Supporting Materials

Studying the impacts of non-routine extended schools' closure on heavy metals release to the tap water

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SI-1 Water Sampling for Chemical Quality Analysis

To evaluate the chemical quality of the water entering the schools' plumbing, the water samples were collected at the buildings' point of entry (POE). For this purpose, prior to collecting the water sample at each POE, its outlet was flushed for 5 min to remove the water being stagnant in the pipes connected to the POE. Then, 250 mL water samples were collected in the plastic bottles for metal analysis. It was followed by the collection of two 50 mL samples for quantification of pH, total chlorine residuals, temperature, and dissolved oxygen (DO). Furthermore, a 250 mL water sample was collected and transported to the lab for alkalinity and hardness measurement. A similar water sampling practice was conducted after the collection of sequential water samples to analyze the water chemical quality.

SI-2 Statistical Analysis

The IBM SPSS software, version 26, was used for the statistical analysis. The Normality of water quality data was examined using the Kolmogorov-Smirnov test.[30] The paired t-test and the non-parametric test of the independent-samples median test were applied to identify the significant differences between the water quality data with the normal distribution and non-normal distributed water quality parameters, respectively. A type I error of 0.05 was selected as the significance level for all tests. For illustrations and statistical analysis, the values less than detection limits have been replaced by half of the detection limits. The Pearson correlation coefficients were calculated for heavy metals concentrations in water samples collected after extended water stagnation from problematic fixtures.

SI-3 Blood Lead Level Modeling

The IEUBK model (Windows version 1.1 Build 11) was downloaded from the US EPA website and the advanced user interface was used. Due to the model assumptions, the model outputs for each year are only estimates. However, because all assumptions and inputs have been held constant (aside from the school drinking water concentrations for the year of interest), the relationship between the model outputs generated for water samples collected under regular water use conditions and after prolonged water stagnation can be deduced with confidence. Because the data did not fit a normal distribution, the Wilcoxon Signed Rank test ($\alpha = 0.05$) was employed to compare the 2019 values with the 2020 values.

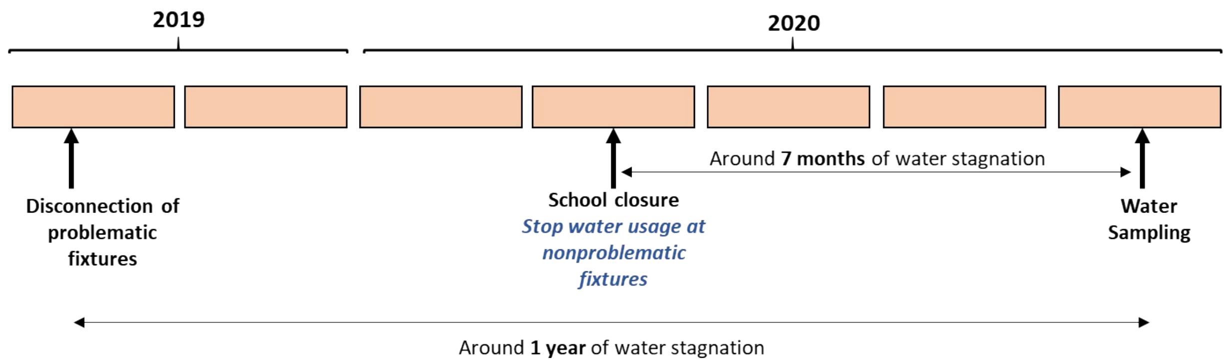

Figure SI-1: The timeline illustrating the duration of water stagnation in problematic and nonproblematic water fixtures

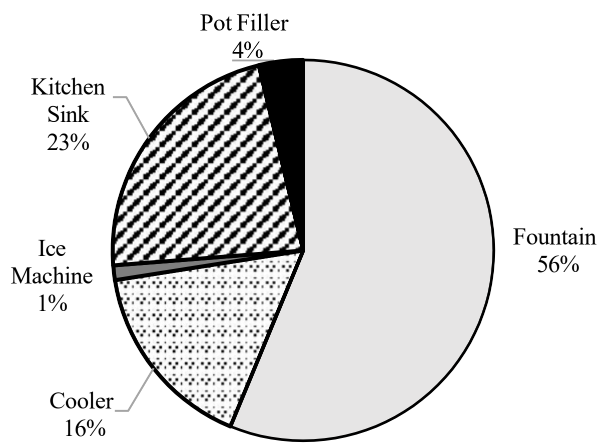

Figure SI-2: The distribution of fixtures with Pb>15 μg/L in 2019 water sampling

Figure SI-3: The aerators were removed from kitchen faucets in schools

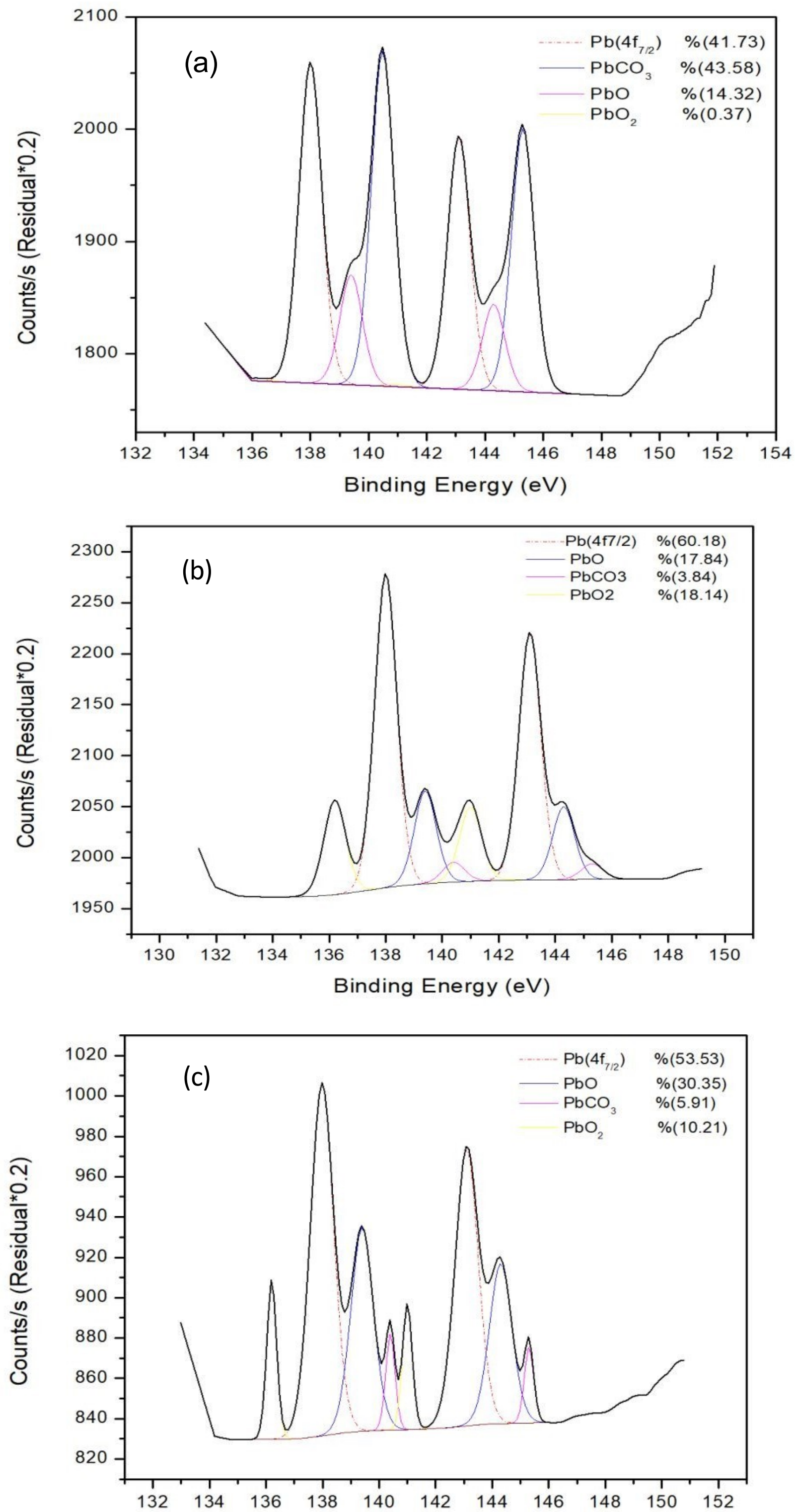

Figure SI-4: The Pb 4f XPS spectra for the deposit removed from (a) a water fountain, (b) a cooler, and (c) a pot filler.

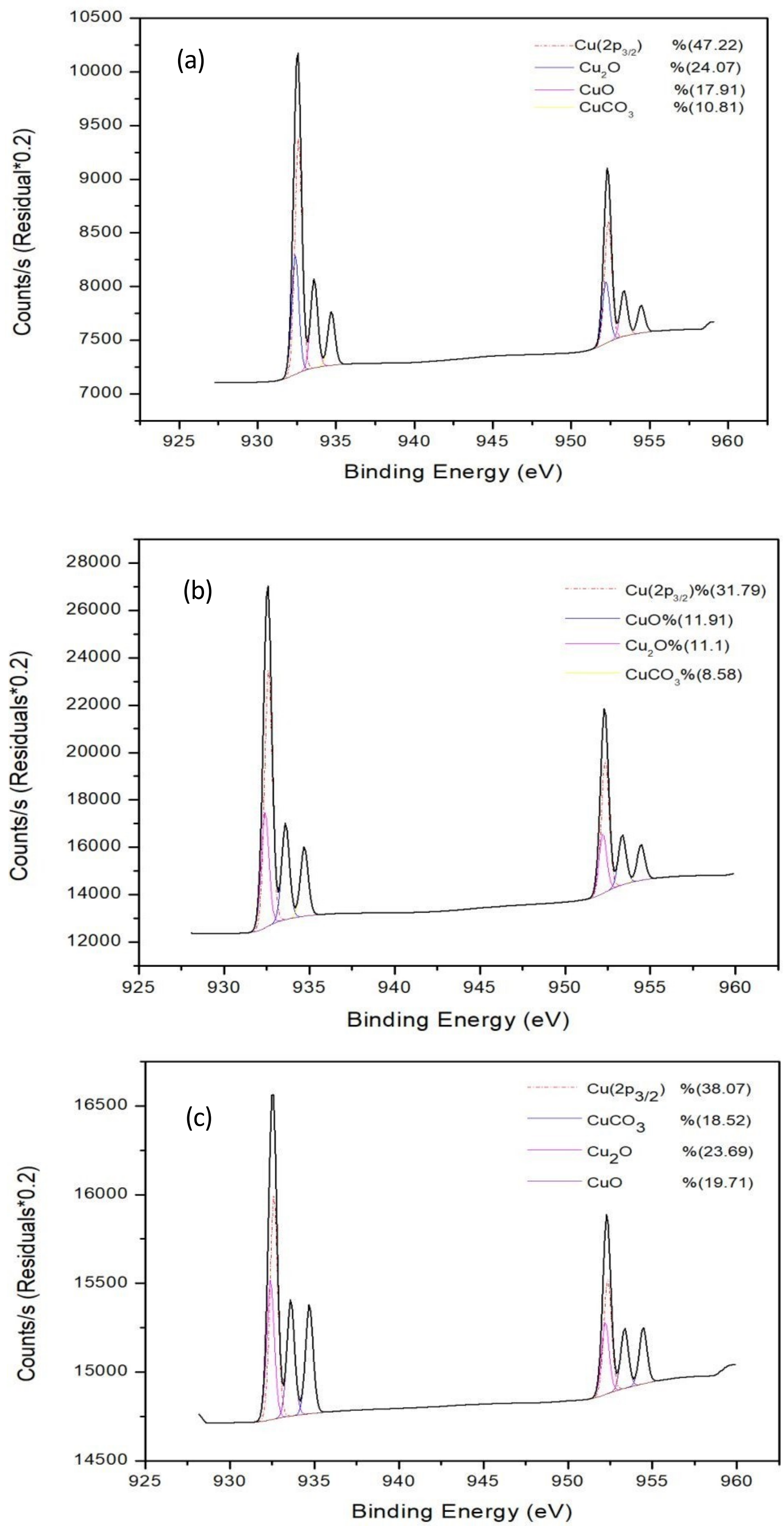

Figure SI-5: The Cu 2p XPS spectra for the deposit removed from (a) a water fountain, (b) a cooler, and (c) a pot filler.

Table SI-1: The list of samples collected from different schools after prolonged water stagnation (N/P: Without the past lead problem, Y/P).

Fixture / School	Total # schools	# Schools built before 1986	Fountain		Cooler		Kitchen Faucet	
			N/P	Y/P	N/P	Y/P	N/P	Y/P
Elementary	14	13	16	7	32	5	1	5
Middle	3	3	5	9	9	1	0	1
High	8	7	5	2	32	2	3	4
Total	25	23	26	18	73	8	4	10

Table SI-2: The list of samples collected from 26 schools to identify the sources of lead in schools

Fixture / School	Total # schools	# Schools built before 1986	Fountain			Cooler			Kitchen Faucet		
			Seq.	30 s Flush	Post Rem.	Seq.	30 s Flush	Post Rem	Seq.	30 s Flush	Post Rem
Elementary	13	12	7	7	7	5	5	5	4	4	4
Middle	4	4	8	8	8	1	1	1	1	1	1
High	9	9	3	3	3	2	2	2	3	3	3
Total	26	25	18	18	18	8	8	8	8	8	8

Table SI-3: Pearson correlation coefficients for heavy metals concentrations in water samples collected from problematic fixtures after extended stagnation (*significant correlation, *p*-value<0.05)

Heavy Metal		Pb	Cu	Fe	Zn
Fountain	Pb	1.000			
	Cu	0.996*	1.000		
	Fe	0.983*	0.984*	1.000	
	Zn	0.559*	0.532*	0.542*	1.000
Cooler	Pb	1.000			
	Cu	0.620	1.000		
	Fe	0.623	0.993*	1.000	
	Zn	0.089	-0.020	0.048	1.000
K. Faucet	Pb	1.000			
	Cu	0.731*	1.000		
	Fe	0.656*	0.994*	1.000	
	Zn	0.841*	0.845*	0.811*	1.000

Table SI-4: The metals concentrations in sequential water samples collected from water fountains

Metal		1st draw	2nd draw	3rd draw	30 s flush
Fe	Median	556.9	249.0	161.0	101.2
	10tile	17.5	33.1	15.7	15.7
	90tile	2998.5	3218.7	1424.3	708.9
	n ≥ 300 µg/L	11.0	8.0	6.0	5.0
Cu	Median	321.5	345.1	247.5	202.7
	10tile	64.4	45.8	21.3	7.8
	90tile	1265.5	694.9	501.7	319.8
	n ≥ 1.3 mg/L	2.0	2.0	1.0	0.0
Zn	Median	704.6	268.9	179.2	193.9
	10tile	146.7	31.0	20.3	13.1
	90tile	2596.3	1538.6	1043.8	794.4
	n ≥ 5.0 mg/L	1.0	1.0	0.0	0.0

Table SI-5: The metals concentrations in sequential water samples collected from coolers

Metal (µg/L)		1st draw	2nd draw	30 s flush
Fe	Median	82.2	254.5	71.4
	10tile	14.0	14.0	14.0
	90tile	1038.5	1133.0	457.5
	n ≥ 300 µg/L	3.0	4.0	2.0
Cu	Median	330.6	268.7	167.3
	10tile	178.6	194.8	88.5
	90tile	942.7	1017.5	370.4
	n ≥ 1.3 mg/L	0.0	0.0	0.0
Zn	Median	94.2	248.5	86.6
	10tile	25.4	57.7	11.0
	90tile	1383.2	1582.8	1421.7
	n ≥ 5.0 mg/L	0.0	0.0	0.0

Table SI-6: The metals concentrations in sequential water samples collected from kitchen faucet

Metal (µg/L)		1st draw	2nd draw	30 s flush
Fe	Median	155.2	70.0	17.5
	10tile	2.1	17.5	17.5
	90tile	2626.9	339.3	178.7
	n ≥ 300 µg/L	2.0	2.0	0.0
Cu	Median	331.0	268.6	142.7
	10tile	179.7	116.1	31.4
	90tile	660.8	716.4	336.4
	n ≥ 1.3 mg/L	0.0	0.0	0.0
Zn	Median	242.7	55.6	13.1
	10tile	73.4	24.9	6.0
	90tile	468.3	125.9	31.9
	n ≥ 5.0 mg/L	0.0	0.0	0.0

Table SI-7: Summary water chemical quality statistics for schools' water samples

Parameter		POE	In-building fixtures	POE	In-building fixtures	POE	In-building fixtures
		Minimum		Median		Maximum	
Hardness (mg/L as $CaCO_3$)		21.0	30.0	43.0	44.5	101.1	95.1
Alkalinity (mg/L as $CaCO_3$)		26.3	26.3	48.8	49.4	100.0	93.8
Temperature (°C)		16.2	15.6	19.8	22.2	22.8	30.6
pH		6.3	6.4	6.7	6.8	7.6	7.7
Dissolved Oxygen (mg/L)		4.7	1.5	9.3	8.3	10.9	9.9
Total Chlorine (mg/L)		<0.1	<0.1	0.8	0.1	1.8	1.1
Turbidity (NTU)	5 min Flush	0.2	-	0.2	-	4.2	-
	1st draw	-	0.2	-	1.9	-	136
	2nd draw	-	0.2	-	1.3	-	99.9
	3rd draw	-	0.5	-	1.7	-	55.4
	30 sec Flush	-	0.2	-	0.7	-	6.3

Table SI-8: The Pb4f and Cu 2p binding energies and atomic percentage of various lead and copper species in deposits removed from the select cooler, water fountain, and pot filler

Species	BE (eV)	Atomic Percentage (%)			BE (eV)	Ref
	Pb4f7/2 - Cu2p3/2	Cooler	Fountain	Pot Filler	Pb4f5/2 - Cu2p1/2	
Pb	138.0	53.5	41.7	60.2	143.1	32
PbO	139.4	30.6	14.3	17.8	144.3	
PbO_2	136.2	10.2	0.4	18.1	141.0	
$PbCO_3$	140.4	5.9	43.6	3.8	145.3	
Cu	932.6	47.2	38.1	31.8	952.3	33
CuO	933.6	17.9	19.7	11.9	953.3	
Cu_2O	932.4	24.1	23.7	11.1	952.2	
$CuCO_3$	934.7	10.8	18.5	8.6	954.4	