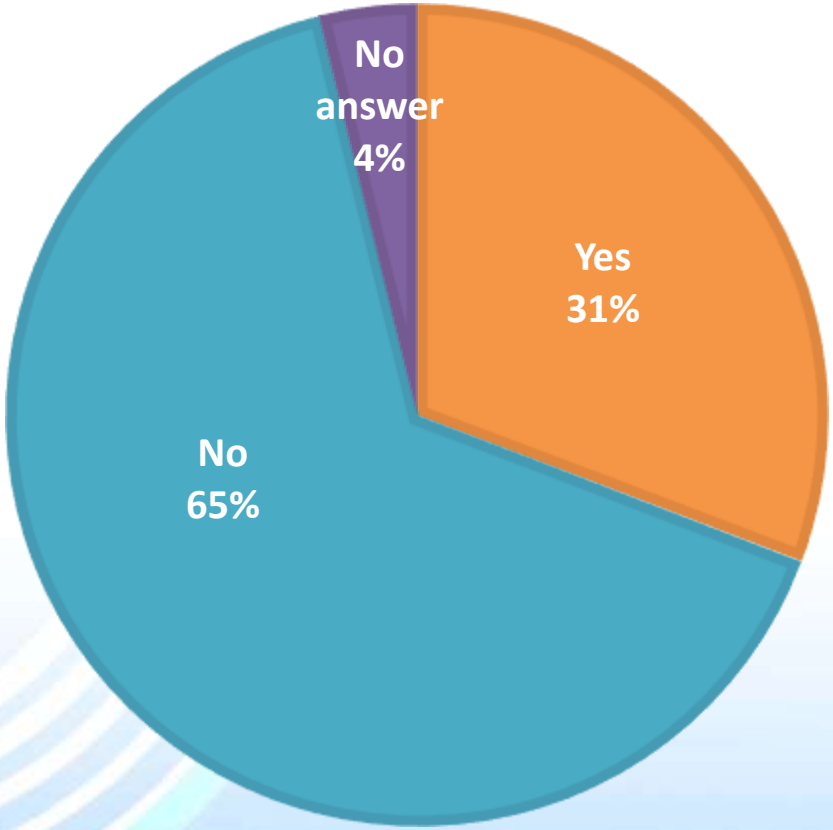
Season which makes air quality the worst

Results - Workers

Conditions which make air quality worse



Results - Chlorine scent (W)



Pungency of chlorine scent

- Chlorine scent generally associated with swimming pools is a result of chloramines, specifically Trichloramine (ISDH, 2017)
- Thus, can be an indicator of poor air quality

Results – Participant characteristics (P)

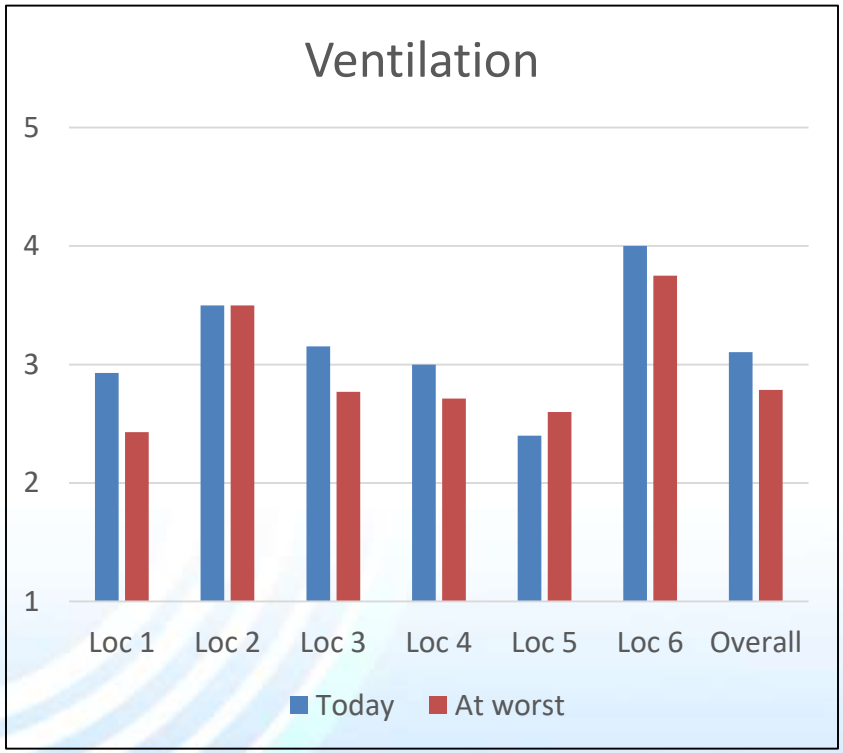
Gender (n=48)	
Female	29
Male	19
Age	
18-30	7
31-40	8
41-50	28
50+	5
Hours per week at pool	
< 2	35
3+	13

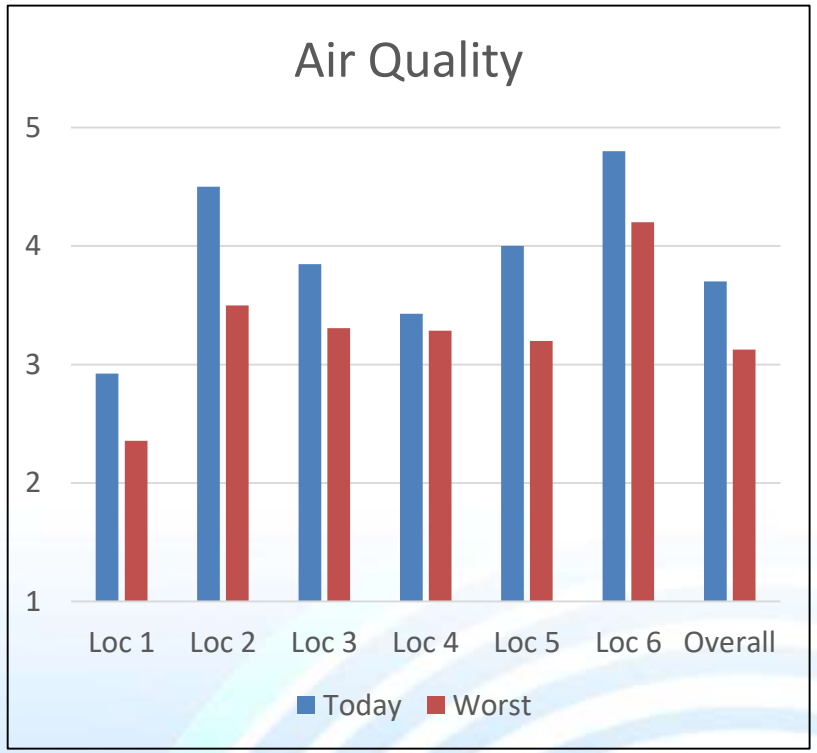
Results - Current health symptoms (P)

	Symptom	N
Ocular	Itchy Eyes	16
	Red Eyes	14
	Watery Eyes	7
Respiratory	Runny nose	13
	Blocked or stuffy nose	13
	Cold	8
	Shortness of breath	7
	Cough	7
	Wheeze	5
	Voice loss	3

93 symptoms were identified by survey participants as ones they were experiencing at the time of the survey; an average of 1.94 symptoms identified per respondent

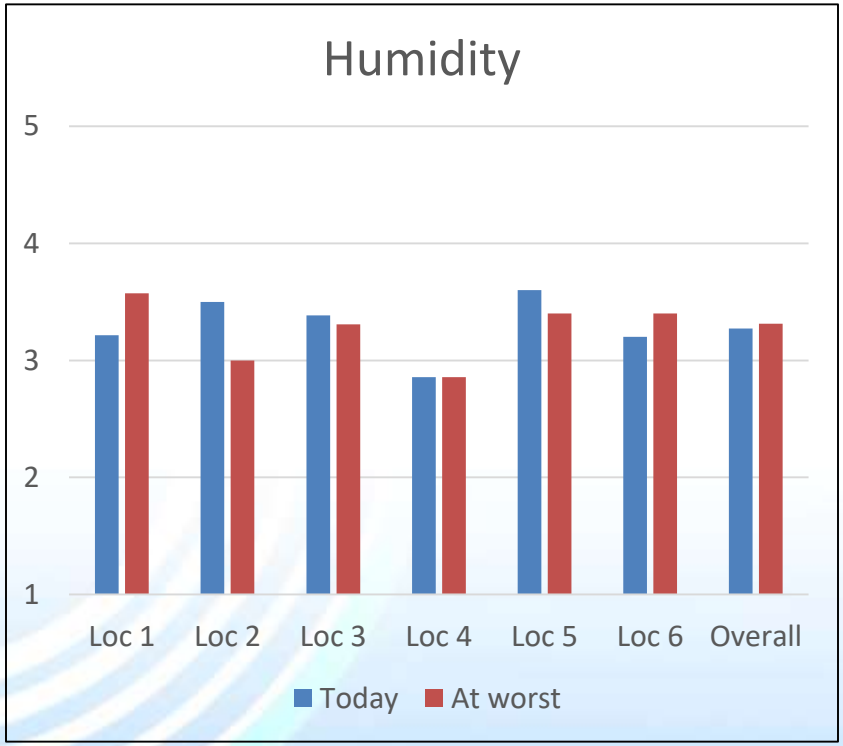
Results - Air quality & ventilation (P)

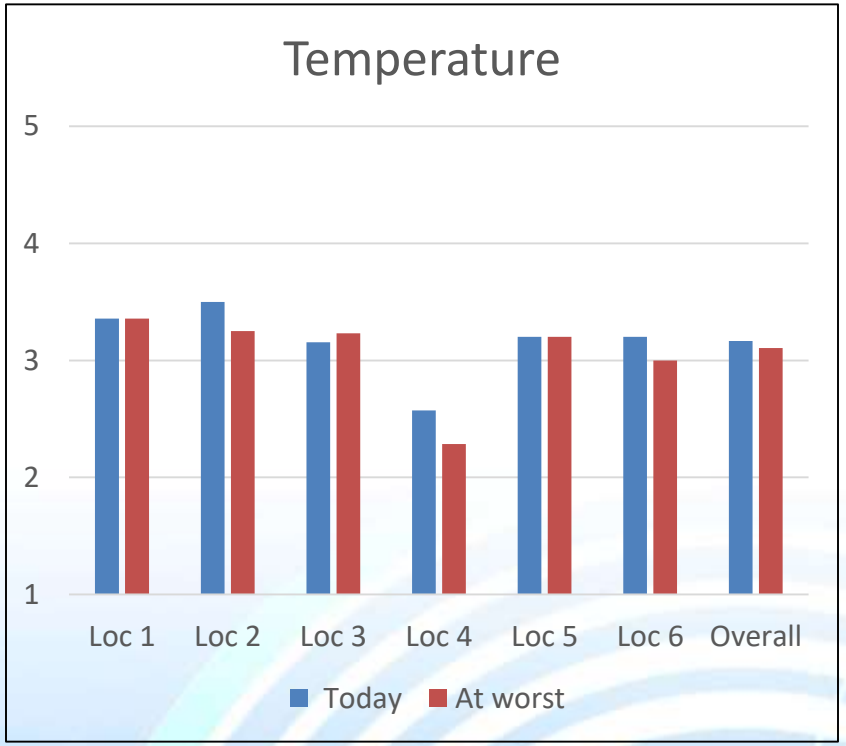




1 = very poor; 5 = very good i.e. the higher the better

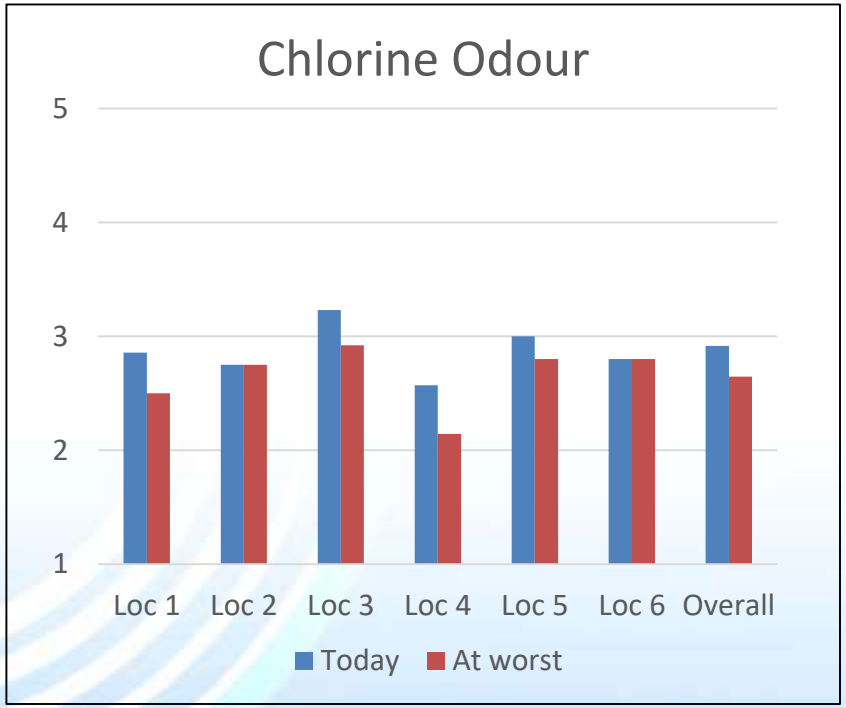
Results - Humidity & temperature (P)

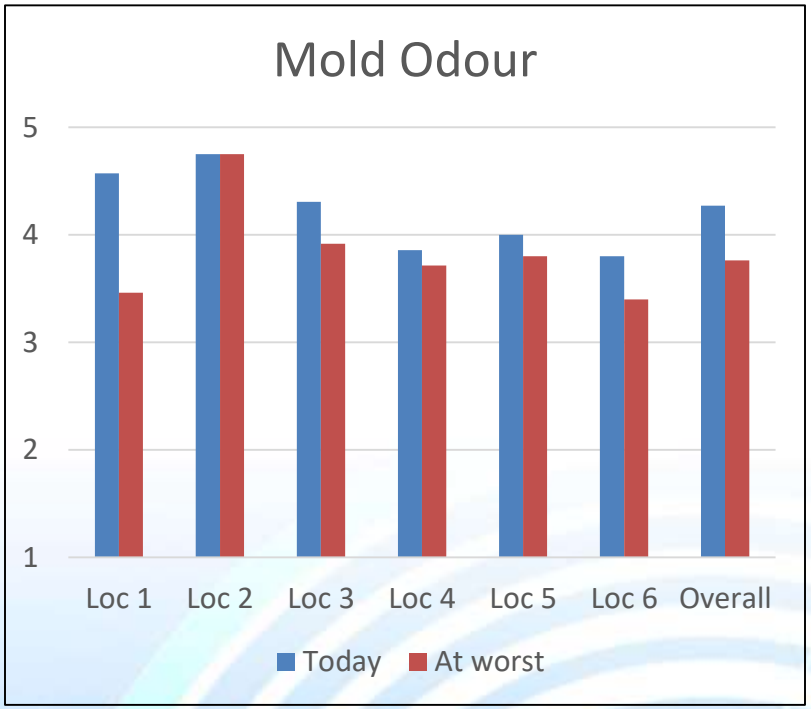




1 = too cold; 5 = too hot; 3 is ideal – neither hot nor cold (neutral)

Results - chlorine and mold odour (P)





1 = strong odour; 5 = no odour i.e. the higher the better

Discussion and Conclusion

- The results show that both workers and the public are generally satisfied with the indoor air quality
- Both workers' and public's perceptions are reflective of measured IAQ values
- Most frequently listed symptoms are non-specific

Study Conclusions

- The indoor air quality at the participating sites appears to be satisfactory to both staff and visitors
  - Low chemical levels
  - Low mold counts
  - Limited number of reported symptoms associated with being at the pool

Study Limitations

- Only representative of the sites sampled
- Only representative of the time sampled
- Could not verify participant responses
- Non-specific nature of symptoms
- No personal samples collected
- Only collected viable samples using SAS sampler
- Small sample size
- Only asked perceptions of adults

Recommendations – Future studies

1. **Obtain larger sample size** – include employees who are under the age of 18
2. **Include more sites** – ideally, in different municipalities
3. **Vary sampling time period** – Different times of day and/or different time of the year
4. **Health evaluation** – longitudinally
5. **Compare to other types of water treatment** – participating sites all used UV

Resulting publication

Pilot study: Assessment of the presence of mold in indoor swimming pools

Milena Agababova and Chun-Yip Hon
School of Occupational and Public Health, Ryerson University, Toronto, ON, Canada

Abstract: Indoor swimming pools are the ideal environment for mold growth as they are intentionally humid and warm. Although there are no established safe exposure levels for airborne mold spores, their presence has been associated with adverse health effects that may put individuals at risk. The objective of this pilot study was to observe the occurrence of airborne mold within indoor swimming pools ($n = 6$) in the Greater Toronto Area. Viable air samples were taken using a Surface Air System air sampler and cultured to quantify and identify airborne mold using microscopy. In addition, relative humidity and temperature were measured and facility characteristics were recorded. Overall, the mold counts were relatively low and were consistent with the literature. However, a biodiverse fungal profile was found at most sites—some of which included fungal groups linked to harmful health effects in humans. Since this was a pilot study, further research is suggested to determine whether the concentration of mold is a cause for concern.

Key words: fungal contamination, indoor swimming pool, mold, health and safety, viable sampling.

Environmental Health Review 61(2) 35–38 DOI: 10.5864/d2018-009

Assessment of Noise

Exposure to noise

- Noise is everywhere
  - At work, at home
  - Inside, outside
  - Recreational activities

- Swimming pools are no exception
  - Splashing of water
  - Talking, shouting, screaming
  - Whistle blowing

Image courtesy of Google images

Exposure to noise

- Noise in the workplace greater than 85 dB is considered excessive
- No "threshold" for public; therefore, generally use the workplace limit
- Exposure to noise greater than 85 dB increases risk of developing noise-induced hearing loss
  - According to the Canadian Hearing Society, 1 in 4 Canadians have reported some degree of hearing loss
  - Most common occupational disease claim according to WSIB

Health effects

- In addition to hearing loss, there are also non-auditory health effects
- Includes (Basner et al., 2014) :
  - Sleep disturbance (esp. with tinnitus)
  - Anxiety and stress
  - Fatigue
  - Social isolation
  - Cardiovascular disease

Hearing loss complications

- No physical damage or pain
- Develops over time
- Denial
- From occupational and non-occupational exposure
- Non-reversible

It is preventable in most cases!!!

Literature review

- Maffei et al., (2009) investigated the level of noise exposure of school gym teachers during class time within gymnasia and swimming pools
- The study found that weekly noise exposure was higher when a) the number of students exceeded 30, b) there was more than one class at the same time, and c) intense whistle blowing

Literature review

- Another study conducted by Hall (2016) investigated noise levels and public perception at several indoor aquatic facilities located in Sweden.
- The researcher measured background noise levels prior to any visitors attending the pool, and sound was also measured during regular scheduled activities.
- The study found an increase in sound pressure levels between 16-23 dB when going from background to activity

Purpose of study

- To our knowledge, no study has been conducted to determine the level of noise within indoor swimming pools in Canada
- Explore the environmental noise levels at indoor aquatic facilities across the Greater Toronto Area (GTA)
- Looked at perception of noise from staff as well as public perspective

Study Methods

- Quantify noise levels
  - Used *noise dosimeters* for pool staff
  - Used *sound level meters* to assess environmental noise levels

- Perception surveys
  - Pool workers
  - Members of the public

Measurement of noise levels

- 8 indoor pools within the GTA
- Each facility was sampled only once, and the duration of sampling ranged from 1 to 3 hours

Hall, M. (2016)

Measurement of noise levels

Occupational Noise Exposure

- Brüel & Kjær Type 4448 dosimeters
- Dosimeters attached to collars of pool staff
- Calibrated prior to each sampling session
- Three staff members at each facility were assessed

Measurement of noise levels

Ambient or Environmental Noise

- Larson Davis Soundtrack LxT2 sound level meters (SLM)
- SLMs were on tripods approximately 5 feet tall, and set to A-weighting frequency and "SLOW" response
- Calibrated prior to each sampling session
- One placed on deck, the other near the public viewing area

Perception surveys

- Developed based on Hall's (2016) research on public noise perception and acoustic design in swimming pools and Beach and Nie's public perception in fitness classes (2014)
- Research ethics approved prior
- Participants recruited based on convenience sampling
- Self-administered

Methods

- Included demographic and questions related to perception of noise *(see next slide)*
  - Similar questionnaire given to staff and public
- Noise levels and perceptions were rated on a Likert scale for both the day of the visit and at perceived noisiest
- Also asked which in-pool activities they believed most contributed to noise levels

Perception surveys – Sample questions

1) On a scale of 1-5, how would you rate the pool **today** in terms of the noise level?

Very loud	☐1	☐2	☐3	☐4	☐5	**Quiet/ Comfortable**

2) On a scale of 1-5, when the pool is **at its noisiest i.e. worst**, how loud is it?

Very loud	☐1	☐2	☐3	☐4	☐5	**Quiet/ Comfortable**

3) How often do you feel the **noise level** is too loud at this facility?

- ☐ More than 50% of the time
- ☐ 50% of the time
- ☐ Less than 50% of the time
- ☐ Never
- ☐ Unsure

Results – Site Characteristics

Age, Amenities and Acoustic Characteristics of Participating Facilities				
	Age	**Pool Type**	**Amenities**	**Acoustic Features**
Site A	10	25 metre pool	Glass enclosure with retractable roof/walls	Sound absorption panels
Site B	2	25 metre pool, therapeutic pool (max depth 6 feet)	Diving board	Acoustic ceiling tile system, sound absorption panels
Site C	20	25 metre pool, 30-person whirlpool	Two-storey waterslide, children's play pool with water spray	Sound absorption panels
Site D	5	25 metre pool, therapeutic pool, children's pool	Water slide, splash pad	Sound absorption panels
Site E	15	25 metre pool, leisure pool	Splash pad	Sound absorption panels
Site F	>20	25 metre pool, leisure pool, whirlpool	Water slide	N/A
Site G	17	25 metre pool, toddler's play pool	Viewing gallery directly on deck	Vinyl wrapped acoustic panels
Site H	9	25 metre pool, therapeutic pool	1 metre diving board, tarzan rope	Sound absorption panels

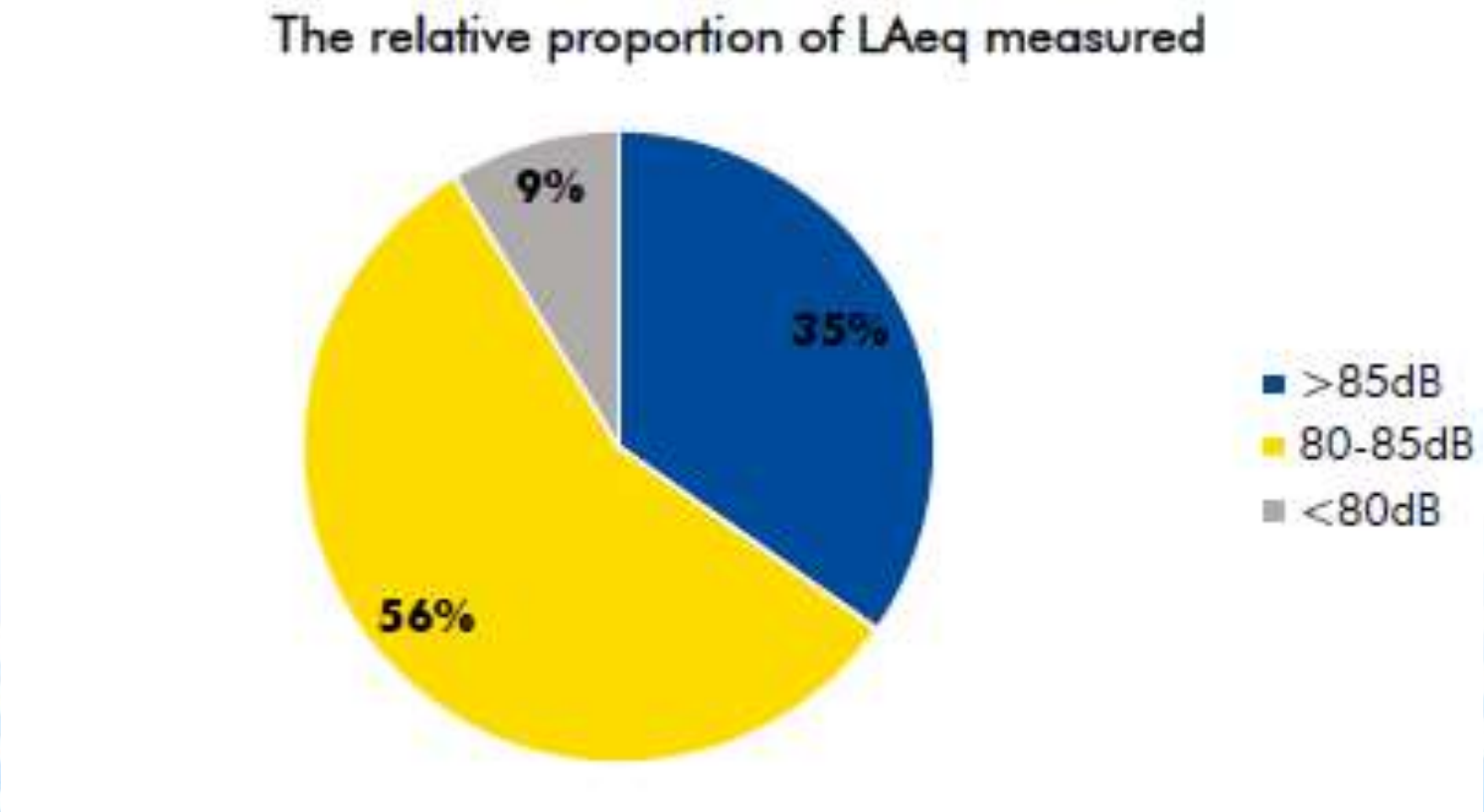
Results – Definitions

- **A-weighted frequency** = is a setting on a sound level meter which accounts for the loudness that is perceived by the human ear
- **Decibel or dB** = the unit used to measure sound level
- **Exchange rate** = the amount by which the permitted sound level may increase if the exposure time is reduced by 50%
- **LA_{eq}** = the equivalent continuous sound pressure level or the average level of noise (in dB) over a given period of time
- **LA_{peak}** = the maximum sound pressure level that is measured by a sound level meter (in dB) at any instance over a given measurement period

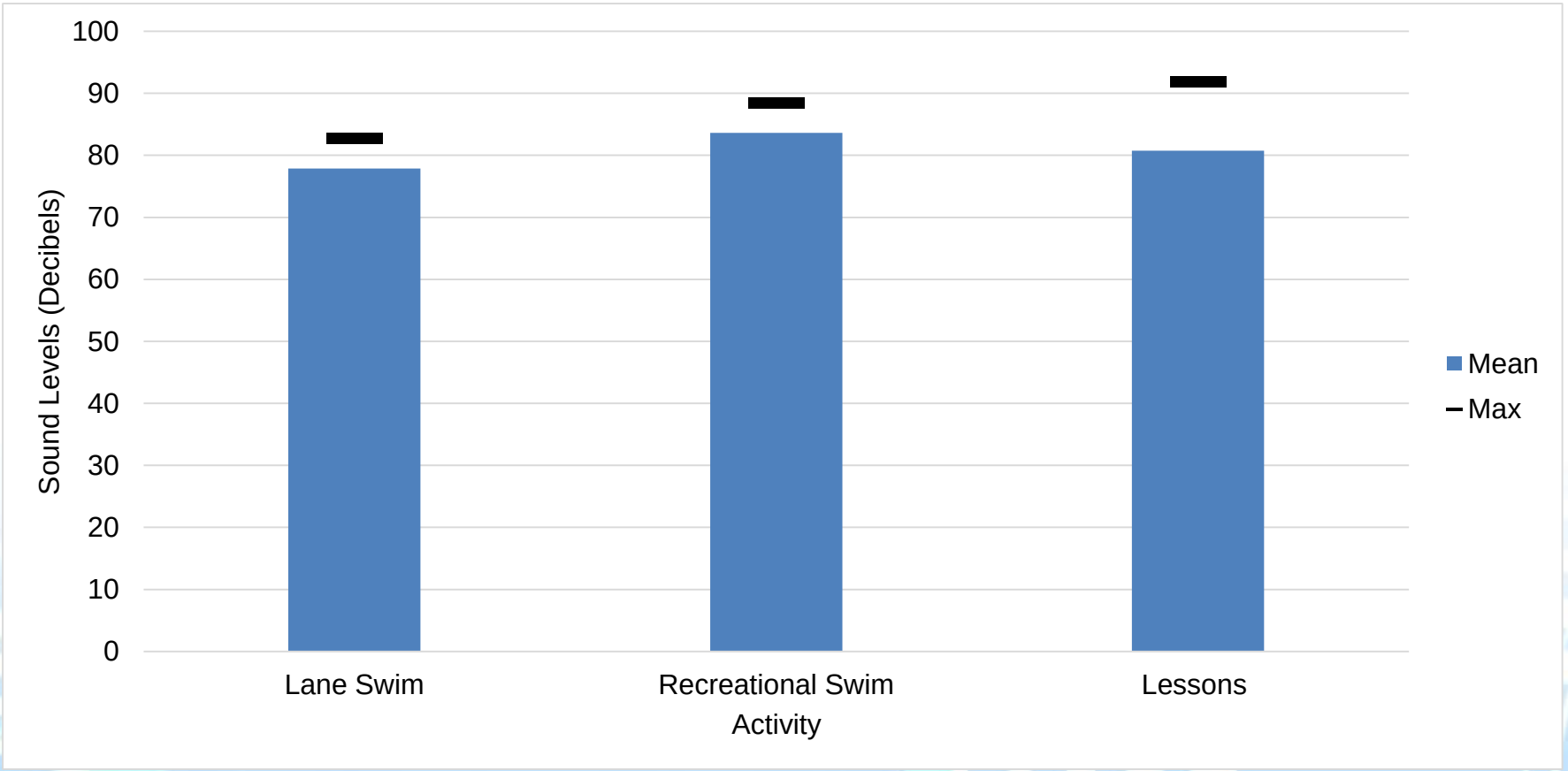
Results – Occupational noise levels

- A total of 23 personal noise measurements were collected across eight different aquatic facilities.
- The sampling length varied between an hour to three and a half hours, depending on the shift or visitation duration.
- The average noise level (LA_{eq}) of all samples was 84.2dB
- The average peak sound pressure level (LA_{peak}) was125.6dB

Results – Occupational noise levels



Results – Occupational noise levels



Results – Legislated noise level

- Ont. Reg. 381/15: Noise
- Sec. 2(4) - every employer shall ensure that no worker is exposed to a sound level greater than an equivalent sound exposure level of 85 dB
  - Average noise exposure is <u>below</u> legislated limit

Results – Legislated noise level

Table 1–1. Combinations of noise exposure levels and durations that no worker exposure shall equal or exceed

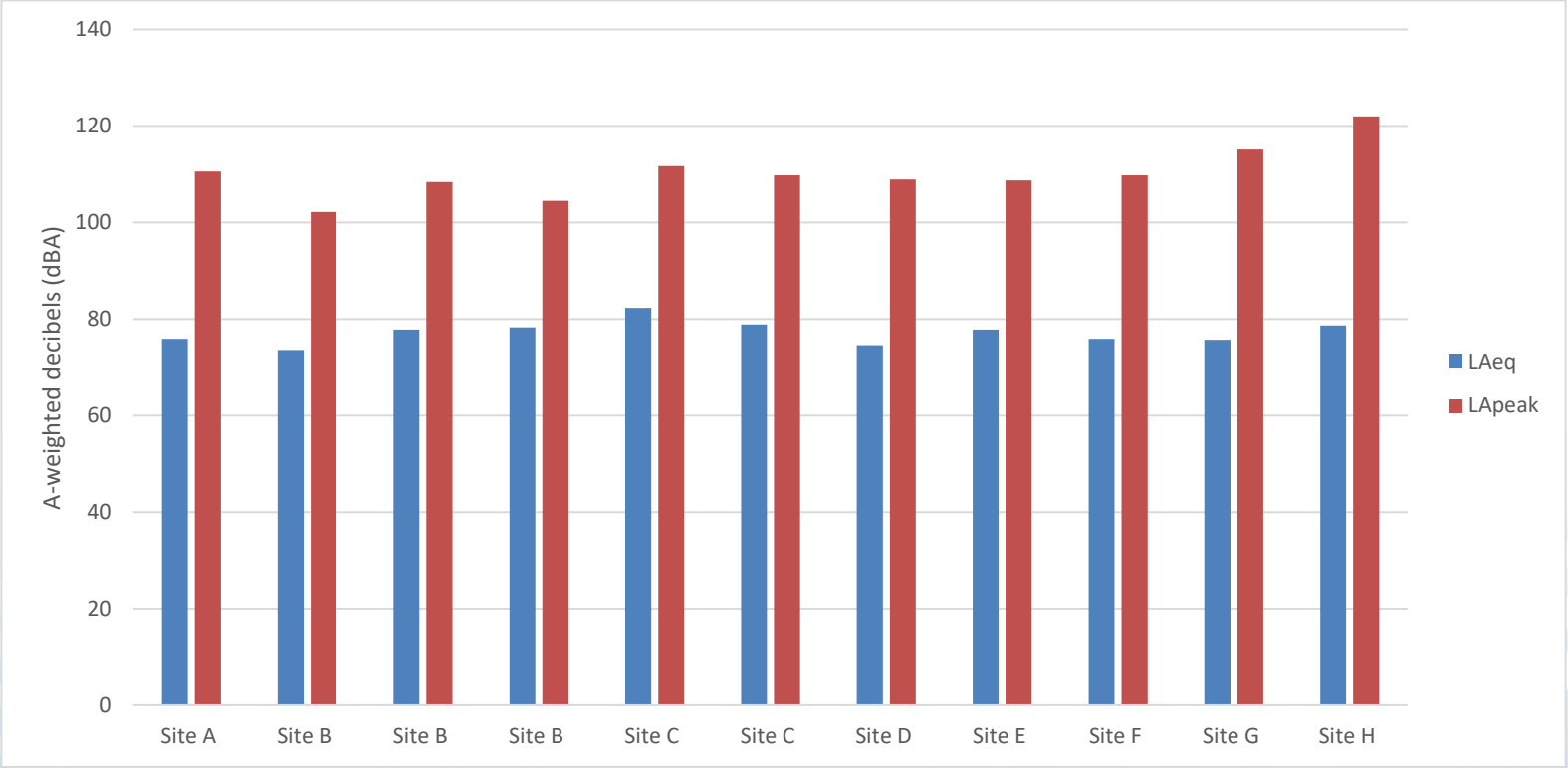
Exposure level, *L* (dBA)	Duration, *T*			Exposure level, *L* (dBA)	Duration, *T*		
	Hours	Minutes	Seconds		Hours	Minutes	Seconds
80	25	24	—	106	—	3	45
81	20	10	—	107	—	2	59
82	16	—	—	108	—	2	22
83	12	42	—	109	—	1	53
84	10	5	—	110	—	1	29
85	8	—	—	111	—	1	11
86	6	21	—	112	—	—	56
87	5	2	—	113	—	—	45
88	4	—	—	114	—	—	35
89	3	10	—	115	—	—	28
90	2	31	—	116	—	—	22
91	2	—	—	117	—	—	18
92	1	35	—	118	—	—	14
93	1	16	—	119	—	—	11
94	1	—	—	120	—	—	9
95	—	47	37	121	—	—	7
96	—	37	48	122	—	—	6
97	—	30	—	123	—	—	4
98	—	23	49	124	—	—	3
99	—	18	59	125	—	—	3
100	—	15	—	126	—	—	2
101	—	11	54	127	—	—	1
102	—	9	27	128	—	—	1
103	—	7	30	129	—	—	1
104	—	5	57	130–140	—	—	<1
105	—	4	43	—	—	—	—

Results – Legislated noise level

- **Occupational Noise Levels**
- For the peak level of 126 dB, one can only be exposed for 3 seconds!!!

Image courtesy of Google Images

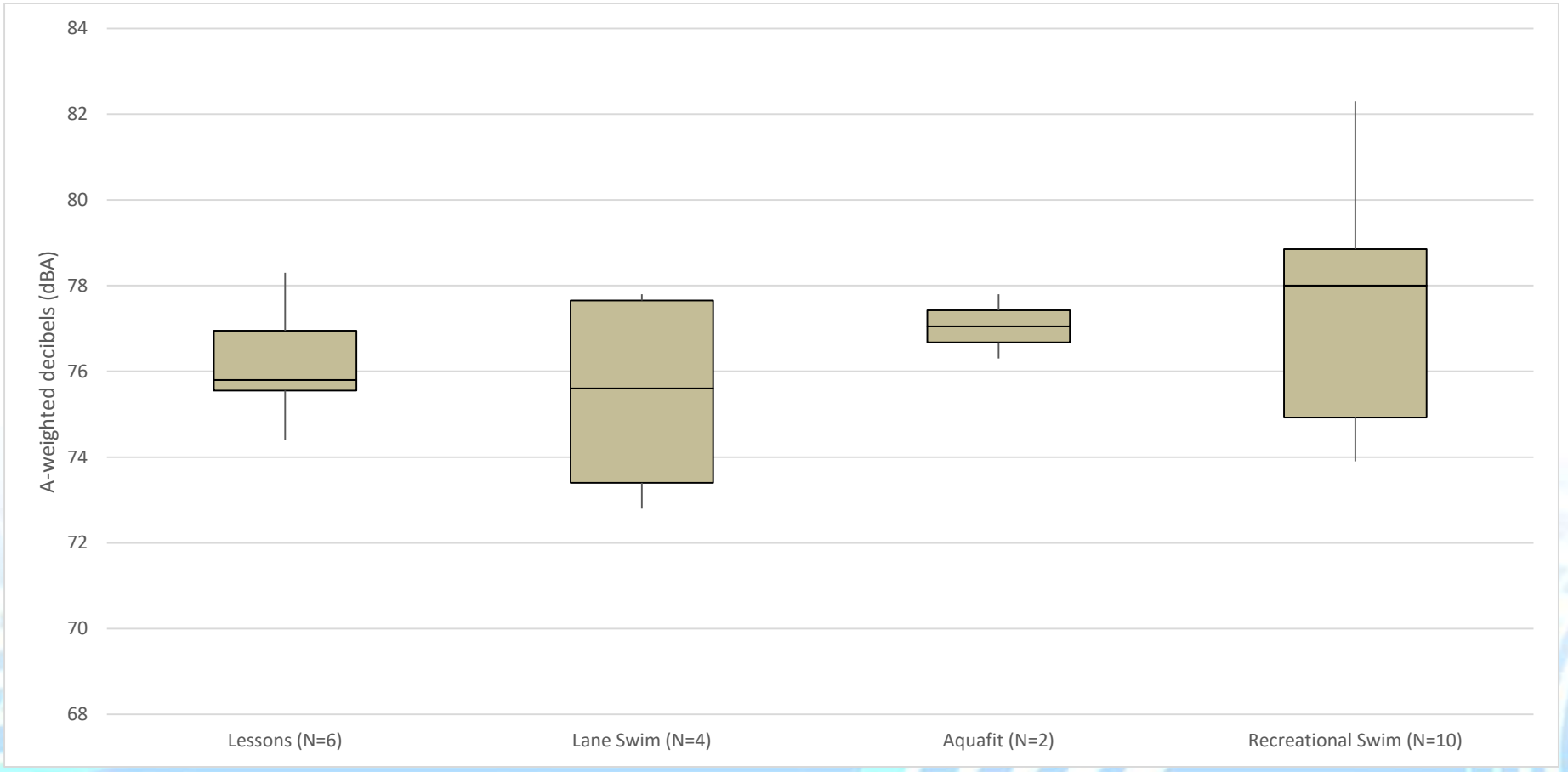
Results – Ambient/Environmental Noise



Results – Ambient/Environmental noise levels

- 11 different in-pool activities sampled between the 8 sites
- LA_{eq} values ranged from 73.6 dB-82.3 dB
- LA_{peak} values ranged from 102.2 dB-122 dB

Results – Ambient/Environmental noise levels



Results – Legislated noise level

Table 1–1. Combinations of noise exposure levels and durations that no worker exposure shall equal or exceed

Exposure level, *L* (dBA)	Duration, *T*			Exposure level, *L* (dBA)	Duration, *T*		
	Hours	Minutes	Seconds		Hours	Minutes	Seconds
80	25	24	—	106	—	3	45
81	20	10	—	107	—	2	59
82	16	—	—	108	—	2	22
83	12	42	—	109	—	1	53
84	10	5	—	110	—	1	29
85	8	—	—	111	—	1	11
86	6	21	—	112	—	—	56
87	5	2	—	113	—	—	45
88	4	—	—	114	—	—	35
89	3	10	—	115	—	—	28
90	2	31	—	116	—	—	22
91	2	—	—	117	—	—	18
92	1	35	—	118	—	—	14
93	1	16	—	119	—	—	11
94	1	—	—	120	—	—	9
95	—	47	37	121	—	—	7
96	—	37	48	122	—	—	6
97	—	30	—	123	—	—	4
98	—	23	49	124	—	—	3
99	—	18	59	125	—	—	3
100	—	15	—	126	—	—	2
101	—	11	54	127	—	—	1
102	—	9	27	128	—	—	1
103	—	7	30	129	—	—	1
104	—	5	57	130–140	—	—	<1
105	—	4	43	—	—	—	—

Results – Allowable noise level

- **Ambient/Environment Noise Levels**
- For the peak level of 122 dB, one can only be exposed for 6 seconds!!!

Image courtesy of Google Images

Results – Allowable noise level

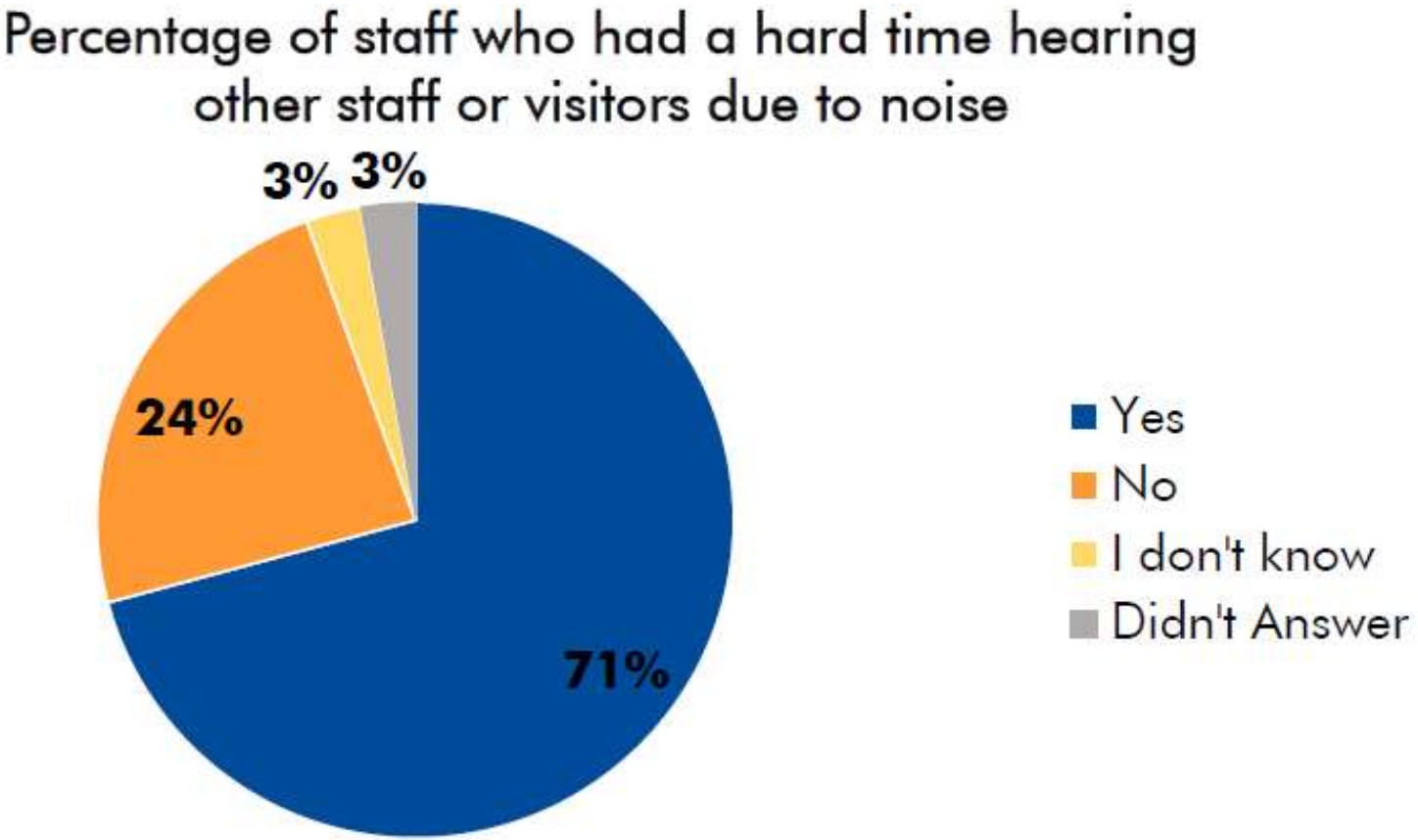
- None available for public exposure
- Refer to Ont. Reg. 381/15: Noise
  - Rationale: occupational and non-occupational noise exposure results in the same health effect
- Sec. 2(4) - every employer shall ensure that no worker is exposed to a sound level greater than an equivalent sound exposure level of 85 dB
  - Average noise exposure is <u>below</u> this limit

Perception of Noise: Workers and Public

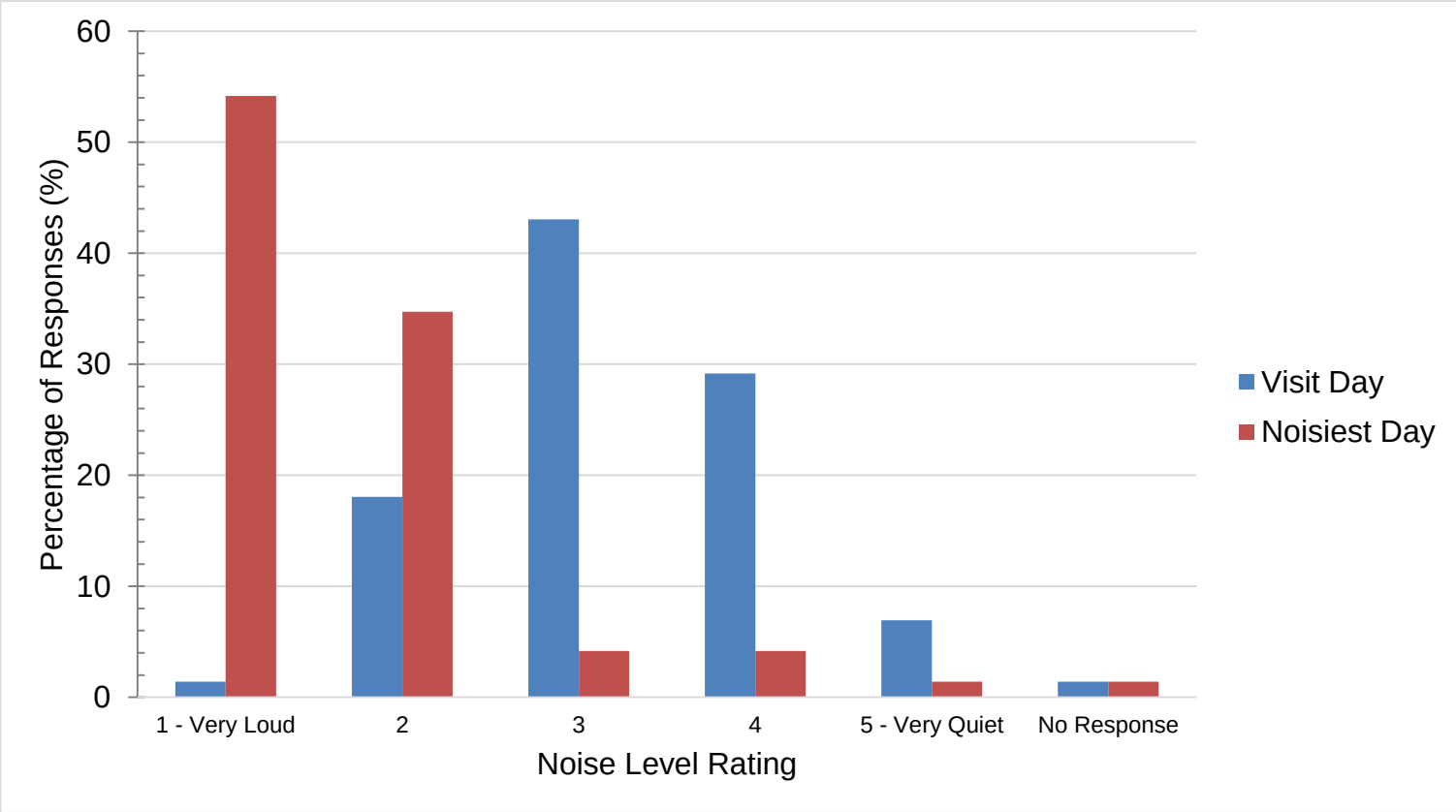
Results – Staff noise perception

Participant demographics – Occupational (n=72)	
Age	**Number**
16-24	66
25-34	5
35-44	1
Gender	
Male	28
Female	43
Others	1
Job title	
Instructor Only	2
Lifeguard Only	0
Both instructor and lifeguard	52
Supervisor	15
Program Coordinator	3

Results – Staff noise perception



Results – Staff noise perception

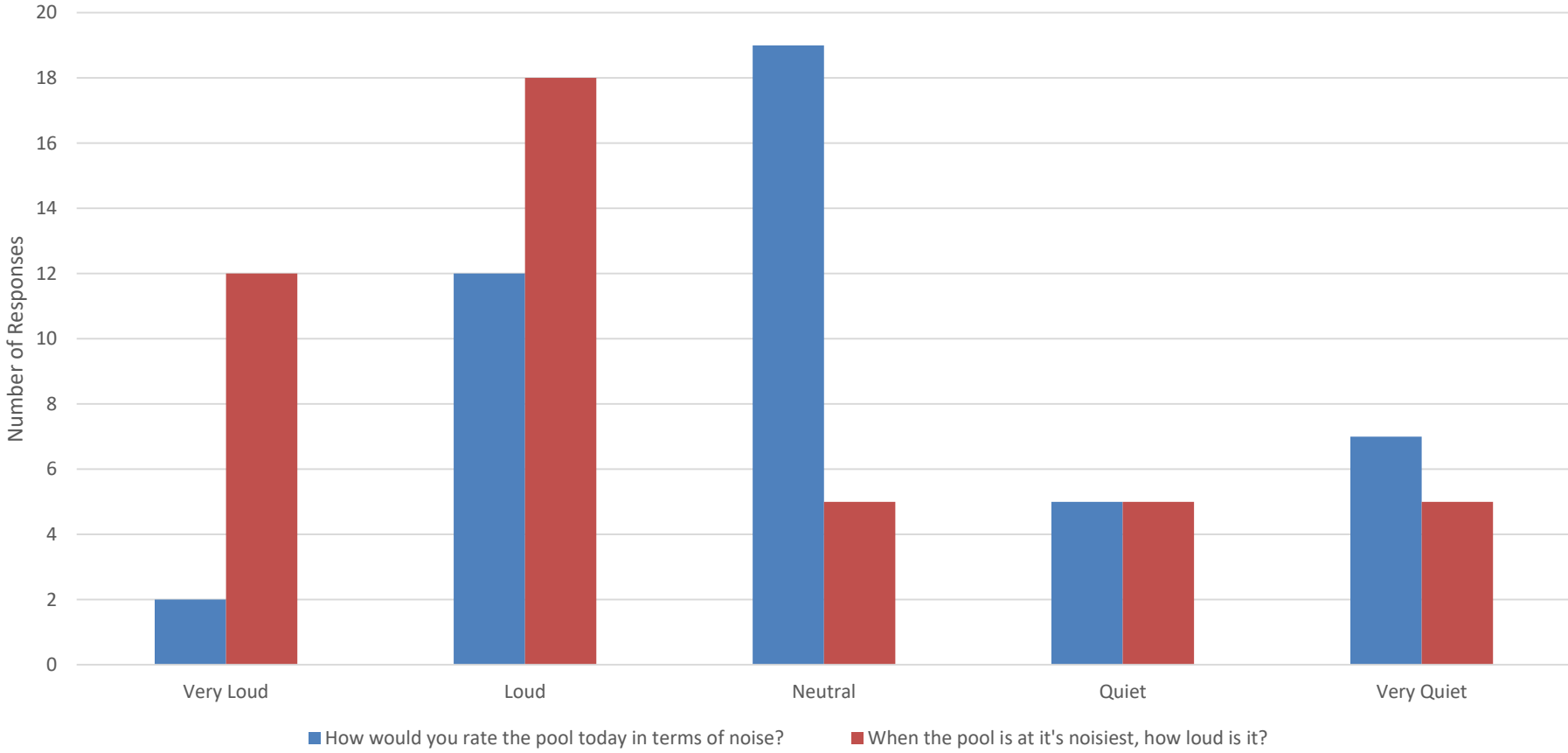


Staff rating of pool noise on day of visit compared to noisiest day

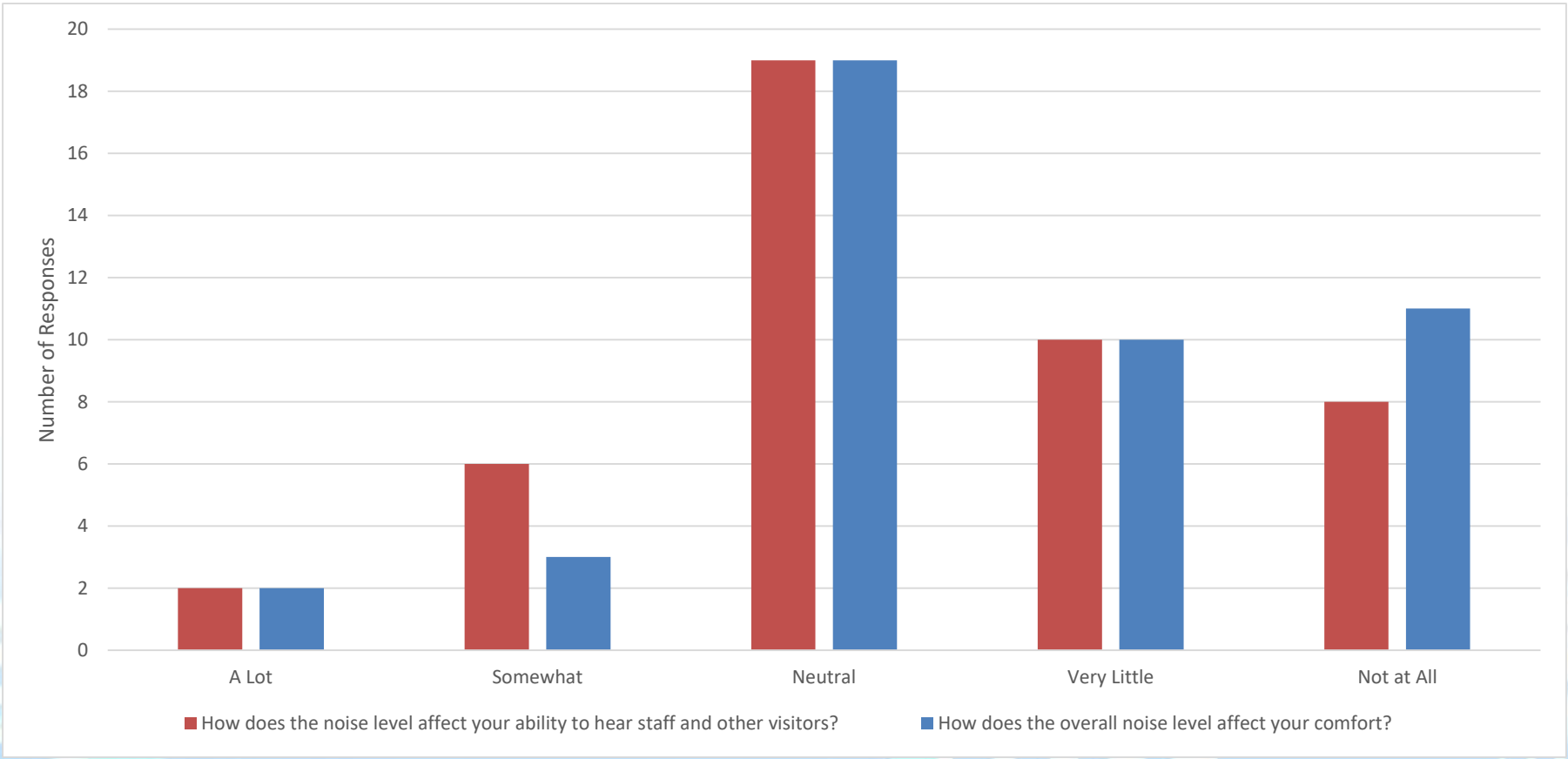
Results – Public noise perception

Participant demographics - Public (N=45)		
	Number	Percent
Age		
18-29	1	2.22%
30-39	22	48.89%
40-49	18	40.00%
50-59	2	4.44%
60 and older	2	4.44%
Gender		
Male	17	37.78%
Female	28	62.22%
Frequency of visit		
A Few Days a Week	4	8.89%
Once A Week	32	71.11%
Other	9	20.00%
Reason for Visit		
Recreational	11	24.44%
Watching kids swim	30	66.67%
Exercise	1	2.22%
Other	3	6.67%

Results – Public noise perception



Results – Public noise perception



Data Interpretation

- Overall, sound pressure levels in the participating aquatic facilities were found to be within the acceptable limits as per the Ontario Noise Regulation
- However, LA_{peak} values are of concern
  - Prolonged exposure at these peak levels should not be allowed
- Despite max recorded levels being quite high, both public and staff were indifferent to the noise levels
  - Findings consistent with the literature

Data Interpretation

- Noise levels are likely higher at other times as both staff and public indicated that noise can be "very loud" when at its noisiest
- No apparent association between noise levels and number of people or facility characteristics
- There might be a relationship between noise and in-pool activity
  - Needs to be explored further

Study Limitations

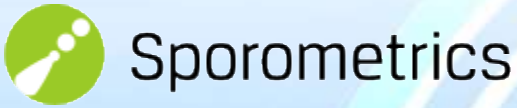
- Only representative of the sites sampled
- Only representative of the time sampled
- Does not take into account seasonal variations
- Could not identify source(s) of peak noise
- Respondent answers are not representative of all pool visitors and staff
- Could not verify participant answers

Recommendations – Future studies

1. **Sample for an 8-hour period**
2. **Vary sampling time period** – Different times of day and/or different time of the year
3. **Sample duration to be reflective of in-pool activity**
4. **Evaluate impact of the public viewing area** – whether noise levels vary depending on proximity of viewing area to pool and if a barrier exists

Acknowledgements

These project were generously funded by the Life Saving Society and Ryerson University . We wish to acknowledge the time and cooperation of all participating facilities as well as those who individuals who responded to the surveys. In addition, we would like to recognize Sporometrics Inc. and Dr. Melissa Moos of Ryerson University for their assistance with data analysis and interpretation.




thank you
danke
謝謝
gracias
merci
obrigado
dziękuję
bedankt
go raibh maith agat
teşekkür ederim
ngiyabonga
спасибо
рахмат
Баярлалаа
faafetai lava
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blagodaram
dank je
misaotra
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tapadh leat
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obrigada
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