Exposure to Arsenic and Chromium on Children Playgrounds

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Wood Preservatives

- Wood treated with chromated copper arsenate (CCA)
- Mixture contains
  - 34.0% As2O5
  - 47.5% CrO3
  - 18.5% CuO
- Typical retention level 0.25-2.5 pcf (lb of chemical/ft^3 of wood)

CCA-Treated Wood

- CCA is a common wood preservative
- CCA-treated wood exists and it is still in use
- In the U.S., 70% single-family houses have decks or porches containing CCA (EPA 2003)
- In Edmonton, Canada, 222 of 317 public playgrounds (~70%) contain CCA-treated wood structures

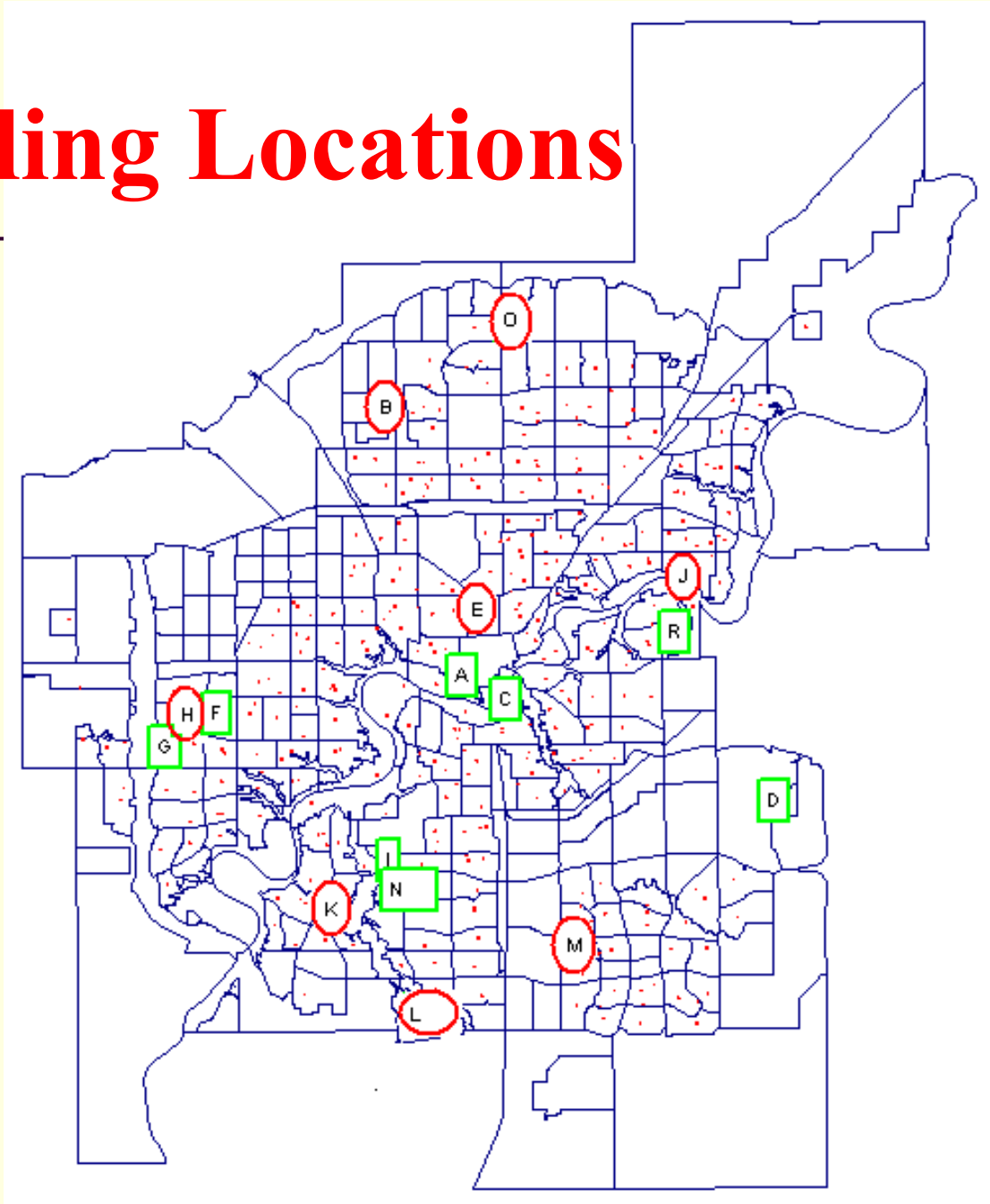
Public Health Concern

- As and Cr may leach from the CCA-treated wood
- As and Cr may be transferred to the hands of children in contact with the wood, sand and soil in playgrounds
- Frequent hand-to-mouth action of young children (8-30 per hour)
- Ingestion of As and Cr is the main route of exposure

Study Objectives

- Determine and quantify the amount of As and Cr on the hands of children after playing on both CCA and non-CCA playgrounds
- Identify the main sources of As and Cr on playgrounds

Sampling Locations



Sampling

- As children arrived, their time of arrival was recorded, and parental permission was obtained for participation in the study
- A hand-washing sample was collected from each of the participants
- Three sand and soil samples were collected from each playground for metal analysis

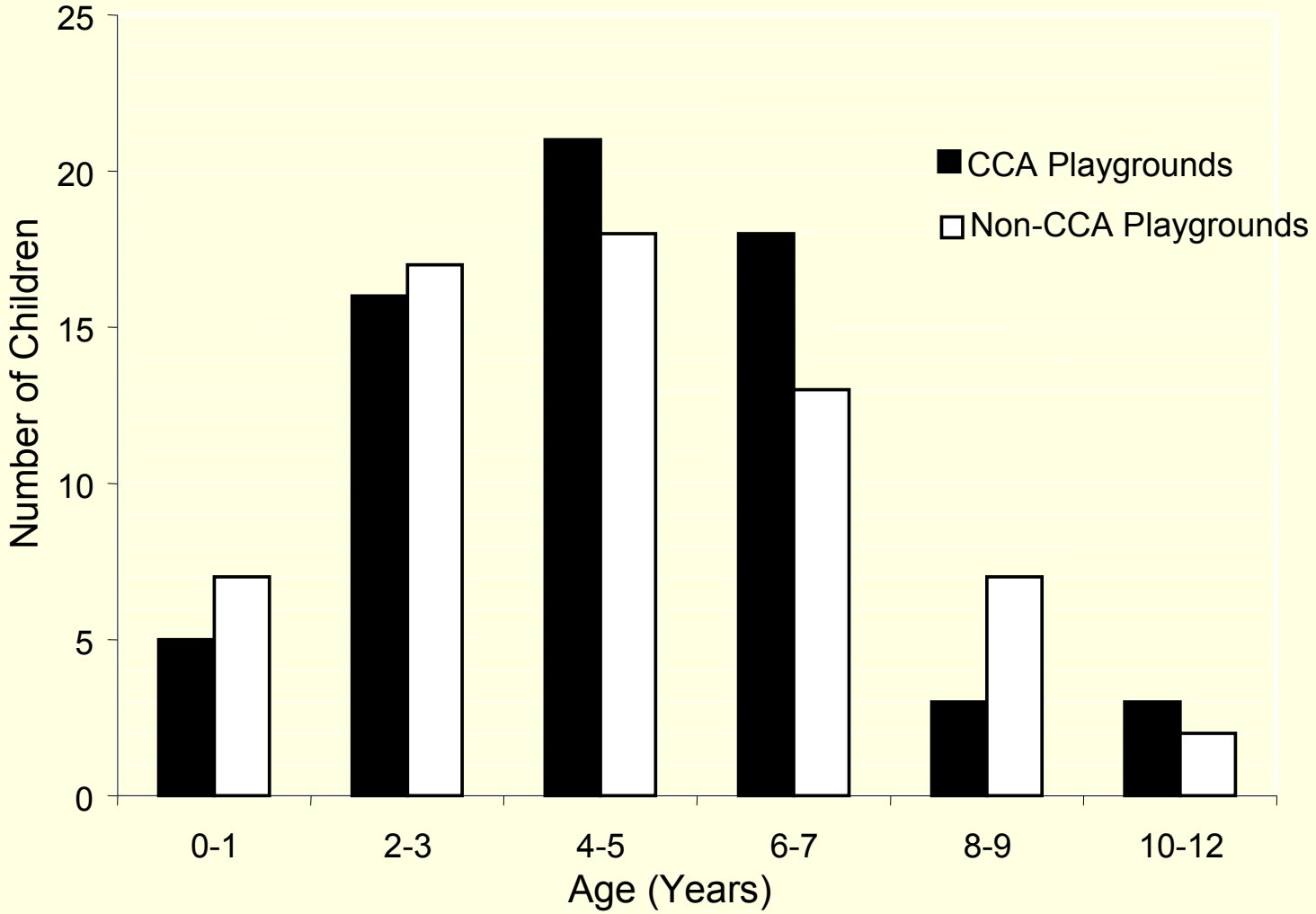
Hand-Washing Samples

- At the end of playtime, the children washed each of their hands for 1 min into a plastic bag of 150 ml de-ionized water
- These hand-washing samples were taken to the lab, filtered, and stored at 4 ^{o}C
- Multi-element analysis by ICPMS: As, Be, Ba, Bi, Cd, Co, Cr, Cu, Fe, Ga, In, Mg, Mn, Ni, Pb, Rb, Se, Sr, Tl, V, Zn.

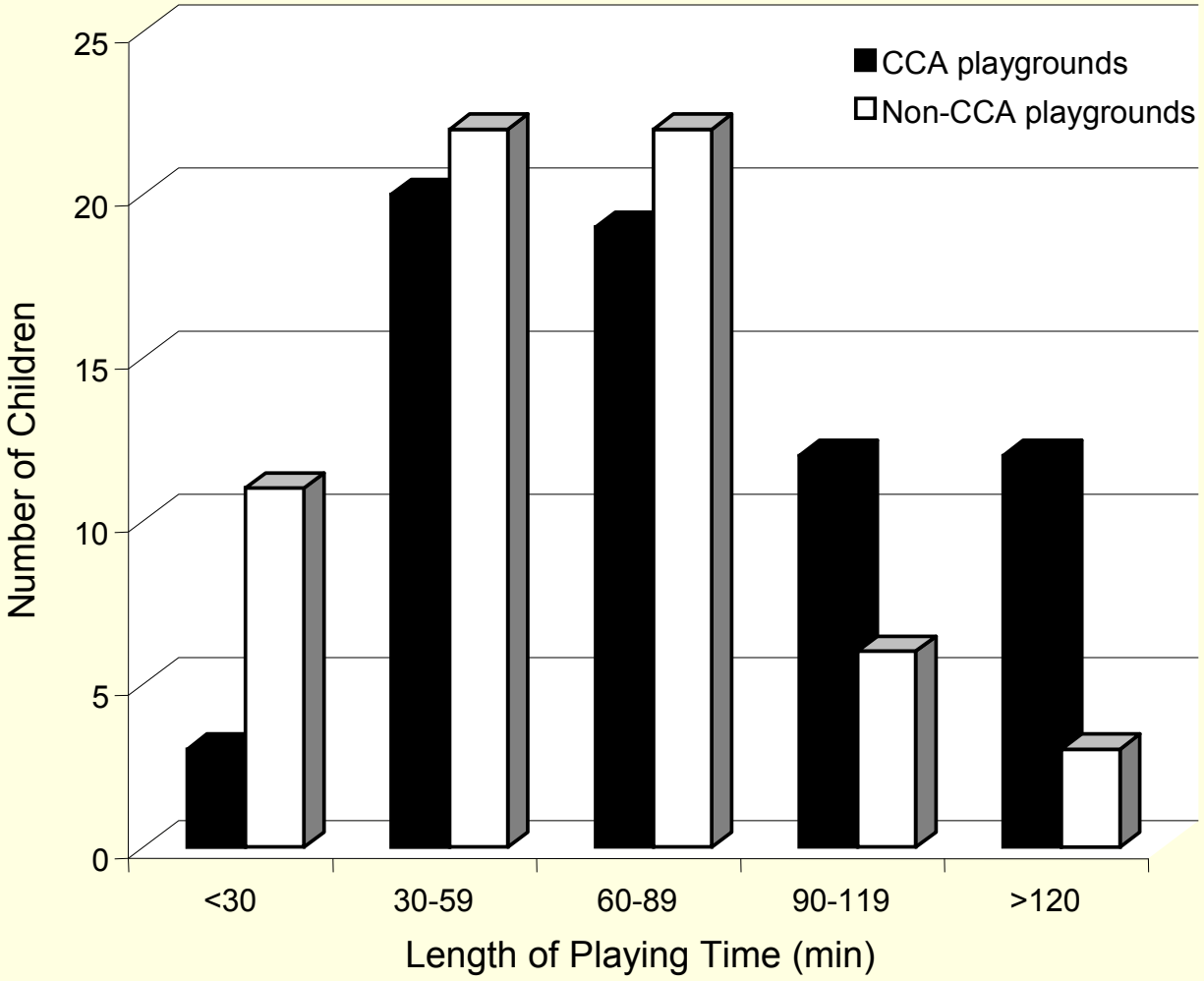
Sample Processing and Analysis

- Hand-washing samples were filtered (0.45 μm)
- Sand collected on the filter was dried and weighed
- Filtrate of hand-washing was analyzed for soluble metals by ICPMS
- Sand and soil were digested and analyzed for metals by ICPMS
- Water Standard Reference Materials were tested every 10 samples as a quality control

Age Distribution of Children



Length of Playing Time



Soluble As on the Hands of Children

CCA playgrounds	Non-CCA playgrounds
(n=66)	(n=64)
Mean: 501 ± 512 ng	Mean: 95 ± 70 ng
Median: 398 ng	Median: 72 ng
Range: 8 - 3536 ng	Range: 11- 407 ng

Insoluble As on the Hands of Children (on the Filter)

CCA playgrounds	Non-CCA playgrounds
(n = 66)	(n = 64)
Mean: 418 ± 601 ng	Mean: 172 ± 278 ng
Median: 191 ng	Median: 78 ng
Range: 8-3310 ng	Range: 4-1787 ng

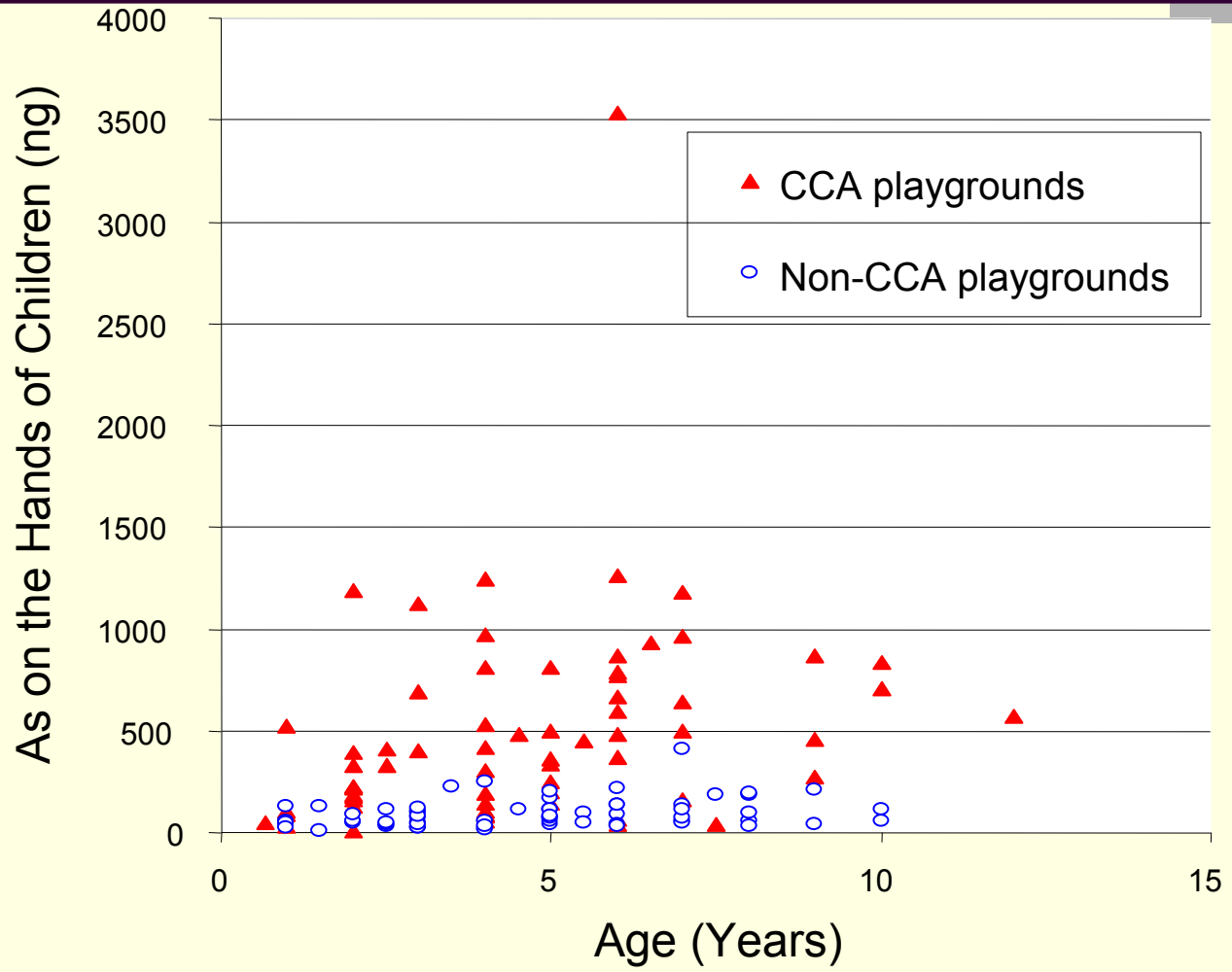
As on the Hands of Children

	CCA playground	Non-CCA playground	P value
Soluble As (ng)	501±512	95±70	<0.001
Insoluble As (ng)	418±601	172±278	
Total As (ng)	919± 940	267±312	<0.001

As on the Hands of Children on CCA-playgrounds

Before playing	**26 ± 14 ng**
First wash after playing	**1202 ± 598 ng**
Second wash after playing	**116 ± 68 ng**

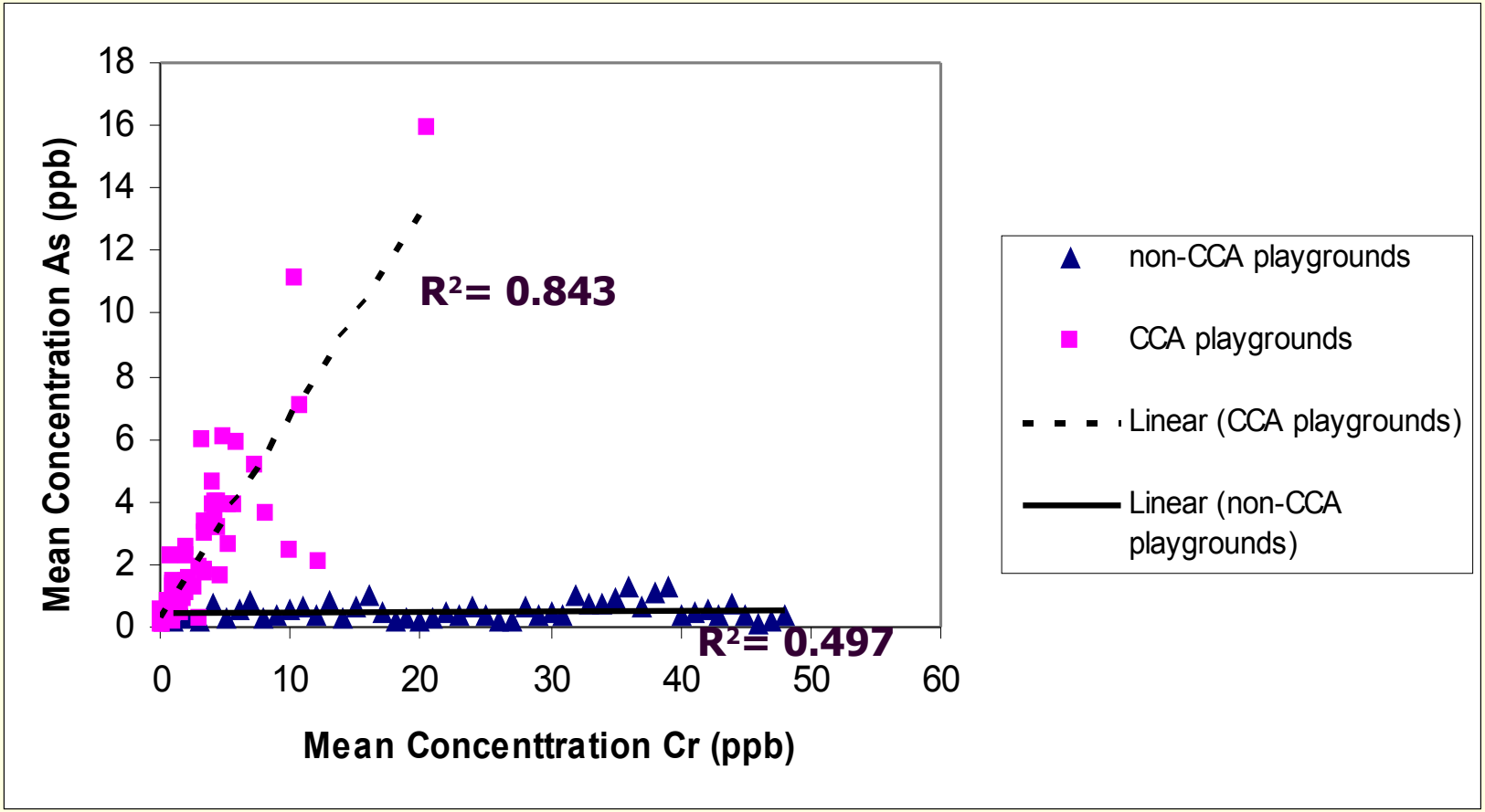
Distribution of As on the Hands of Children (n=130)



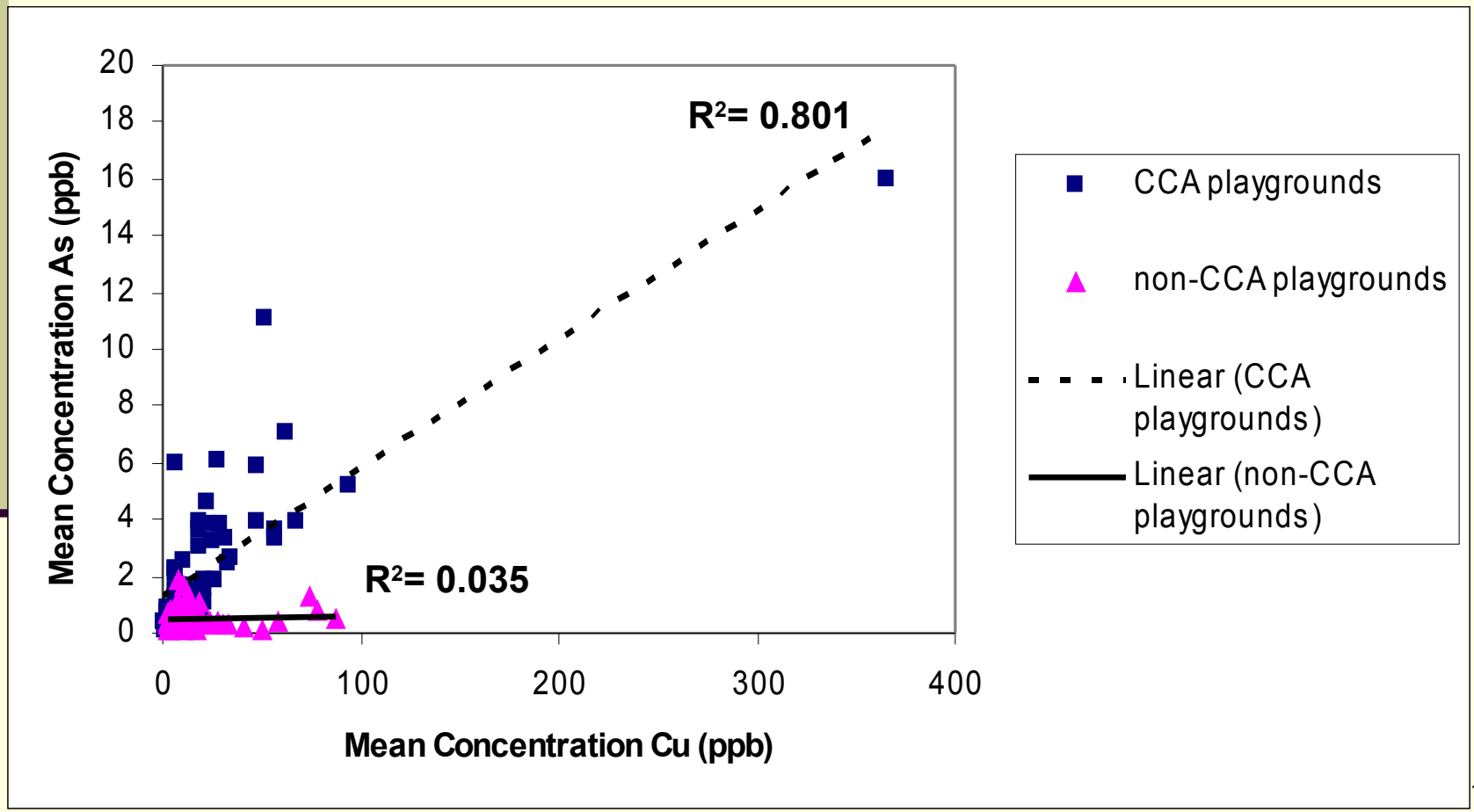
Cr on the Hands of Children (n=128)

	CCA playground	Non-CCA playground	P value
Soluble Cr (ng)	759±575	304±265	<0.003
Insoluble Cr (ng)	409±646	348±509	0.56
Total Cr (ng)	1112 ± 1089	652 ± 586	0.004

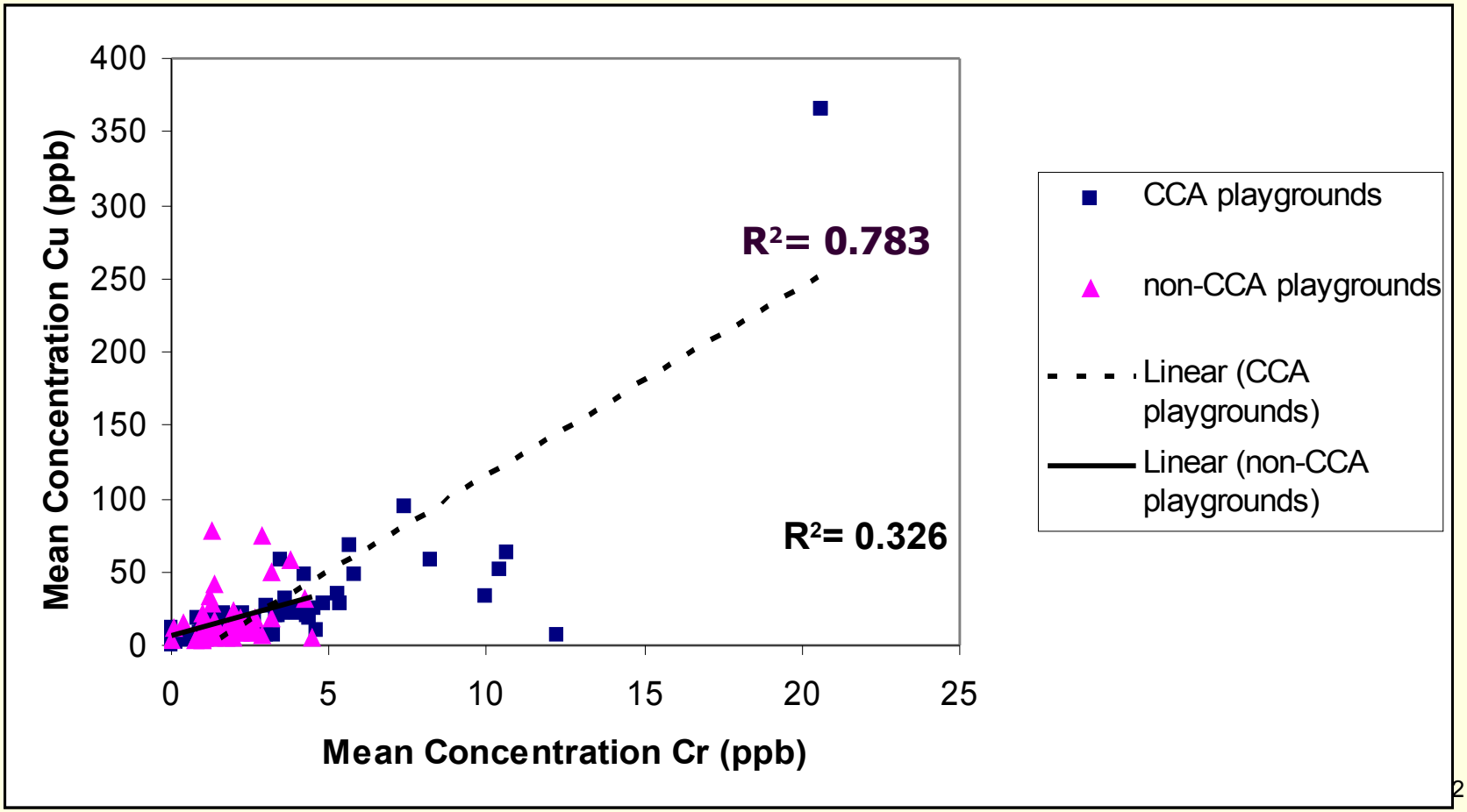
Correlation of As and Cr Concentrations in Hand-Washings



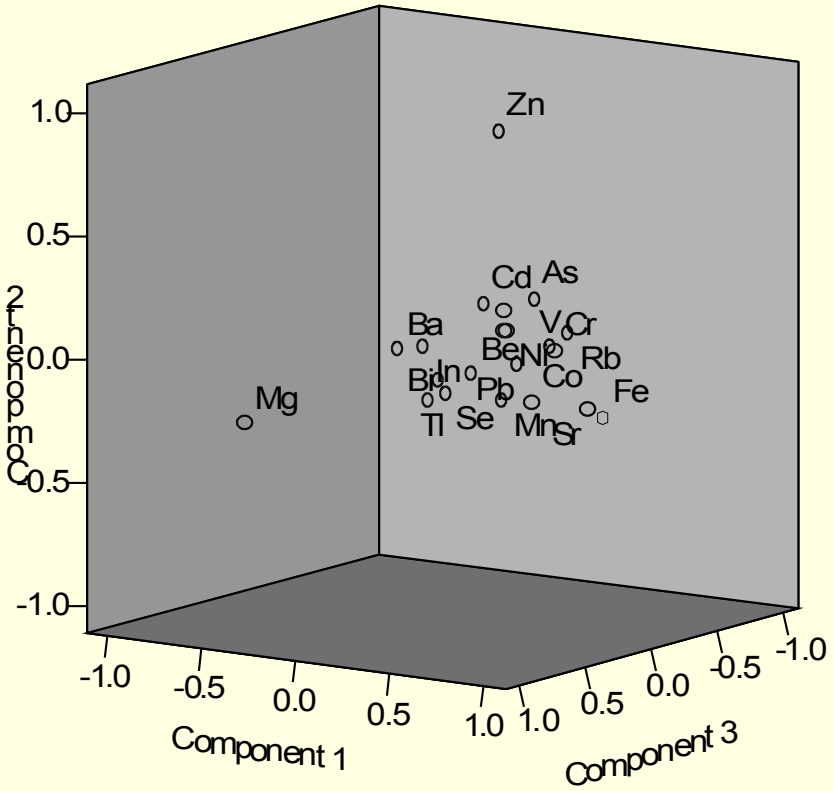
Correlation of As and Cu Concentrations in Hand-Washings



Correlation of Cr and Cu Concentrations in Hand-Washings



Component Plot in Rotated Space resulting from PCA of 21 metals in CCA hand-washing samples



Conclusions

- On the hands of children on CCA playgrounds As is five-fold higher than those on non-CCA playgrounds, respectively Cr is two-fold higher
- The elevated As and Cr levels are probably due to direct skin contact between the hand of children and CCA-treated wood.
- The increase is in the soluble fraction

(cont'd)

Conclusions

- There is little difference in the soil concentration of As and Cr between the CCA and non-CCA playgrounds
- A grouping of As, Cr, and Cu can be observed and there is a correlation between As, Cr, and Cu in CCA, but not on non-CCA playgrounds
- Washing hands after playing reduces As and Cr exposure