

Electronic Supplementary Material

Article: Lead in New York City Community Garden Chicken Eggs: Influential Factors and Health Implications

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Authors: Henry M. Spliethoff ^{a,*}, Rebecca G. Mitchell ^a, Lisa N. Ribaldo ^a, Owen Taylor ^b, Hannah A. Shayler ^c, Virginia Greene ^d, Debra Oglesby ^d

^a Bureau of Toxic Substance Assessment, New York State Department of Health, Empire State Plaza, Corning Tower, Room 1743, Albany, New York, 12237

^b Just Food, 1155 Avenue of the Americas, 3rd Floor, New York, New York, 10036

^c Cornell Waste Management Institute, Department of Crop and Soil Sciences, Cornell University, Bradfield Hall, Ithaca, New York, 14853

^d New York State Department of Agriculture and Markets, 7 Harriman Campus Road, Albany, New York, 12206

* Corresponding author email: hms01@health.state.ny.us; phone (518) 402 7820; fax (518) 402-7819

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Table S1 Henhouse characteristics and management practices and analytical results for 9 NYC henhouses and 1 rural henhouse

Characteristics and Practices	NYC Henhouses									Rural Hen-House
	1	2	3	4	5	6	7	8	9	
Number of Chickens	16	123	147	20	28	19	7	5	36	7
Number of Laying Hens	16	123	147	20	20	19	7	3	36	2
Number of Chicken Breeds	2	1	5	4	4	5	3	4	6	2
Average Chicken Residence Time in Garden (months)	18	9	9	5	11	34	12	36	20	36
Average Number of Eggs per Laying Hen per Day	0.7	0.7	0.7	0.7	0.1	0.3	0.9	0.3	0.3	0.4
Run Area (m ²)	9	692	286	9	9	10	6	3	7	49
Run Area per Chicken (m ²)	0.6	5.6	1.9	0.4	0.3	0.5	0.8	0.7	0.2	6.9
Run Cover Material - Fraction of Run Covered by										
Bare Soil	90%	0%	0%	90%	95%	40%	100%	100%	15%	100%
Grass	0%	100%	100%	0%	0%	0%	0%	0%	0%	0%
Mulch (e.g., bark, straw, coffee chaff)	10%	0%	0%	10%	5%	60%	0%	0%	85%	0%
Fraction of time chickens have access to areas outside of henhouse and enclosed run	1%	0%	0%	1%	0%	50%	1%	4%	42%	0%
Diet - Fraction from										
Commercial Layer Feed	75%	84%	84%	75%	60%	20%	90%	80%	75%	90%
Food Scraps	25%	15%	15%	25%	30%	20%	5%	5%	15%	0%
Other (e.g. corn, grain, seed)	0%	1%	1%	0%	10%	0%	0%	15%	10%	10%
Analytical Results										
Number of Eggs Analyzed	3	6	6	6	7	10	6	6	8	6
Fraction of Eggs with Lead Detected (F _{PbEgg})	0%	17%	33%	0%	14%	60%	100%	83%	88%	0%
Number of Chicken-Area Soil Samples Analyzed	2	1	1	2	1	1	3	3	2	1
Lead Concentration in										
Eggs (µg/kg)										
Minimum Egg from Henhouse	< 10	< 10	< 10	< 10	< 10	< 10	17.9	< 10	< 10	< 10
Median Egg from Henhouse	< 10	< 10	< 10	< 10	< 10	13.6	39.8	19.4	18.9	< 10
Mean Egg from Henhouse ^a	< 10	6.6	7.7	< 10	7.9	19.6	37.2	20.2	35.1	< 10
Maximum Egg from Henhouse (Pb _{EggMax})	< 10	14.7	16.1	< 10	25.5	73.2	58.8	42.1	167.0	< 10
Soil (mg/kg)										
Chicken Run (Pb _{SoilRun})	20	51	57	64	71	103	241	351	192	15
Maximum for all Chicken Areas (Pb _{SoilMax})	60	51	57	94	71	103	465	447	631	15
Exposure-Weighted (Pb _{SoilExp})	21	51	57	65	71	92	242	352	558	15
Water (µg/L)	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5
Layer Feed ^b (µg/kg)	123	168	168	123	187	128	128	272	111	92.2
Kitchen Scraps ^c (µg/kg)							1530		224	
Garden Scraps ^c (µg/kg)							1020			
Other Feed (corn, grain, seed) (µg/kg)		11.9	11.9					80,<10		< 10
Calcium Supplements (µg/kg)		556	556					237	213	
Grit (µg/kg)									1770	

^a Concentrations below the detection limit were substituted with one-half the detection limit in calculating mean.

^b Some chicken keepers did not provide the brand name of commercial layer feed samples; those that were provided were Purina Layena, Homegrown Brand Layer Feed, Blue Seal Feed, and Lightning Tree Organic Layer Feed.

^c Kitchen scraps included cabbage and acorn squash; garden scraps included callaloo and other garden vegetables.

Table S2 Lead concentrations in chicken run soil samples (mg/kg) measured by ICP-AES and XRF. Results are strongly correlated ($R = 0.992$).

Linear regressions: (a) all data $Pb(XRF) = 0.77 Pb(ICP) + 23, R^2 = 0.98$
 (b) $Pb < 200$ mg/kg $Pb(XRF) = 1.00 Pb(ICP) + 11, R^2 = 0.98$

Henhouse ID	Lead Concentration (mg/kg)	
	ICP-AES	XRF (mean of 3 readings)
Rural	2.45	15
1	24.4	20
2	36.2	51
3	43.0	57
4	57.0	64
5	49.7	71
6	87.6	103
7	184	192
8	290	241
9	438	351

Table S3 Correlations between measures of lead in eggs and potentially influential variables for 10 henhouses (Spearman coefficients and p values)

Predictor	Measure of Lead in Eggs			
	Detection Frequency (%) (F_{PbEgg})		Maximum Concentration in Eggs from Henhouse ($\mu\text{g}/\text{kg}$) (Pb_{EggMax})	
	Coefficient	p Value	Coefficient	p Value
Lead Concentration in Soil (mg/kg)				
Chicken Run ($Pb_{SoilRun}$)	0.83	0.003	0.82	0.004
Maximum in Chicken Area ($Pb_{SoilMax}$)	0.74	0.014	0.78	0.008
Exposure-Weighted ($Pb_{SoilExp}$)	0.83	0.003	0.88	0.001
Lead Concentration in Layer Feed ($\mu\text{g}/\text{kg}$)	0.29	0.415	0.23	0.524
Number of Chickens	-0.06	0.879	0.03	0.933
Run Area (m^2)	-0.48	0.162	-0.44	0.202
Run Area per Chicken ($\text{m}^2/\text{chicken}$)	-0.13	0.723	-0.42	0.223
Fraction of Run with Bare Soil	-0.01	0.973	-0.08	0.837
Bare Soil Area per Chicken ($\text{m}^2/\text{chicken}$)	-0.14	0.709	-0.23	0.516
Eggs per Laying Hen per Day	-0.06	0.862	-0.43	0.214
Average Chicken Residence Time (months)	0.23	0.514	0.31	0.376

Table S4 Measures of lead in eggs for 10 henhouses grouped by dichotomous variables (Median, Range, and Mann-Whitney p-values)

<u>Categorical Variable</u>	<u>Median (and Range) of Measure of Lead in Eggs</u>			
		Detection Frequency (%) (F_{PbEgg})		Maximum Concentration in Eggs from Henhouse ($\mu\text{g}/\text{kg}$) (Pb_{EggMax})
Feed scattered	No (n = 4)	7%	(0% - 100%)	15.3 (< 10 - 58.8)
	Yes (n = 6)	47%	(0% - 88%)	29.1 (< 10 - 167)
	p		0.39	0.39
Calcium supplements provided (S_{Ca})	No (n = 3)	60%	(0% - 100%)	58.8 (< 10 - 73.2)
	Yes (n = 7)	17%	(0% - 88%)	16.1 (< 10 - 167)
	p		0.56	0.56
Limited access to outdoors (< 24 h/d)	No (n = 5)	33%	(14% - 100%)	25.5 (14.7 - 58.8)
	Yes (n = 5)	0%	(0% - 88%)	< 10 (< 10 - 167)
	p		0.24	0.60

Table S5 Regression coefficients, p-values, and goodness-of-fit statistics

Predictor variable:	log(Pb_{SoilExp})		S_{Ca}		Intercept		Model AIC ^a
	Coefficient	p	Coefficient	p	Value	p	
Response variable (Model description)							
F_{PbEgg} (Generalized linear model with probit link function)							
Model 1:	2.57	0.0016			-5.3	0.002	27.1
Model 2:	2.60	0.0015	-0.91	0.07	-4.8	0.003	24.3
log(Pb_{EggMax}) (Linear regression, left-censored Tobit analysis)							
Model 1:	0.95	< 0.0001			-0.5	0.26	10.1
Model 2:	0.92	< 0.0001	-0.26	0.09	-0.2	0.52	8.8

^a AIC = Aikake information criterion, a measure of a model's goodness-of-fit. Among similar models (e.g., the two models for FPbEgg), a lower AIC value indicates a better fit.

Table S6 Predicted fraction of eggs with lead detected (FPbEgg) and maximum lead concentration (PbEggMax) in eggs from a henhouse at three different soil concentrations

Predictor	Pb _{SoilExp} = 100 ppm		Pb _{SoilExp} = 400 ppm		Pb _{SoilExp} = 1000 ppm	
	F _{PbEgg}	Pb _{EggMax} (µg/kg)	F _{PbEgg}	Pb _{EggMax} (µg/kg)	F _{PbEgg}	Pb _{EggMax} (µg/kg)
Soil only	43%	26	91%	96	99%	230
Soil, S _{Ca} = 1	31%	22	86%	80	98%	187
Soil, S _{Ca} = 0	66%	41	98%	147	100%	342