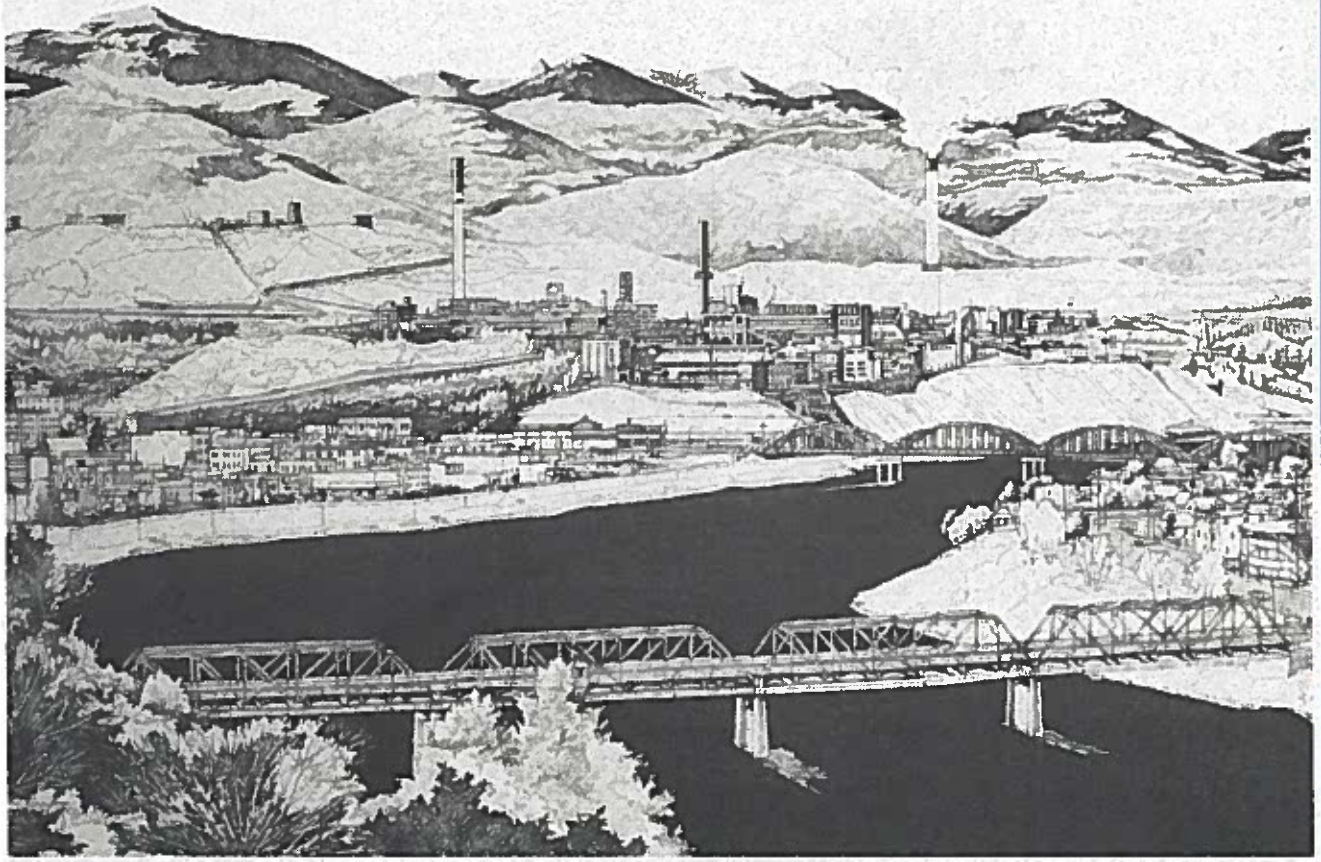
WORKING HAND IN HAND



"Trail from Daniel Street"

TRAIL COMMUNITY LEAD TASK FORCE

TRAIL LEAD PROGRAM

HEPA HOUSE CLEANING PILOT PROJECT

FINAL REPORT

March 31, 1994

S. R. Hilts, P. Geo.,
Environmental Coordinator

PREFACE

Trail, British Columbia has been the site of a major lead and zinc smelting facility since 1916. In 1975, children's blood lead levels in Trail were found to be significantly higher than those in a nearby comparison community (Neri et. al., 1978). The primary correlates of blood lead were identified as neighbourhood soil lead concentrations and proximity to the smelter (Schmitt et. al., 1979). A 1989 study found that soil lead concentration and, secondarily, house dust lead concentration, were the principal environmental determinants of elevated blood lead levels in Trail children (Hertzman et. al., 1991). Although the average blood lead level had declined from 22.4 μg/dl for 1–3 year olds in 1975 to 13.8 μg/dl for 2–5 year olds in 1989, 39.4% of the children tested in 1989 were above the U.S. Environmental Protection Agency's "level of no concern" of 15 μg/dl (US EPA, 1986). The 1989 study's recommendations prompted the formation of the Trail Community Lead Task Force, which was given responsibility for developing a strategy to reduce Trail children's lead exposures.

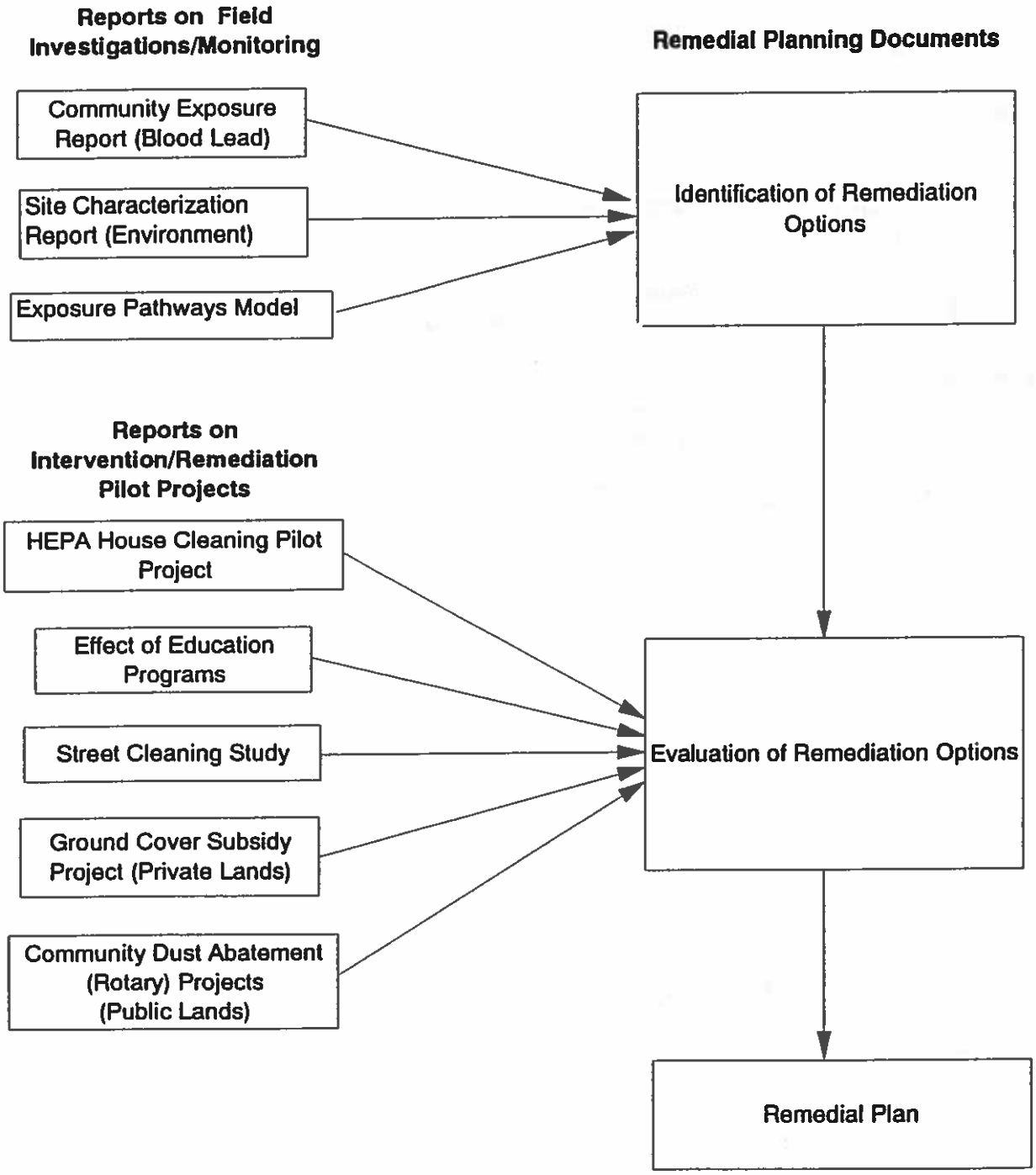
The Task Force was struck in June, 1990 and is composed of representatives from B.C. Environment, the B.C. Ministry of Health, Cominco Limited the City of Trail, the general public, the local School District, the United Steelworkers of America, the Village of Warfield, a network of environmental groups and the regional government. The Trail Lead Program is the operational arm of the Trail Community Lead Task Force. Funding for the program is shared by B.C. Environment, the Ministry of Health, Cominco Ltd. and the City of Trail.

In 1990, the Task Force embarked on comprehensive programs of community education and case management, as well as investigations of lead exposure pathways and intervention options.

In 1994, B.C. Environment requested that the Task Force prepare a remedial plan and supporting documentation. This request precipitated development of the documents shown in the chart on the following page.

TRAIL LEAD PROGRAM

Proposed Documents Flow Chart



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EXECUTIVE SUMMARY

An investigation of the potential benefit of repeated house vacuuming using HEPA vacuum cleaners commenced in the active lead/zinc smelter community of Trail, British Columbia in November, 1992. Children under 72 months of age, who had blood lead tests in September/October, 1992, were recruited to the program and randomly assigned to two groups. The 55 homes in the treatment group received vacuuming once every six weeks, while the 56 control homes did not.

Over a ten month period, treatment homes received 7 thorough HEPA vacuumings of all finished accessible floor areas. Hand wipes and carpet dust samples were collected at homes in both groups at the beginning, middle and end of the project. Post-intervention blood leads were collected in September, 1993.

The results of pre-intervention sampling indicated that the treatment and control groups were well matched with respect to baseline blood lead, age and handwipe lead. The mean baseline floor dust lead level was significantly higher in treatment than in control. Relationships between blood lead and baseline environmental lead were of approximately the same magnitude as have been observed elsewhere. Pre-intervention blood lead was most strongly related to HEPA vacuum bag lead loading, which suggests that the whole-house sample obtained by vacuuming is more representative of overall exposure risk than are samples from a few areas of carpet. Throughout the project, the amount of dust on floors was very strongly related to the amount of lead in floor dust. In other words, homes within the study area having high amounts of dust on their floors also had high amounts of lead on their floors.

The HEPA vacuuming achieved statistically significant immediate reductions in surface lead loading of carpeted floor areas. The reduction was 39% on the first vacuuming, 37% on the fourth and 46% on the seventh vacuuming.

Based on analyses of HEPA vacuum bag contents, significant reductions in the amount of lead removed from homes occurred over the course of the study. The average amount of lead recovered from vacuum bags declined by 43% from the first vacuuming to the final vacuuming.

The net effect of the vacuuming service on blood lead was 0.3 μg/dL, which is neither clinically nor statistically significant.

The treatment group homes experienced significant declines in carpet surface dust loading (43%) and lead loading (36%) from pre-intervention to post-intervention. In the control group, dust loading and lead loading were unchanged. The net difference between groups (0.16 mg/m^2) fell short of the estimated 0.30 mg/m^2 required for clinical significance.

Hand lead increased by 36% in the treatment group and fell by 40% in the control group. This significant difference between groups is not consistent with the effect of HEPA vacuuming in reducing floor lead loadings. It is hypothesized that some of the treatment group families may have relaxed their hygiene efforts with their children due to a perceived reduction in exposure risk.

A survey completed by participants, analyzed in conjunction with sampling results, showed that:

(a) Vacuum cleaner use among parents of young children in Trail is quite high. All study participants had regular use of vacuum cleaners and reported that they used them frequently.

(b) The use of vacuum cleaner power nozzle attachments on domestic vacuums is effective in reducing carpet dust loadings.

(c) Those who vacuum frequently (once per week, or more often) with their own vacuum cleaners did not benefit as much from the HEPA vacuuming as those who vacuum less frequently.

(d) Frequent vacuuming by the householders did not insure that their carpet lead loadings would be low. Other factors affecting the "cleanability" of the carpets (such as carpet age or rapid recontamination) must limit some householders' efforts to achieve very low lead loadings.

(e) Carpet age was not strongly related to initial floor lead loadings. However, those who reported that they did not know how old their carpets were had significantly higher lead loadings.

(f) Removing shoes at the door can be an important factor in the fight against lead contamination of interior floors.

(h) Children with a dog or cat indoors tended to have higher levels of lead in their blood and on their carpets.

A subset of 18 treatment group homes received re-sampling of carpets once per week for six weeks following the final vacuuming. On average, it took about 2.5 to 3 weeks for carpet lead loadings to return to the levels they were at prior to the final vacuuming. This rapid recontamination suggests the vacuuming might be more effective if employed more frequently.

This study failed to demonstrate that thorough HEPA vacuuming of floor areas once every six weeks results in a significant reduction in children's indoor exposure risk. However, it has provided much useful insight into the factors that influence indoor lead exposure and an indication that more frequent vacuuming might be beneficial in some cases.

ACKNOWLEDGEMENTS

This research was conducted by the Trail Community Lead Task Force with funding received from the B.C. Ministry of Environment, Lands and Parks, B.C. Ministry of Health, Cominco Limited and the City of Trail.

Dr. Clyde Hertzman had valuable input during the study design, data analysis and reporting phases. Dr. Stephen Marion also provided helpful recommendations for statistical data analysis and reporting. Dr. Scott Clark made useful comments on an interim project report.

Laboratory analyses were performed by Quanta Trace Laboratories, Cominco Analytical Services, B.C. Children's Hospital and the University of Alberta Hospital.

Thanks are due to numerous Lead Program staff: Eric White and Cheryl Yates for study design, sample collection and quality assurance; Ulrike Sliworsky for careful oversight of sampling, vacuuming and documentation; Carolyn Reynolds for dedicated recruiting of families and scheduling of appointments; Donna McManus and Shelley Coy for quick and sure drawing of venous blood samples; David Limacher, Shelley McIvor, Leona Powell and Karen Yuris for sample collection; Kevin West and Karen Yuris for vacuuming; Leona Powell for database management, Michelle Ferraro for data entry and administrative assistance.

Special thanks are due to Walter Kuit and Herb Teindl for developing the original concept for this study.

Above all, thank you to the families who put up with our regular intrusions into their households during this study.

1. INTRODUCTION

Trail, British Columbia has been the site of a major lead and zinc smelting facility since 1916. Neri et. al. (1978) reported that children's blood lead levels in Trail were significantly higher than those in the nearby comparison community of Nelson, B.C. The primary correlates of blood lead at that time were identified as neighbourhood soil lead concentrations and proximity to the smelter (Schmitt et. al., 1979). In 1989, a study by Hertzman et. al. (1991) found empirical evidence that soil lead concentration and, secondarily, house dust lead concentration, were the principal environmental determinants of elevated blood lead levels in Trail children. The study's recommendations prompted the formation of the Trail Community Lead Task Force, which was given responsibility for developing a strategy to reduce Trail children's lead exposures.

In 1990, the Task Force embarked on comprehensive programs of community education and case management, as well as investigations of lead exposure pathways and intervention options. Pathway intervention options were considered in light of current rates of contamination (approximately 300 kg lead per day in smelter stack emissions). That is, one-time clean-up efforts such as soil removal or house decontamination were not implemented or tested, as the work might be undone by recontamination.

A review of lead intervention trials reported in the literature reveals that various dust control measures employed in combination (e.g. house cleaning, ground cover improvement, risk avoidance education) have been successful in either reducing blood lead levels (Charney et. al., 1983) or preventing increases in blood lead levels (Mielke et. al., 1992). The study described here is the first known attempt to measure the impact on blood lead of a single dust control measure employed in isolation.

2. METHODS

2.1 Study Design and Sampling Methods

The purpose of the HEPA house cleaning project was to investigate the benefit of repeated house vacuuming using HEPA (High Efficiency Particulate Air) vacuums. The anticipated benefit was prevention of an initial rise in blood lead in infants and a reduction in blood lead in older children. The project was set up with a treatment group and a control group, with approximately 60 homes in each group. The treatment group received 7 household vacuumings over ten months (once every 6 weeks), whereas the control group did not. Families in both groups were encouraged to maintain their normal cleaning habits. As part of the Trail Lead Program's community education and case management efforts, families in both groups received educational materials and advice on how to reduce their children's lead exposures.

Discussions with the project consultant epidemiologist revealed that a sample size of 50 children in each group would allow detection of a difference in blood lead change of about 1.5 μg/dL. (See Appendix E – Minutes of Technical Committee Meeting October 13, 1992.) It was decided that a difference between groups of 1.5 μg/dL would also be the minimum acceptable as clinically significant. The project steering committee decided that 60 children should be recruited for each group, to allow for attrition during the project.

The committee also decided that the study should be limited to the higher risk areas 2 and 3 of the 1989 Trail Lead Study (Hertzman et. al., 1991). Area 2 includes Sunningdale, Glenmerry and Shavers Bench and Area 3 includes West Trail, East Trail, Tadanac and Rivervale.

Rather than performing a one time comprehensive house cleaning (with no follow up), a thorough cleaning of finished, accessible floors was performed once every six weeks. The filter bags in regular household vacuum cleaners fail to retain very fine dust particles (<5 μ), which are typically of higher lead concentration. HEPA vacuum cleaners are certified to capture and retain 99.97% of particles greater than 0.3 microns in diameter. The vacuum cleaner used in this study was the Nilfisk model GS80 equipped with a power agitator nozzle. Previous studies (Ewers et. al., 1993 and Saskatchewan Research Council, 1992) found that power agitator nozzles produce higher lead mass removal efficiencies than do plain nozzles.

The rate of HEPA vacuuming on carpeted floors was initially 22 seconds per square metre. From the second vacuuming cycle on, the rate was slowed to 32 s/m^2. Non-carpeted areas were simply vacuumed at a typical household rate (approximately 4 s/m^2). After each home was vacuumed, the contents of the paper vacuum bag were sent to the laboratory for weighing and analysis for lead. Details of the vacuuming protocol and a list of the complete project team can be found in Appendix D (Study Protocol).

Hand lead and floor dust lead were sampled 3 times during the course of the project (beginning, middle and end). In the treatment homes, floor dust lead was measured immediately prior to and immediately after HEPA vacuuming at each of the 3 project phases. Baseline blood lead for each subject child was obtained in the Trail Lead Program's annual fall screening clinic in September and October of 1992. Final blood lead was obtained as part of the fall 1993 screening. A final HEPA vacuuming was offered to both treatment and control homes after final blood lead samples had been collected. The purpose of this additional vacuuming cycle was to compare amounts of lead removed from treatment homes on their eighth vacuuming with amounts removed from control homes on a first vacuuming. The study schedule is summarized in Table 1 on page 6.

Blood samples were obtained by venipuncture and analyzed by graphite furnace atomic absorption spectrometry. Hand lead samples were collected and analyzed using the wipe procedure developed by Que Hee et. al. (1985). Composite floor dust samples were collected from three carpeted areas of child activity using the "microvac" method, which employs personal air monitoring samplers as described in Que Hee et. al. (1985). Details of sampling and analytical methods can be found in Appendices F and G, respectively.

2.2 Recruitment and Randomization

The project recruiter contacted 176 households with children under 60 months who participated in the September/October 1992 blood screening to see if they would participate in the house cleaning program. (See Table 2 on page 6.) During this contact, householders were screened to eliminate those with plans to move or conduct major renovations in the next ten months. 26 households were ineligible because they planned to move or had not lived at their present address for more than one month. 30 households were not interested in participating in the project.

Table 1 – Schedule of Project Activities

Date	Project Phase	Vacuuming Cycle	Samples Collected			
			Blood Lead	Carpet Dust by HEPA Vac	Carpet Dust by Microvac	Hand Lead
Sept/Oct '92	Pre-intervention		✓			
Nov/Dec '92	Pre-intervention	1		✓	✓	✓
Jan/Feb '93		2		✓		
Feb/Mar '93		3		✓		
Mar/Apr '93	Mid-project	4		✓	✓	✓
May/Jun '93		5		✓		
Jun/July '93		6		✓		
Aug '93	Post-intervention	7		✓	✓	✓
Sept '93	Post-intervention		✓			
Sept/Oct '93	Post-intervention	8		✓		

Note: Carpet dust samples by HEPA vac collected at treatment homes only, except on Cycle 8.

Table 2 – Summary of Recruitment Data

Families contacted initially (with children up to 60 months age)	176
Families ineligible to participate (moving or short time at current residence)	-26
Families not interested in participating	-30
Families in initial randomization to groups	120
Families lost near beginning of project	-6
Families recruited in second phase (with children up to 72 months)	+8
Total number of families starting project	122
Families lost during project (moved or did not have final blood lead taken)	-11
Families completing entire project	111

Children whose parents accepted (120 households) were stratified by area, sorted by blood lead within areas, then assigned randomly within blocks of six to treatment and control groups. This procedure yielded a control group of 60 children and a treatment group of 60 children.

Early into the first cycle of sampling and vacuuming, three households were lost from the control

group and three were lost from the treatment group. Two of the lost control homes were due to lack of interest and one was moving. Two of the treatment homes were uninterested in participating and one was found to have no carpeted floors.

A decision was made to recruit additional households by expanding the age window to 72 months to bring the totals in each group back up to approximately 60. This action resulted in a treatment group of 61 and a control group of 61.

A total of 55 treatment homes and 56 control homes completed the entire project. That is, these 111 families did not move during the project and they brought their children in for blood lead testing in fall 1993. However, several of these families did miss one vacuuming during the project.

2.3 Quality Assurance Program

Quality assurance procedures included the use of double entry of sample tracking data, electronic transfer of lab results, blind field blanks, blind field splits, laboratory splits, co-located samples, blind standard reference materials and blind local reference materials.

The overall level of quality control sample analyses was 12% of environmental samples and 20% of blood samples.

The results of the quality assurance program indicate that environmental samples were free of lead contamination and that analytical precision was acceptable. The one problem with the environmental results was that imprecision in determining microvac total dust weight rendered the floor lead concentration data unreliable.

The results of the rigorous quality control sampling for the blood lead monitoring provided assurance that the blood lead results are both accurate and precise.

See Appendix C for details and results of the Quality Assurance Program.

2.4 Data Analysis Procedures

Blood and environmental data are generally log-normally distributed, with a longer "tail" at the upper end of the distribution. Histograms were plotted to confirm that data distributions were log-normal. Averages are expressed as geometric means and all hypothesis testing and regressions have been performed on natural log-transformed data using WinSTAR statistical analysis software, unless otherwise noted. Computer outputs for most of the tests reported here may be found in Appendix B (Statistical Outputs).

2.5 Initial Home Assessment For Treatment Group Homes

After recruitment, an initial home visit was undertaken at treatment group homes. During this visit, the purpose of the project was explained and householders' questions were answered.

A floor plan of the whole house was drawn, documenting all rooms (e.g. bedrooms, storage areas, play rooms, etc.). The approximate dimensions of accessible floor in each room and the

type of floor covering (carpet or smooth) were noted on the plan. Rooms to be sampled for floor dust and approximate locations of sample points in each room were also noted on the floor plan. Areas of the house which would not be vacuumed – garages, workshops, unfinished basements and attics, rooms which are used exclusively for storage – were also noted.

Table 3 shows that the average area of accessible finished floor was 78.7 m^2 (847 ft^2) and the average percentage carpeted area was 68%.

Table 3 – Summary of Initial Home Assessment for Treatment Group

Accessible Finished Floor Area	
Arithmetic mean	78.7 m^2 (847 ft^2)
Minimum	36.6 m^2 (394 ft^2)
Maximum	176.0 m^2 (1894 ft^2)
Percentage Carpeted	
Arithmetic mean	68%
Minimum	18%
Maximum	100%

3. RESULTS

3.1 Pre-Intervention Lead Levels

3.1.1 Comparison of Initial Blood Lead, Age and Sex Data

Table 4 on page 9 shows that blood lead was closely matched between the two groups. An unpaired t-test showed no significant difference in mean blood lead ($p=0.46$) and an unpaired Kolmogorov-Smirnov test showed no significant difference between the distributions ($p=0.41$). The table also shows that the two groups were matched with respect to age (no significant difference in mean age ($p=0.75$) and no significant difference between age distributions ($p=0.73$)).

The treatment group was 49% male and the control group was 45% male. An unpaired t-test showed no significant difference in sex distribution between the groups ($p=0.64$).

The randomization procedure produced well-matched groups that were suitable for testing the effect of the vacuuming treatment on blood lead.

3.1.2 Comparison of Initial Exposure Levels

Table 5 on page 9 shows that lead loading and dust loading on carpets were significantly greater ($p<0.05$) in the treatment homes. The data suggest that the treatment and control groups were

Table 4 – Initial Blood Lead and Age Data

Parameter	Control	Treatment
Number of children	56	55
Blood Lead		
Geometric mean	11.3 μg/dL	11.9 μg/dL
Range	4–22 μg/dL	4–26 μg/dL
≥15 μg/dL	27%	27%
10–14 μg/dL	32%	35%
<10 μg/dL	41%	38%
Age		
Arithmetic mean	31.9 mos.	32.9 mos.
Range	6–69 mos.	6–70 mos.

Table 5 – Pre-Intervention Dust Sample Results

Parameter	n		Geometric Mean		Range	
Group	Ctrl	Treat	Control	Treatment	Control	Treatment
Hand Wipe Lead Loading	55	55	10 μg	11 μg	2–73 μg	2–100 μg
Carpet Dust Loading	56	55	364 mg/m^2	578 mg/m^2	20–8252	21–12972
Carpet Lead Loading	56	55	0.27 mg/m^2	0.56 mg/m^2	N.D.–3.49	N.D.–7.47
Carpet Dust Lead Concentration	56	55	748 ppm	971 ppm	N.D.–2336	N.D.–12931

N.D. = "not detectable"

not well matched with respect to baseline floor dust lead loadings. Further discussion of this difference is found later in section 3.7 – Changes in Exposure Levels.

Table 5 also shows that the two groups were well matched with respect to the amount of lead on the children's hands. An unpaired t-test showed no significant difference in means (p=0.53) and an unpaired Kolmogorov–Smirnov test showed no significant difference between the distributions (p=0.57). The overall mean hand lead for both groups at baseline was 11 μg per pair of hands. By comparison, the mean hand lead loading (using the same wipe procedure) for 45 children less than 72 months of age in the former mining town of Telluride, Colorado was reported to be 4.5 μg per pair of hands by Bornschein et. al. (1988). The mean blood lead for the children in that study was 6.1 μg/dL. Brunekreef et. al. (1987) report a mean hand lead of 12 μg per hand for 54 inner city Rotterdam children with a mean blood lead or 13.1 μg/dL. However, the Rotterdam

Table 6 – Comparison of Mean Hand Leads at Various Sites

Location	Reference	n	Mean Hand Lead (µg/pair of hands)	Mean Blood Lead (µg/dL)
Telluride, Colorado	Bornshein et. al. (1988)	45	4.5	6.1
Trail, British Columbia	Current study	111	11	11.5
Rotterdam, Netherlands	Brunekreef et. al. (1987)	54	24	13.1

study collected lead from hands using a rinse procedure, rather than the wipe procedure. (See Table 6.)

Clark et. al. (1991) used an estimate of 0.040 m^2 for the surface area of hands of 3 to 4 year old male children (U.S. EPA, 1989) to calculate hand lead loadings per unit area. Using the same methods for sampling hand lead and carpet surface lead as in this study, Clark et. al. found that the calculated mean hand lead loading for children in inner city Cincinnati was remarkably similar to the mean interior dust lead loading in their homes. The calculated mean hand lead loading for this study (about 0.27 mg/m^2) is also very similar to the mean interior dust lead loading in study homes (0.39 mg/m^2).

3.1.3 Comparison of Initial HEPA Vac and Microvac Results

The first vacuuming was performed at treatment homes from November 17 through December 9, 1992. Two HEPA vacuum operators cleaned 50 homes, an alternate operator cleaned 3 homes and the project field coordinator cleaned 2 homes. Vacuum bag analytical results are expressed as milligrams dust or lead per square metre of floor area vacuumed (carpeted and smooth floor total). Table 7 shows that the loadings of dust and lead obtained by vacuuming are greater than

Table 7 – Pre-Intervention Carpet Dust Results – HEPA Vac versus Microvac

Parameter	HEPA Vac	Microvac
Geometric Mean Dust Loading	1592 mg/m^2	628 mg/m^2
Geometric Mean Lead Loading	1.16 mg/m^2	0.56 mg/m^2

those obtained by carpet dust sampling. This finding is understandable given that Que Hee et. al. (1991) report that the microvac carpet sampling technique used in this study was developed to quantify available lead near the carpet top surface.

3.1.4 Correlations Between Blood Lead and Environmental Lead

Correlations between environmental lead and blood lead can be computed to assess the relationships between blood lead and potential determining factors. The presence of significant correlations between parameters does not necessarily indicate causation. For example, soil lead and blood lead levels in Trail have previously been shown to be correlated (Hertzman et. al., 1991). But blood lead and soil lead may be correlated due to some other factor that affects both, such as the geographical distribution of lead in dustfall.

Correlations between parameters may be interpreted as indicators of the *possibility* that one measure affects the other. For example, if floor dust lead is correlated with blood lead, it is possible that reducing floor lead will ultimately result in a reduction in blood lead. Correlations can also be indicative of the quality of data collected – if correlations expected on the basis of previous research are found in the data, then the data are reliable.

Microvac Carpet Samples and Blood Lead

Correlations between microvac floor dust parameters and blood lead are quite strong in both the control and treatment groups. (See Table 8.)

Table 8 – Correlation (r) Between Initial Blood Lead and Initial Floor Dust

Blood Lead and:	Treatment Group		Control Group	
	Sampled by:	r	Sampled by:	r
Floor Dust Lead Concentration	All	0.15	All	0.32*
Floor Dust Total Dust Loading	All	0.43*	All	0.35*
Floor Dust Lead Loading	All	0.50*	All	0.50*
	Tech. 2 pre-vac	0.52*	Tech 1	0.20
	Tech. 5 pre-vac	0.54*	Tech 2	0.65*
			Tech 4	0.69*

* Statistically significant correlation ($p<0.05$)

The strongest correlation is between lead loading and blood lead ($r=0.50$). Results obtained by the two main technicians produced similar correlations in both groups. Technician 1 sampled only homes of children with elevated blood lead, which might explain the lower correlation. The correlation between lead concentration and blood lead was weaker in both groups. Thornton, et. al. (1990) reported similar blood lead correlates for 97 children two years of age in Birmingham, England. They found a correlation with lead loading on floors of 0.46, while the correlation with floor dust lead concentration was only 0.21. Rabinowitz et. al. (1985) found that blood lead for 249 children in Boston aged 1 to 24 months was correlated with floor dust lead loading measured

by surface wipes (r=0.48). Bornschein et. al. (1986) found a correlation of 0.53 between both floor dust lead loading and concentration among 18 month olds in Cincinnati.

The stronger relationship between blood lead and floor dust lead loading suggests that, in the homes under study, the *amount* of lead dust present on the surface of the carpet may be a more critical determinant of exposure risk than the *concentration* of lead in the dust.[1] Therefore, HEPA vacuuming (which removes lead dust particles from the house but should not appreciably affect concentration) may be effective in reducing indoor exposure risk.

Hand Lead Samples and Blood Lead

Correlations between hand lead and blood lead were marginally weaker than those reported above for floor dust lead loading and blood lead. In this case, the correlations were stronger in the control group than in the treatment group. (See Table 9.)

Table 9 – Correlation (r) Between Initial Blood Lead and Initial Hand Wipe Lead

Blood Lead and:	Treatment Group		Control Group	
	Sampled by:	r	Sampled by:	r
Hand Wipe Lead Loading	All	0.22	All	0.43*
	Tech. 2	0.48*	Tech 1	0.29
	Tech. 5	0.11	Tech 2	0.62*
			Tech 4	0.39*

* Statistically significant correlation ($p<0.05$)

The amount of lead on a child's hands is highly dependent on his/her activities immediately prior to sampling, whereas floor lead levels are somewhat more stable. Hence, the weaker relationship between hand lead and blood lead, as compared with that between floor lead and blood lead, is understandable.

HEPA Vacuum Bag Samples and Blood Lead

Correlations between vacuum bag dust parameters and blood lead were stronger than those reported above for either microvac carpet samples or hand lead samples. (See Table 10 on page 13.)

The fact that vacuum bag dust, which represents dust from deeper within carpets, correlates better with blood lead than does dust from carpet samples is surprising. As mentioned earlier, the carpet samples collected with personal air monitor pumps are thought to better represent the

[1] As mentioned under "2.3 Quality Assurance Program", the microvac floor lead concentration data are not reliable due to weighing problems. However, the HEPA vacuum bag analyses also showed that blood lead was better correlated with lead loading than with concentration.

Table 10 – Correlation (r) Between Initial Blood Lead and Initial Vacuum Bag Dust

Blood Lead and:	Vacuumed by:	r
HEPA Vacuum Bag Dust Loading	All	0.61*
	Operator 1	0.64*
	Operator 2	0.61*
HEPA Vacuum Bag Lead Loading	All	0.61*
	Operator 1	0.61*
	Operator 2	0.65*

*Statistically significant correlation ($p<0.05$)

dust available to children. In fact, Simpson (1992) found that in a comparison of various house dust sampling methods (including vacuum bags) the personal air monitors performed best in terms of correlation with blood lead. However, von Lindern (1992) has had success relating lead in vacuum bags collected from householders with blood lead in the former lead smelting town of Kellogg, Idaho. A study by the Lewis and Clark County Health Department (1986) involving 396 children in East Helena, Montana reports a weak correlation of 0.24 between blood lead and the concentration of lead in householders' vacuum bags.

The superior performance of vacuum bag samples in predicting blood lead in this study may be due to a combination of four factors:

1) The whole–house sample collected by HEPA vacuuming may be more representative of overall exposure risk than are carpet samples from a few rooms.

2) The HEPA vac measurements of floor lead loadings may be subject to less measurement error than the microvac measurements.

3) The studies referred to above determined only the concentration of lead in vacuum bag dust, not the calculated *loading* on floors.

4) Other studies referred to above used vacuum bags collected from householders, whereas this study used only two operators following the same protocol using identical vacuum cleaners.

Summary of Relationships

Correlations between pre–intervention blood lead and environmental lead are summarized in Table 11 on page 14.

Blood lead is most strongly correlated with the amounts of lead and dust in vacuum bags, then with amounts of dust and lead in microvac carpet samples, then with hand lead and finally with concentration of lead in microvac carpet dust samples.

Table 11 – Summary of Baseline Correlations (r)

	Blood Lead (µg/dL)	Carpet Sample Dust (mg/m2)	Carpet Sample Lead (mg/m2)	Carpet Sample Lead (ppm)	Hand Lead (µg)	Vacuum Bag Dust (mg/m2)	Vacuum Bag Lead (mg/m2)	Vacuum Bag Lead (ppm)
Blood Lead (µg/dL)	1.00	0.40**	0.50**	0.24*	0.33**	0.61**	0.61**	0.27*
Microvac Carpet Dust (mg/m2)		1.00	0.87**	-0.14	0.27*	0.60**	0.58**	0.20
Microvac Carpet Lead (mg/m2)			1.00	0.38**	0.38**	0.61**	0.66**	0.37*
Microvac Carpet Lead (ppm)				1.00	0.25*	0.04	0.17	0.36*
Hand Lead (µg)					1.00	0.47**	0.46**	0.16
HEPA Vac Bag Dust (mg/m2)						1.00	0.92**	0.22
HEPA Vac Bag Lead (mg/m2)							1.00	0.58**
HEPA Vac Bag Lead (ppm)								1.00

* Statistically significant correlation ($p<0.05$)
** Statistically significant correlation ($p<0.001$)

A somewhat surprising result is that dust loadings obtained by either vacuuming or carpet sampling are strongly correlated (r=0.92 for HEPA vac, r=0.87 for microvac) with lead loadings obtained by the same method. In other words, homes with high amounts of dust on their floors also have high amounts of lead on their floors. **This suggests that lead contamination is sufficiently widespread throughout Trail that houses in all neighbourhoods can have high**

amounts of lead indoors. It is possible that this relationship might not hold if the study extended to neighbourhoods outside Trail, where lead concentrations in the environment tend to be lower.

There is a significant but weak negative correlation (r=–0.29,p=0.02) between vacuum bag lead and percent carpeted area. This inverse relationship is counter–intuitive, as one would expect that lead loadings per unit floor area would be higher in homes with more carpet. There is no significant correlation between blood lead and percent carpeted area.

Table 12 shows that the amount of lead on carpets appears to be a stronger determinant of blood lead and hand lead in children under 18 months than in older children. **This suggests that abatement of indoor floor dust may be of greater benefit to younger children.**

Table 12 – Age–Dependency of Correlations

Correlation Between:	Children ≤ 18 months			Children > 18 months		
	r	n	p–value	r	n	p–value
Blood Lead (μg/dL) and Microvac Carpet Lead (mg/m^2)	0.56	25	0.003	0.42	86	<0.001
Hand Lead (μg per pair of hands) and Microvac Carpet Lead (mg/m^2)	0.53	25	0.007	0.29	85	0.007

3.2 Microvac Samples as a Measure of Vacuuming Effect

The immediate effect of the cleaning protocol may be assessed by examining results of the microvac carpet sampling conducted before and after vacuuming. A significant (p=<0.001, paired t–test) reduction of 39% in mean surface lead loading was observed after the first vacuuming (Cycle 1). (See Table 13.) Total dust loading declined by a similar percentage.

Table 13 – Post–Vacuuming Floor Dust Results for Cycle 1 – 55 Treatment Homes

Parameter	Geometric Mean	Minimum	Maximum	Percent Change in Geometric Mean Pre/Post
Total Dust Loading	382 mg/m2	6 mg/m2	8381 mg/m2	–34%
Lead Loading	0.34 mg/m2	N.D.	5.15 mg/m2	–39%
Lead Concentration	879 ppm	N.D.	10299 ppm	–8%

By comparison, Ewers et. al. (1994) found that one HEPA vacuuming of inner–city Cincinnati carpets at 60 s/m^2 (about twice as slowly as in this study) resulted in a mean reduction in surface lead loading of 45%. A demonstration project in 8 homes in Toronto found a reduction in surface

lead loading of 56% after HEPA vacuuming at about 3 min/m^2 (Concord Scientific et. al., 1988). Both the Cincinnati and Toronto studies used the microvac method for sampling surface dust.

Carpet lead concentration showed no significant change ($p=0.41$), likely because the HEPA vacuums remove dust particles through the whole size range, with no preference for smaller, lead-containing particles. A house dust remediation study at a former smelter site in Idaho also found that cleaning carpets using externally exhausted or HEPA filtered vacuums results in decreased lead loading with no consistent effect on lead concentration (CH2M Hill, 1991).

Lead loading was slightly higher after vacuuming in 3 of the 60 homes. This phenomenon, which was also observed by Ewers et. al. (1993), may result from the vacuum cleaner bringing dust to the surface, where it can then be collected by the carpet sampler. This effect has shown up in 5% of the homes in this study, whereas Ewers et. al. found that surface lead loading increased in 14% of carpets after one intensive cleaning.

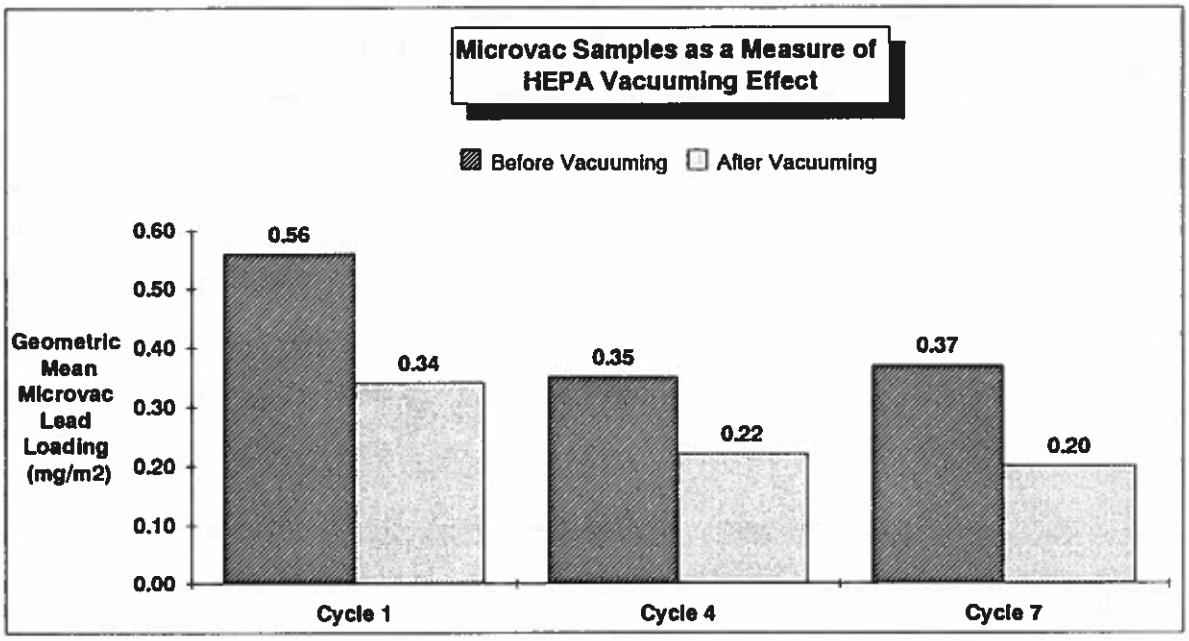
Significant ($p<0.001$, paired t-test) reductions in mean surface lead loading were also achieved in Cycle 4 and Cycle 7 vacuuming. Again, total dust loading declined by a similar percentage and concentration was unchanged. (See Table 14.)

Table 14 - Post-Vacuuming Floor Dust Results for Cycles 4&7 - 52 Treatment Homes

Parameter	Geometric Mean	Minimum	Maximum	Percent Change in Geometric Mean Pre/Post
Cycle 4				
Total Dust Loading	295 mg/m2	N.S.S.	1755 mg/m2	-34%
Lead Loading	0.22 mg/m2	N.D.	2.32 mg/m2	-35%
Lead Concentration	755 ppm	N.D.	6842 ppm	-3%
Cycle 7				
Total Dust Loading	339 mg/m2	N.S.S.	3902 mg/m2	-46%
Lead Loading	0.37 mg/m2	N.D.	3.84mg/m2	-47%
Lead Concentration	999 ppm	N.D.	5000 ppm	0%

Figure 1 on page 17 shows the effect of vacuuming on surface lead loading in graphical form.

Figure 1 – Microvac Samples as a Measure of Vacuuming Effect



3.3 Vacuum Bag Results

3.3.1 Comparison Between Cycles

Table 15 on page 18 shows the timing of vacuuming cycles and the number of homes vacuumed in each cycle.

During Cycle 2, one home was not vacuumed due to scheduling difficulties. The vacuuming protocol was changed at the start of Cycle 2 to allow more thorough vacuuming within the time allotted. In Cycle 2 and in all subsequent cycles, the operators made three passes over each area, rather than two passes.

Two homes were inadvertently missed during Cycle 4 due to a scheduling oversight. In Cycle 6, two homes were accidentally vacuumed using the same bag, thereby losing two samples. Three homes could not be scheduled for vacuuming during Cycle 7 and the sample bags for two homes were lost after shipment to the lab.

Table 16 on page 18 shows the average amounts of dust and lead removed by vacuuming in each cycle, as well as paired t-test p-values for differences in means.

The decrease in amount of lead removed from Cycle 1 to Cycle 2 indicates that the homes generally did not recontaminate to Cycle 1 levels. There were, however, 8 homes at which the amount of lead recovered increased from Cycle 1 to Cycle 2. Five of these 8 homes had lead levels well below average initially, so the increase in Cycle 2 could be due to regression to the

Table 15 – Timing of Vacuuming Cycles and No. of Homes Vacuumed per Operator

Cycle	No. Homes by Operator 1	No. Homes by Operator 2	No. Homes by Other	Start Date	End Date
1	30	20	5	Nov. 17/92	Dec. 9/92
2	28	23	3	Jan. 4/93	Feb. 9/93
3	27	28	0	Feb. 15/93	Mar. 16/93
4	26	25	2	Mar. 29/93	Apr. 27/93
5	27	26	2	May 10/93	Jun. 8/93
6	28	25	0	Jun. 21/93	Jul. 23/93
7	27	23	0	Aug. 3/93	Aug. 31/93

Table 16 – HEPA Vacuum Bag Results – Both operators included throughout

Cycle	Total Dust Removed		Lead Removed	
	Geometric Mean	p-value for difference in means	Geometric Mean	p-value for difference in means
1	1573 mg/m^2		1.16 mg/m^2	
2	1245 mg/m^2	<0.001*	0.68 mg/m^2	<0.001*
3	1158 mg/m^2	0.22	0.66 mg/m^2	0.78
4	1126 mg/m^2	0.67	0.75 mg/m^2	0.31
5	901 mg/m^2	0.009*	0.60 mg/m^2	0.04*
6	628 mg/m^2	<0.001*	0.35 mg/m^2	<0.001*
7	475 mg/m^2	0.02*	0.31 mg/m^2	0.24

* statistically significant change between cycles

mean.

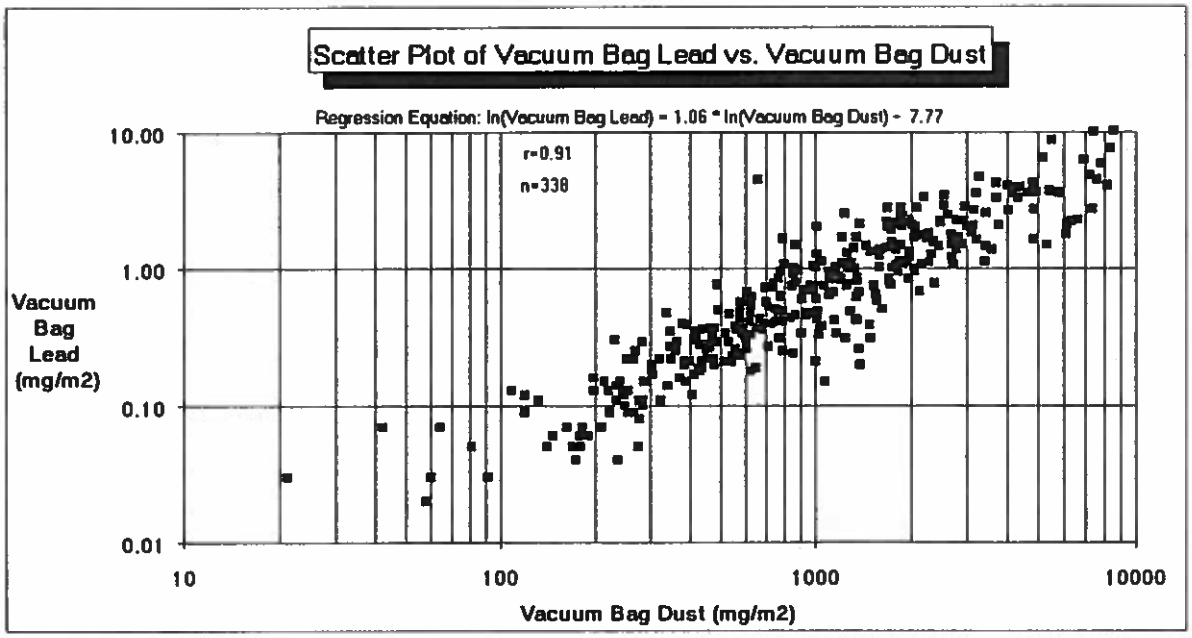
The average amounts of dust and lead removed remained the same from Cycle 2 to Cycle 3 and Cycle 3 to Cycle 4. This suggests that homes generally recontaminated to previous levels between visits during this period. From Cycle 4 to Cycle 5 and Cycle 5 to 6, further reductions in dust and lead removed were sustained.

Table 17 and Figure 2 on page 19 show that although there was a general reduction in lead removed from homes, the amount of dust removed continued to be a strong predictor of lead removed.

Table 17 – Correlation (r) between Vacuum Bag Lead Loading and Dust Loading

Cycle	Correlation Coefficient (r)	p-value for r
1	0.92	<0.001
2	0.90	<0.001
3	0.89	<0.001
4	0.88	<0.001
5	0.92	<0.001
6	0.89	<0.001
7	0.90	<0.001

Figure 2 – Vacuum Bag Dust as a Predictor of Vacuum Bag Lead



3.3.2 Comparison Between Vacuum Operators

Table 18 on page 20 and Figure 3 on page 21 show that there is no significant difference in mean vacuum bag dust loading obtained by the two operators until Cycle 7. This suggests that the cleaning protocol was applied consistently throughout most of the project.

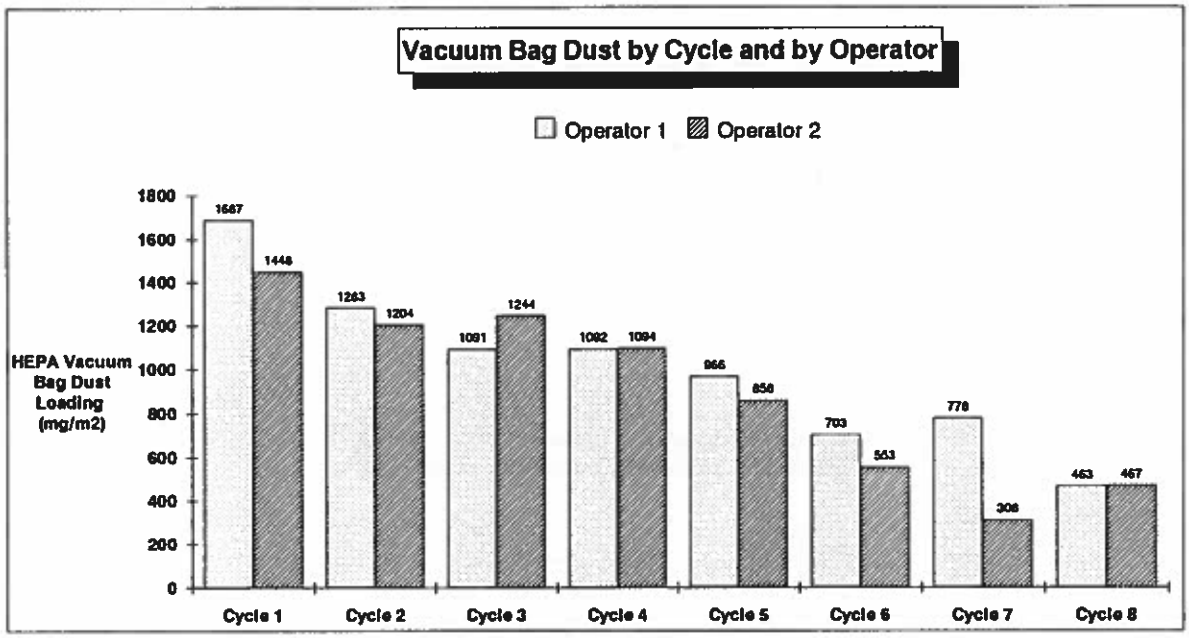
Table 18 – Comparison between Vacuum Operators

Cycle	Operator	Geometric Mean Dust (mg/m^2)	Geometric Standard Deviation	Number of homes vacuumed	p-value for difference in means
1	1	1687	2.57	30	0.58
	2	1448	2.73	20	
2	1	1283	2.29	28	0.79
	2	1204	2.30	23	
3	1	1091	2.33	27	0.56
	2	1244	2.30	28	
4	1	1092	2.53	26	1.00
	2	1094	2.73	25	
5	1	966	2.29	27	0.64
	2	858	2.79	26	
6	1	703	2.28	28	0.33
	2	553	2.64	25	
7	1	778	2.68	24	0.005
	2	308	3.47	27	
8	1	463	2.10	41	0.97
	2	467	3.64	29	

The significant discrepancy between operators that appeared in Cycle 7 is consistent with feedback received from participant families. A number of participants contacted our office with concerns that operator 2 had not followed the vacuuming protocol on the last few visits to their homes (Cycles 6 & 7). Random surveys of participants turned up several more people who felt that operator 2 had spent less time and missed some area on later visits. People whose homes were vacuumed by the other operator felt that they had received very thorough and consistent vacuuming on all visits. The difference between operators is no longer apparent on Cycle 8. (Cycle 8 was additional vacuuming conducted in October after the blood lead clinic).

The result of not vacuuming according to the protocol is to exaggerate the apparent effect of the treatment. That is, in instances where the vacuuming is not thorough, the amount of lead and dust recovered is lower, creating the impression that the floor loadings were lower due to previous cleanings.

Figure 3 – Comparison between Vacuum Operators



If homes vacuumed by operator 2 during Cycle 6 or 7 are excluded from the analysis, the results in Table 19 are obtained.

Table 19 – Vacuum Bag Results – Excluding Homes by Operator 2 on Cycles 6/ 7

Cycle	Total Dust Removed		Lead Removed	
	Geometric Mean	p-value for difference in means	Geometric Mean	p-value for difference in means
1	1400 mg/m^2		1.03 mg/m^2	
		0.25		0.007
2	1237 mg/m^2		0.74 mg/m^2	
		0.04		0.28
3	1010 mg/m^2		0.63 mg/m^2	
		0.76		0.63
4	987 mg/m^2		0.71 mg/m^2	
		0.81		0.78
5	1029 mg/m^2		0.75 mg/m^2	
		0.001		0.008
6	662 mg/m^2		0.47 mg/m^2	
		0.27		0.16
7	750 mg/m^2		0.59 mg/m^2	

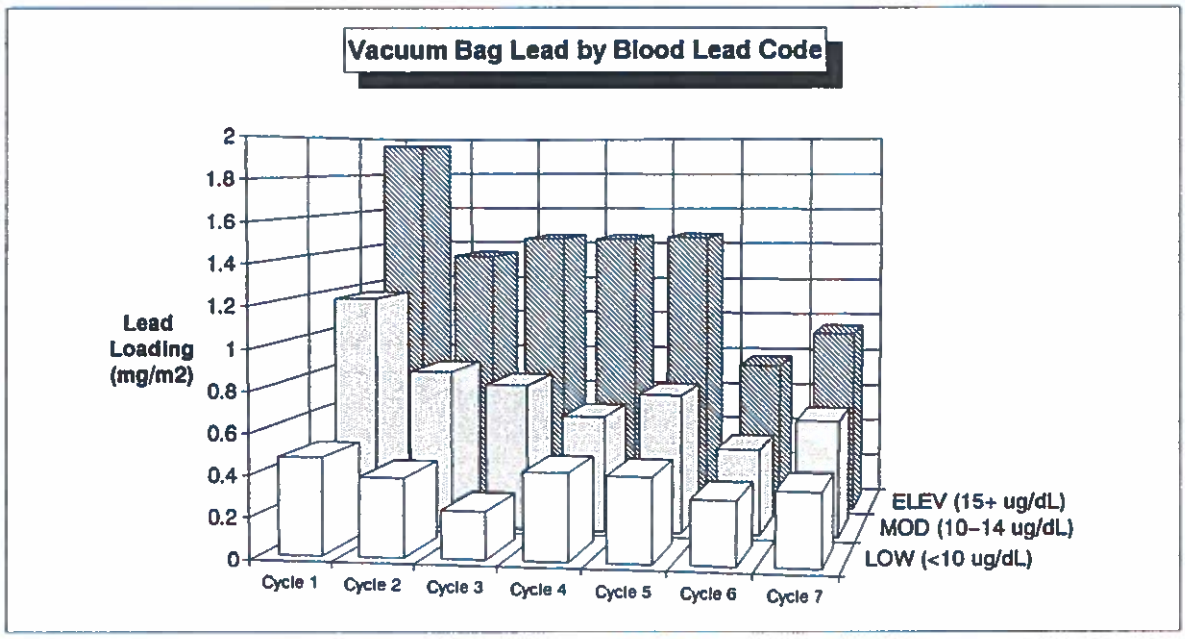
The data in this table are a more realistic representation of the trend in vacuum bag dust and lead over the course of the project. The trend is similar to that discussed above. A substantial decline

in lead removed by vacuuming occurred after the first vacuuming, then the amounts removed remained fairly constant through to Cycle 5 (May/June), followed by a further decline in Cycles 6/7.

3.3.3. Comparison Between Pre-Intervention Blood Lead Ranges

Initial blood lead for subject children in the treatment group was re-coded according to the following scheme: LOW: <10 µg/dL, MOD: 10-14 µg/dL, ELEV: ≥ 15 µg/dL. Figure 4 on page 22 and Table 20 on page 23 emphasize the association between initial blood lead and vacuum bag dust or lead throughout the study.

Figure 4 – Vacuum Bag Lead by Initial Blood Lead Range



Even with the small number of children in each group, there is a significant difference between mean vacuum bag results by initial blood lead range in most of the cycles. In other words, children who had elevated blood leads at the start of the study continued to have higher amounts lead removed from their floors throughout the project. By the end of the study, the amount of lead and dust removed from floors in the ELEVATED blood lead group was slightly less than that for the MODERATE group at the start of the study. Those children whose initial blood lead was LOW did not show any trend toward decreasing removal of floor lead during the study. This data suggests that the HEPA vacuuming treatment might have a greater effect on the indoor lead exposure of children with higher blood leads.

Table 20 – HEPA Vacuum Bag Results by Initial Blood Lead Range

(Excluding Homes Vacuumed by Operator 2 on Cycle 6 or 7)

(LOW: <10 μg/dL, MOD: 10–14 μg/dL, ELEV: ≥ 15 μg/dL)

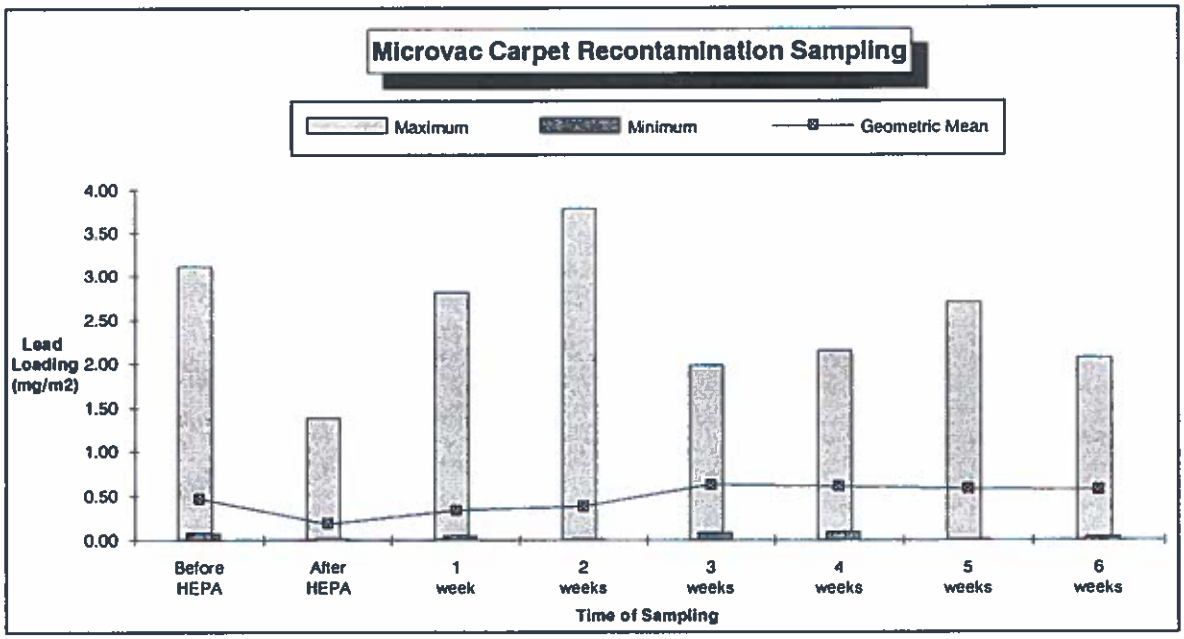
Cycle	Initial Blood Code	No. of Homes	Vacuum Bag Lead Loading	
			Geometric Mean	p-value for difference between groups
1	LOW	7	0.47 mg/m²	0.04
	MOD	7	1.17 mg/m²	
	ELEV	7	1.96 mg/m²	
2	LOW	7	0.38 mg/m²	0.06
	MOD	7	0.80 mg/m²	
	ELEV	7	1.35 mg/m²	
3	LOW	7	0.23 mg/m²	0.02
	MOD	7	0.74 mg/m²	
	ELEV	7	1.45 mg/m²	
4	LOW	7	0.42 mg/m²	0.17
	MOD	6	0.58 mg/m²	
	ELEV	7	1.45 mg/m²	
5	LOW	7	0.41 mg/m²	0.04
	MOD	7	0.70 mg/m²	
	ELEV	7	1.46 mg/m²	
6	LOW	7	0.31 mg/m²	0.31
	MOD	7	0.43 mg/m²	
	ELEV	7	0.77 mg/m²	
7	LOW	7	0.36 mg/m²	0.16
	MOD	7	0.58 mg/m²	
	ELEV	7	0.95 mg/m²	

3.4 Recontamination Between Cleanings

To determine whether carpets were recontaminating in less than the six weeks between vacuumings, 18 homes were sampled weekly following their final vacuuming in August. In these homes, microvac carpet samples were collected from roughly the same locations once every 7 days for 6 weeks. During these 6 weeks, the householders vacuumed at their regular frequencies.

Figure 5 shows that, on average, the surface lead loadings declined by about 50% from immediately before to immediately after vacuuming.

Figure 5 – Recontamination Sampling at 18 Homes – Aug/Sept '93



The graph also shows that the homes had, on average, recontaminated within 2.5 to 3 weeks. It appears that once the carpets recontaminated, they reached a steady state which might indicate a balance between removal by householder cleaning and additions from contamination sources.

These results should be generalisable to the rest of the study group, as the mean lead loadings in this sub-group were about equal to the mean loadings in the entire group. Also, the range of loadings found for the sub-group is similar to that for the entire group. However, these results represent an estimate of the rate of recontamination during August/September, which was one of the hottest and driest periods of the summer. There may have been increased traffic into and out of houses and windows may have been left open more during this time.

It is interesting that the average rate of indoor carpet recontamination (about 12 $\mu g/m^2$/day) is very small compared with the typical rate of outdoor lead deposition in Trail (about 1500 $\mu g/m^2$/day).

3.5 Survey Results

At the completion of the project, participants were asked to complete a nineteen part multiple choice survey. The objective of the survey was to determine whether certain household practices or circumstances were related to environmental or blood lead measurements throughout the study. For example, an effort was made to determine why some households had lower floor dust lead at baseline and why some carpets responded better than others to HEPA vacuuming. (The survey form and compilation of results are in Appendix A.) The survey was completed by 103 of the 111 study participants (52 control and 51 treatment families). A summary of survey responses and associations between survey variables and measurement variables follows.

3.5.1 Access to Vacuum Cleaners

Vacuum cleaner use by participants in the study was very high. All participants reported that they own or have regular use of a vacuum cleaner. 90% of those who responded said that their vacuum cleaner has a power nozzle with revolving brush.

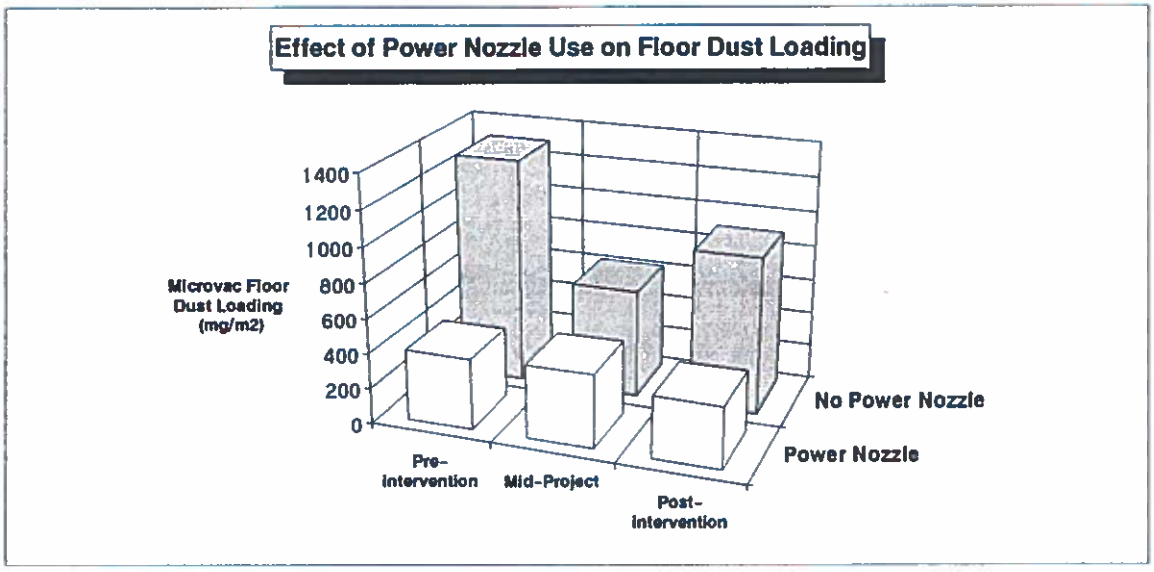
The use of a domestic vacuum cleaner with a power nozzle was associated with consistently lower carpet lead and dust loadings. (See Table 21 on page 25 and Figure 6 on page 26.)

Table 21 – Effect of Power Nozzle use on Microvac Carpet Sample Results

Measurement Parameter	**Survey Variable** Power Nozzle on Domestic Vacuum		
	Yes (n=93)	**No (n=10)**	**p-value**
Microvac Floor Lead Geometric mean (mg/m^2)			
Pre-intervention	0.36	0.71	0.14
Mid-project	0.30	0.40	0.48
Post-intervention	0.27	0.55	0.06
Microvac Floor Dust Geometric mean (mg/m^2)			
Pre-intervention	399	1299	0.005
Mid-project	413	621	0.18
Post-intervention	346	899	0.03
Microvac Floor Dust Mean change, pre to post intervention (mg/m^2)	-73	-1529	0.002

Also, the homes that did not have a power nozzle attachment saw a much bigger decline in carpet dust loading during the project than did those with power nozzles. This was seen in both the treatment and control groups and may be partly due to regression to the mean.

Figure 6 – Effect of Power Nozzle Use on Floor Dust Loading



3.5.2 Vacuuming, Mopping and Steam Cleaning Frequencies

Participants in the study also indicated that they use their vacuum cleaners quite frequently. 91% of those who responded say they vacuum once per week or more frequently. There was very little difference between reported vacuuming frequencies before the study and during the study. Participants in the control group vacuumed slightly more frequently than those in the treatment group, both before and during the study. There were no significant differences in vacuuming frequency by neighbourhood.

One would expect that frequent vacuuming might be associated with lower floor dust and lead loadings, both initially and throughout the course of the study. However, Table 22 on page 27 shows that there was no significant effect of vacuuming frequency on floor dust lead loadings as measured by either the microvac or HEPA vac methods. There appears to be some trend toward higher loadings in those homes that are vacuumed every 2 weeks or less, but the number of homes which are vacuumed that infrequently is very small. The table also shows that **homes which are vacuumed less frequently showed greater reductions in lead loading over the course of the project. This tendency is only apparent in the treatment group, which suggests that the HEPA vacuuming is more effective in homes that are vacuumed less frequently.**

Table 22 also shows that the immediate reduction in carpet surface lead loading after each HEPA vacuuming was closely related to the householders' frequency of vacuuming. These data again

Table 22 – Effect of Householders' Vacuuming Frequency on Floor Lead Levels

Measurement Parameter	Survey Variable: Householders' Vacuuming Frequency						
	Every day	Every 2 days	Twice weekly	Once weekly	Every 2 weeks	< Every 2 weeks	p
Microvac Floor Lead Geometric mean (mg/m²)							
Pre-interv – Cycle 1	0.51	0.36	0.32	0.41	0.86	0.89	0.55
Mid-project – Cycle 4	0.20	0.33	0.28	0.29	0.54	0.63	0.72
Post-interv – Cycle 7	0.15	0.30	0.29	0.25	0.35	0.56	0.79
HEPA Vac Floor Lead Geometric mean (mg/m²)							
Pre-interv – Cycle 1	1.30	0.90	0.97	1.12	5.26	2.45	0.24
Mid-Project – Cycle 4	1.05	0.59	0.65	0.67	2.00	1.21	0.68
Post-interv – Cycle 7	0.34	0.15	0.39	0.24	1.78	0.76	0.04
Microvac Floor Lead Mean change, pre to post intervention (mg/m²)							
Treatment group	–1.87	–0.09	–0.33	–0.43	–2.12	–2.68	0.01
Control group	n/a	–0.17	+0.05	–0.04	–0.16	n/a	0.90
Microvac Floor Lead Mean change, before to after vacuuming (mg/m²)							
Cycle 1	–0.09	–0.21	–0.37	–0.37	–1.39	–1.79	0.03
Cycle 4	–0.40	–0.17	–0.11	–0.21	–0.82	–1.82	0.01
Cycle 7	–0.10	–0.19	–0.41	–0.04	–0.69	–0.95	0.10

suggest that HEPA vacuuming was more effective in homes that are vacuumed less frequently.

Figure 7 and Figure 8 on page 28 show the effects of householders' vacuuming frequency in graphical form.

There was no effect of vacuuming frequency on floor dust lead concentration as measured by either the microvac or HEPA vac (i.e., no evidence that frequent vacuuming with conventional household vacuums increases the concentration of lead in house dust).

Figure 7 – Effect of Householders' Vacuuming Frequency on HEPA Vac Effectiveness

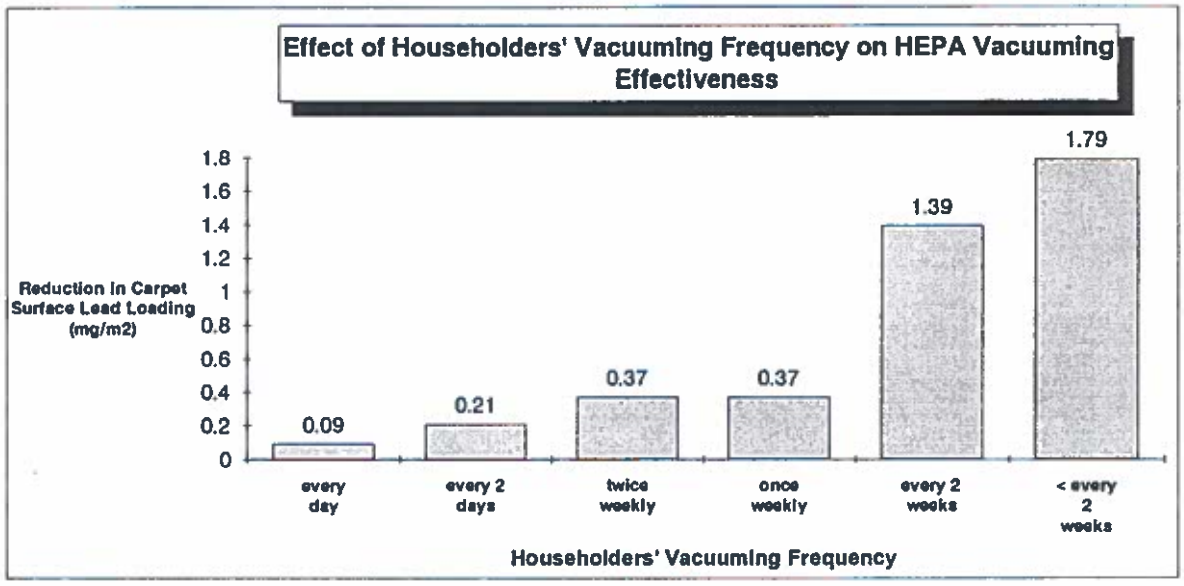
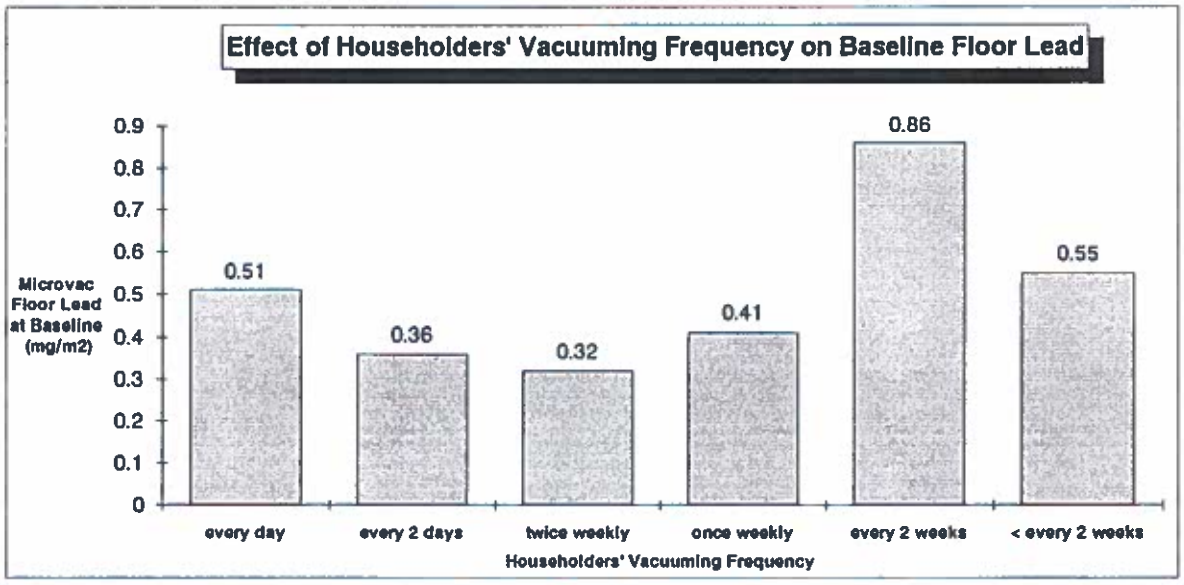


Figure 8 – Effect of Householders' Vacuuming Frequency on Baseline Floor Lead



The indicated frequency of wet mopping was also quite high, with 82% of those who responded mopping once per week or more often. Mopping frequency was about the same in both groups. There was no statistical evidence that mopping frequency affects any of the dust or blood lead levels.

44% of control group and 33% of treatment group families who responded said they had their carpets steam cleaned or shampooed during the study. Measurements of floor dust lead, hand lead and blood lead all suggested a very modest but statistically insignificant benefit from wet carpet cleaning.

3.5.3 Carpet Age

Responses to this question were fairly evenly distributed among the categories. 53% of respondents said their carpets were 6 years old or more and 18% said they did not know how old their carpets were. It appears that carpets in the treatment group homes tended to be slightly older.

Table 23 shows that carpet age did not have a strong effect on floor lead loadings as measured by either the microvac or HEPA vac.

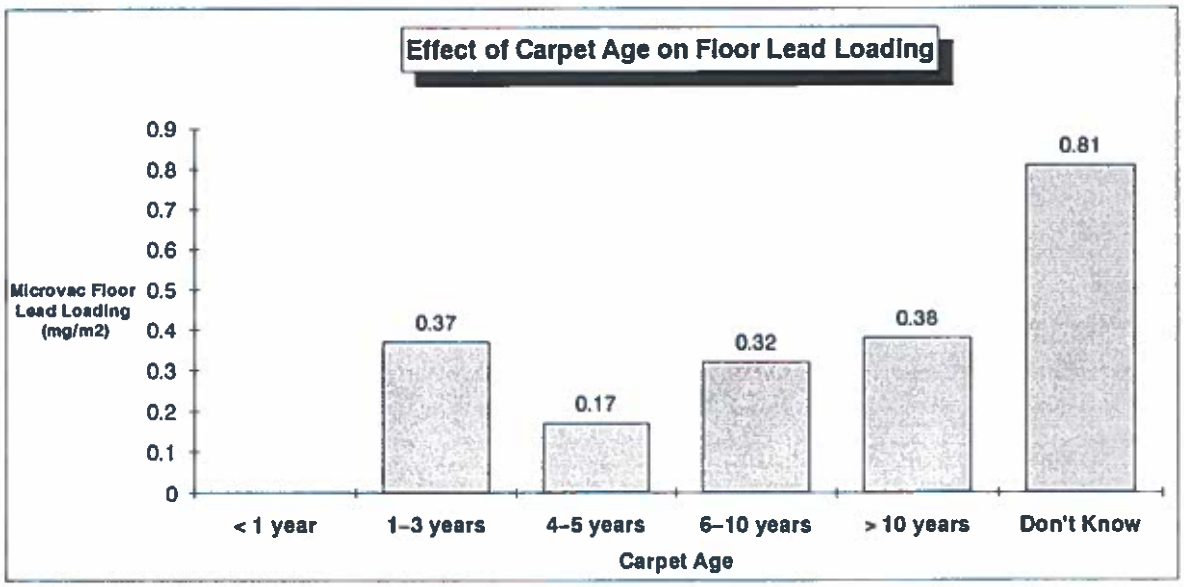
Table 23 – Effect of Carpet Age on Floor Lead Levels

Measurement Parameter	Survey Variable: Average Carpet Age						
	< 1 year	1–3 years	4–5 years	6–10 years	> 10 years	Don't know	p
Microvac Floor Lead Geometric mean (mg/m²)							
Pre–interv – Cycle 1	none	0.37	0.17	0.32	0.38	0.81	0.06
Mid–project – Cycle 4	none	0.26	0.20	0.23	0.30	0.65	0.04
Post–interv – Cycle 7	none	0.25	0.14	0.14	0.29	0.70	0.05
HEPA Vac Floor Lead Geometric mean (mg/m²)							
Pre–interv – Cycle 1	none	0.49	0.65	1.36	1.01	1.90	0.12
Mid–Project – Cycle 4	none	0.25	0.57	1.06	0.45	1.66	0.01
Post–interv – Cycle 7	none	0.13	0.11	0.54	0.23	0.48	0.03

none = no carpets in age category

The only significant effect is that those who did not know how old their carpets were had higher amounts of lead on their floors throughout the study. If one assumes that the carpets of unknown age are likely to be quite old, then it appears that carpet age could have a significant impact on lead loading. (See also Figure 9 on page 30.)

Figure 9 – Effect of Carpet Age on Floor Lead Loading



3.5.4 Dog or Cat Indoors

Participants were fairly evenly divided by this question. 52% indicated that they have a dog or cat that comes indoors. The two groups responded very similarly on this question. The percentage of participants reporting dogs/cats did not vary significantly by neighbourhood.

Table 24 on page 31 shows that **children who had a dog or cat tended to have higher floor and blood lead levels.** These effects could be due to tracking of dust into the homes by the pets, as well as to handling of pets by children.

3.5.5 Number of People Living in House

On average, there were about 4 people living in each participating household during the study. There was no difference between groups.The only effect of number of people per household on the measured parameters was that in the 3 homes with more than 6 people, microvac floor lead and hand lead were significantly higher in some cycles.

3.5.6 Shoes off at Door

The rate of compliance with the Lead Program's advice to remove shoes at the door is reasonably high. 65% of those who responded said that *everyone* in their household removes shoes at the door. The control group had a few more fully compliant families than did the treatment group. There was no significant difference between neighbourhoods.

Table 24 – Effect of Dog/Cat on Floor Lead and Blood Lead

Measurement Parameter	Survey Variable: Dog or Cat in House		
	Yes	No	p-value
Microvac Floor Lead Geometric mean (mg/m^2)			
Pre-intervention	0.42	0.36	0.52
Mid-project	0.39	0.23	0.03
Post-intervention	0.37	0.22	0.02
HEPA Vac Floor Lead Geometric mean (mg/m^2)			
Pre-intervention	1.50	0.85	0.08
Mid-project	1.12	0.44	0.005
Post-intervention	0.36	0.27	0.42
Blood Lead Geometric mean ($\mu g/dL$)			
Pre-intervention	12.6	10.3	0.007
Post-intervention	11.5	10.0	0.04

Table 25 on page 32 shows that **families in the treatment group who removed their shoes at the door tended to have lower floor lead and blood lead levels throughout the study.** Hand lead in the treatment group appeared to be affected in the same direction (not shown in table), but not significantly. These effects are not at all evident in the control group. Roberts et. al. (1991) sampled house dust in 37 Seattle homes and 5 Port Townsend homes and also found that homes which practised removal of shoes at the door and used walk-off mats tended to have lower amounts of floor dust lead. Figure 10 on page 33 shows the effects of removing shoes at the door in graphical form.

3.5.7 Heating Systems

85% of those who responded live in homes with forced air heating. There was no difference between the groups.

74% of respondents with forced air heating change their air filters at least once per year. There was no difference between groups.

A high percentage of participants were not aware of whether their air filters were the regular, pleated high efficiency or electrostatic type. Only 6% of respondents with forced air heating had

Table 25 – Effect of Removing Shoes at Door on Floor Lead, Hand Lead and Blood Lead

Measurement Parameter	Survey Variable: Shoes at Door		
	Yes	No	p-value
Microvac Floor Lead Geometric mean (mg/m²)			
Pre-intervention – Treat	0.43	0.87	0.07
– Ctrl	0.26	0.26	0.97
Mid-project – Treat	0.26	0.58	0.04
– Ctrl	0.27	0.25	0.80
Post-intervention – Treat	0.24	0.69	0.0002
– Ctrl	0.22	0.24	0.83
HEPA Vac Floor Lead Geometric mean (mg/m²)			
Pre-intervention	0.83	1.82	0.02
Mid-project	0.48	1.33	0.003
Post-intervention	0.22	0.58	0.009
Blood Lead Geometric mean (μg/dL)			
Pre-intervention – Treat	10.4	14.0	0.004
– Ctrl	10.9	11.6	0.61
Post-intervention – Treat	9.9	12.5	0.02
– Ctrl	10.7	10.6	0.94

electrostatic filters.

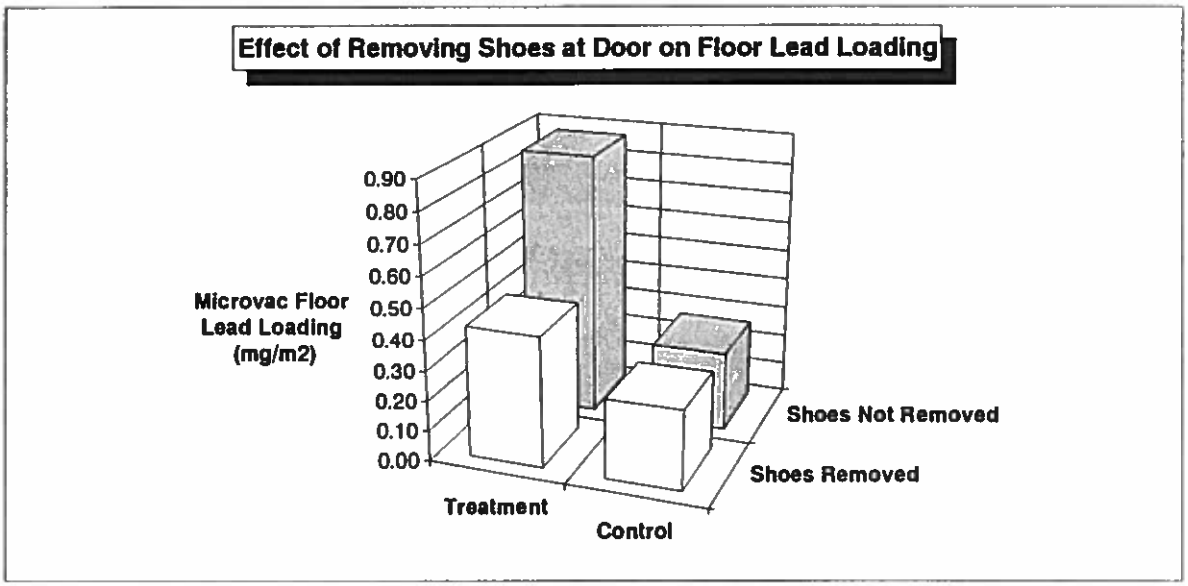
A very high percentage (61%) of respondents with forced air heating did not know when their ducts were last cleaned. Only 12% had been cleaned in the past year. There was no difference between groups here.

None of the questions pertaining to heating systems had any effect on lead in dust or blood.

3.5.8 Renovations

44% of those who responded had done renovations on their homes during the HEPA project

Figure 10 – Effect of Removing Shoes at Door on Baseline Floor Lead



(53% of the control group and 35% of the treatment group).

Of those who made renovations, 59% involved sanding painted surfaces, 46% involved removal of walls or ceilings and 46% involved installation of new flooring.

Quite surprisingly, the only type of renovation activity which had an effect on any of the measured parameters was removal of walls or ceilings. People who removed walls or ceilings during the study had higher microvac floor lead levels at the end of the study (p=0.02).

3.6 Changes in Blood Lead

The primary measure for determining the effect of HEPA vacuuming was defined to be change in blood lead from before the project to after the project. The project steering committee decided during the design phase that if the treatment group mean blood lead declined by 1.5 μg/dL more than the control, the effect would be clinically significant.

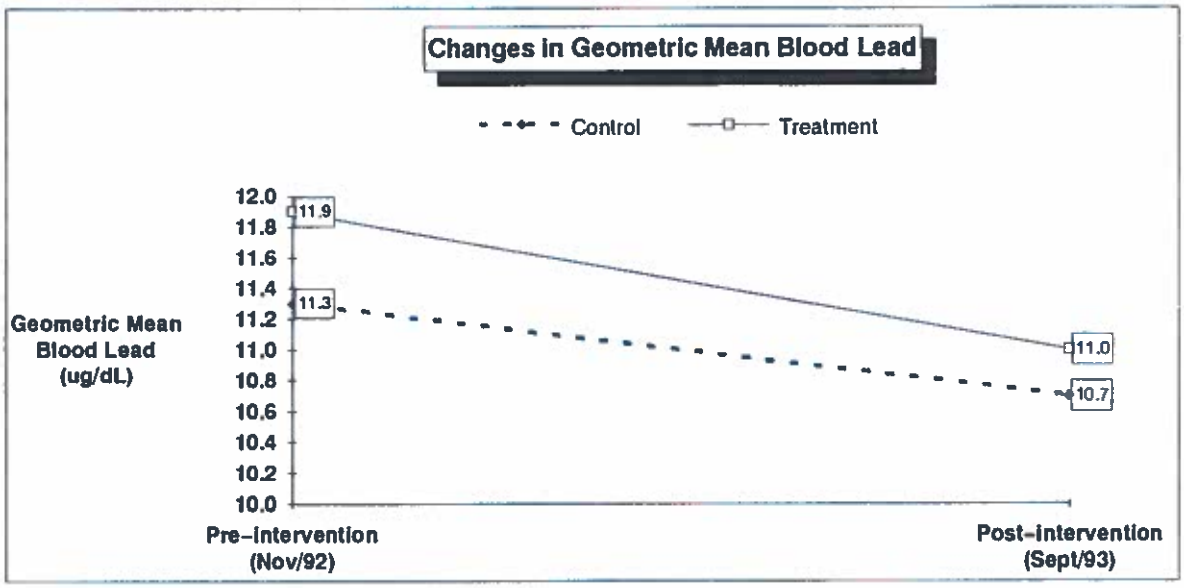
Table 26 and Figure 11 on page 34 show the changes in mean blood lead for both the treatment and control groups. The change was not statistically significant in either group. The decline in geometric mean blood lead is only 0.3 μg/dL greater in treatment than in control.

As discussed in the introduction, children were randomly assigned to treatment or control in blocks of 6, with blocks being matched on initial blood lead and geographic area. Therefore, it was decided to perform an analysis for treatment effect respecting the matching, i.e. using randomization block as a blocking factor. Since change in blood lead might well be influenced by initial blood lead level or geographic area, controlling for these factors could improve the ability to detect a difference between treatment and control.

Table 26 – Trend in Geometric Mean Blood Leads

Parameter	Control	Treatment
Pre-Intervention geometric mean (Nov '92)	11.3 μg/dL	11.9 μg/dL
Post-Intervention geometric mean (Sept '93)	10.7 μg/dL	11.0 μg/dL
p-value for difference	0.23	0.06

Figure 11 – Changes in Blood Lead



A regression model was fit with change in blood lead as dependent variable and indicator variables for randomization blocks and treatment group as independent variables. **The analysis showed that even after controlling for initial blood lead and geographic area, the difference in blood lead change between treatment and control homes was very small and not statistically significant** (p=0.85).

Analyses were also conducted to determine if there might be a significant difference between treatment and control if particular subsets of the data were used. No significant effect was found in analyses confined to: younger children; older children; children with elevated blood lead initially; children with low blood lead initially; children who lived in homes where shoes are not removed at the door; children with cats or dogs; children whose homes were vacuumed less frequently by parents, or children whose parents did not have a power nozzle attachment for their vacuum cleaner. (See Table 27 on page 35.)

Table 27 – Results of Subset Analyses for Changes in Blood Lead

Subset (Children with:)	Treatment Group		Control Group		
	Change in Geometric Mean Blood Lead (μg/dL)	n	Change in Geometric Mean Blood Lead (μg/dL)	n	p–value for difference between groups*
Age at start < 18 months	+2.6	14	+1.9	10	0.80
Age at start > 36 months	–1.8	21	–1.1	22	0.29
Initial Blood Lead ≥ 15 μg/dL	–3.4	15	–3.3	15	0.73
Initial Blood Lead < 10 μg/dL	+0.6	19	+1.5	18	0.43
Cat or dog in house	–0.9	28	–1.2	26	0.67
Shoes not removed at door of home	–1.5	19	–1.0	16	0.89
Homes vacuumed once per week, or less frequently	–1.5	21	–1.4	13	1.00
No power nozzle on home vacuum	–0.7	5	+0.5	5	0.60**

* after controlling for initial blood lead and geographic area
** n too small to control for confounders – unadjusted comparison only

Regressions were also performed to test for other predictors of change in blood lead. Change in blood lead was not found to be correlated with any of: sex, change in microvac lead loading, change in hand lead loading or change in vacuum bag lead loading.

3.7 Changes in Exposure Levels

3.7.1 Hand Lead Loadings

Table 28 on page 36 shows that the geometric mean hand lead in the control group decreased significantly (–4 μg) during the project, while the treatment group mean increased significantly (+4 μg). (See also Figure 12 on page 37.) A t–test for difference in mean change in hand lead between groups showed that the control group decline was significantly different from the treatment group increase (p=0.01).

This difference between groups is difficult to explain. The fact that children in the treatment group showed an increase in amount of lead on their hands suggests that HEPA vacuuming actually increased their exposure, in which case changes in hand lead should be correlated with changes in floor lead loading.

Table 28 – Trend in Geometric Mean Dust Sample Results

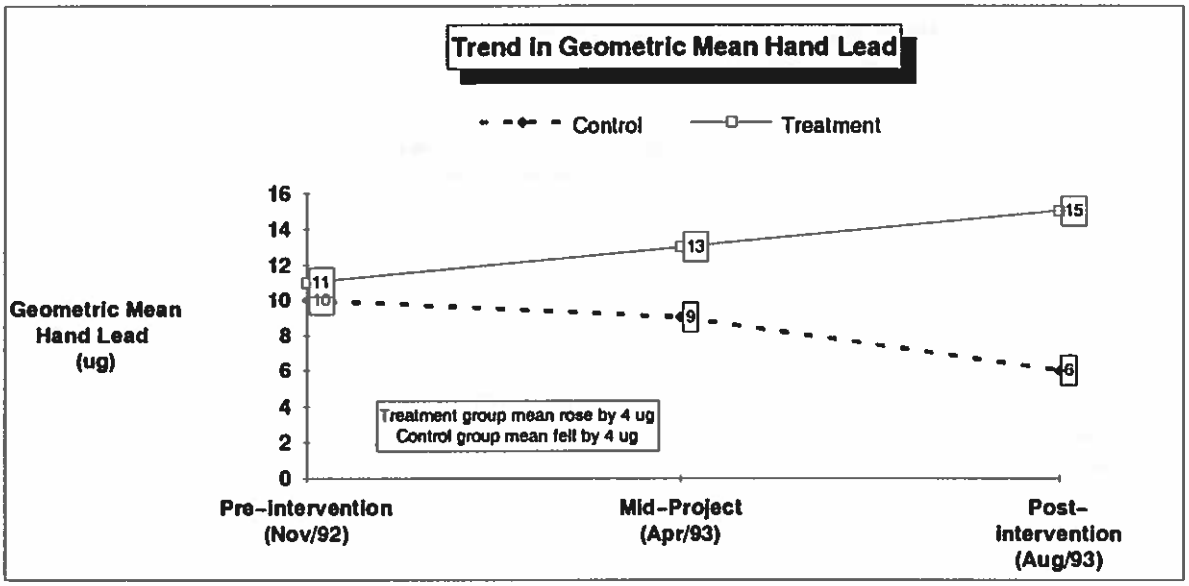
Parameter		Control	Treatment
Hand Wipe Lead Loading			
Pre-Intervention	(Nov '92)	10 μg	11 μg
Mid-Project	(Apr '93)	9 μg	13 μg
Post-Intervention	(Aug '93)	6 μg	15 μg
p-value for difference	(Nov – Aug)	0.005	0.08
Carpet Dust Loading			
Pre-Intervention	(Nov '92)	363 mg/m^2	569 mg/m^2
Mid-Project	(Apr '93)	477 mg/m^2	416 mg/m^2
Post-Intervention	(Aug '93)	443 mg/m^2	325 mg/m^2
p-value for difference	(Nov – Aug)	0.25	0.01
Carpet Lead Loading			
Pre-Intervention	(Nov '92)	0.27 mg/m^2	0.56 mg/m^2
Mid-Project	(Apr '93)	0.27 mg/m^2	0.37 mg/m^2
Post-Intervention	(Aug '93)	0.23 mg/m^2	0.36 mg/m^2
p-value for difference	(Nov – Aug)	0.21	0.01

The sampling technicians kept notes on the children's activities prior to having their hands wiped, which allowed the children to be divided into two groups: those who were primarily outdoors prior to the final hand wipe and those who were primarily indoors. When children are playing indoors, their hands come into contact with a finite amount of dust on interior surfaces. Outdoors, children can contact virtually infinite reservoirs of soil and dust, some of which may be damp and adhere to hands better than dry interior dust. Also, the sort of activities engaged in outdoors are more likely to result in soiling of hands. As the end of project hand wipe was collected during the summer season, the final hand wipe result could very well be largely dependent on whether the child was playing indoors or outdoors.

In fact, a t-test revealed that playing outside is a significant factor ($p=0.04$) influencing change in hand lead from pre-intervention to post-intervention. Children in either group who were outside prior to the final hand wipe showed an arithmetic mean increase in hand lead of 10 μg, while those playing inside showed a decrease of 3 μg.

Another factor that could possibly affect change in hand lead is gender. As children age, the play habits or hygiene practices of boys and girls could change in different ways. In fact, there is a significant difference in change in hand lead by sex ($p=0.04$). The girls showed an arithmetic mean increase in hand lead of 8 μg, while the boys' mean hand lead fell by 3 μg. Boys and girls

Figure 12 – Trend in Geometric Mean Hand Lead



showed no difference in percentage playing outside prior to the final hand wipe.

The two potential confounding factors (gender and playing outside) were forced into a linear regression model along with group assignment and change in floor lead loading as independent variables. The dependent variable in the model was change in hand lead. Even after controlling for differences in gender, location of play and change in floor lead loading, the difference between groups was significant (p=0.01). This suggests that there was some real difference between treatment and control groups, independent of changes in floor lead loading, that caused a difference in hand leads.

One plausible explanation that remains is that perhaps some of the treatment group families relaxed their hygiene habits due to a perceived reduction in exposure risk as their homes were being HEPA vacuumed regularly.

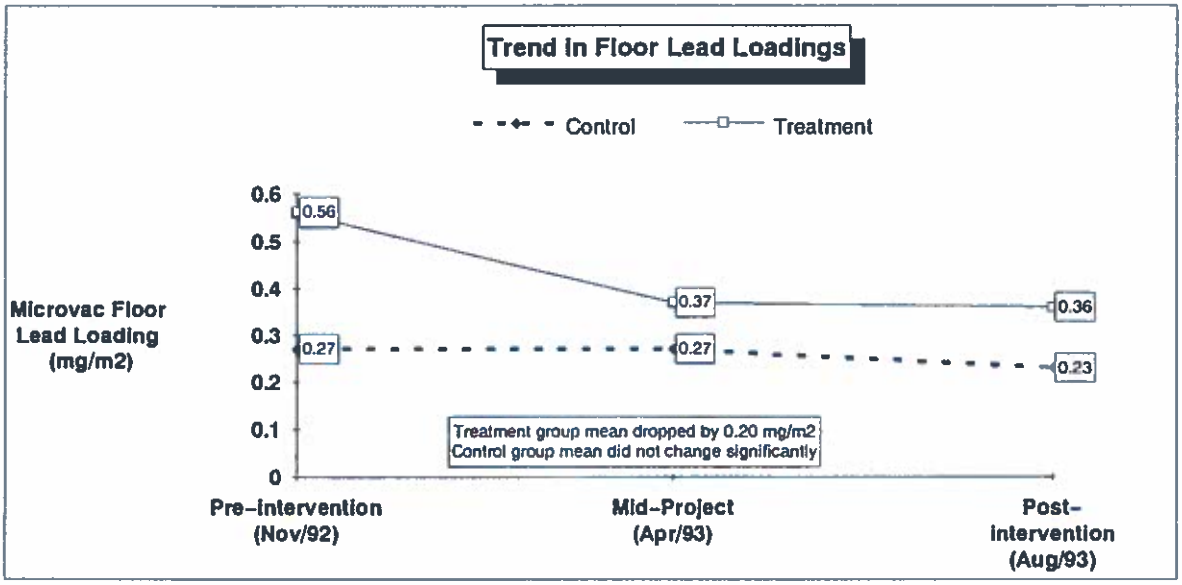
3.7.2 Surface Lead Loading on Carpets

The carpeted areas sampled before intervention were also sampled at mid-project and post-intervention, unless renovations or changes in room use necessitated finding new locations. Two technicians conducted all of the sampling during these latter phases.

Comparisons between pre-intervention and post-intervention project results are based on only those homes which were sampled at both phases (56 control and 55 treatment homes). Paired Student's t-tests were used to test for significant differences between pre-intervention and post intervention within groups. Table 28 on page 36 shows that carpet dust loading did not change significantly in the control group and decreased by 43% in the treatment group. Carpet lead loading did not change in the control group and decreased by 36% in the treatment group. (See

also Figure 13.) The difference in change in floor lead loading between groups was significant (p=0.02).

Figure 13 – Trend in Geometric Mean Floor Lead Loadings



As mentioned earlier in section 3.1 – Pre-Intervention Lead Levels, baseline floor lead loadings were higher in treatment homes than in control homes. It is important to determine whether this initial difference is real, or due to measurement bias.

There is some concern that the difference may be due to differences in sampling technique between technicians. Due to time constraints, six different technicians collected the baseline samples and each technician was not assigned an equal mix of treatment and control homes. One technician did have a higher average lead loading on microvac samples than the rest and that technician sampled mainly treatment group homes.

The difference in floor lead loadings between groups at baseline appears large at first glance – the treatment mean is twice the control mean. However, based on the relationship between floor lead and blood lead, this doubling in floor lead would not translate to a doubling in blood lead. In fact, the mean baseline floor lead of 0.27 mg/m^2 in control predicts a blood lead of 11.0 µg/dL by regression, while the mean floor lead of 0.56 mg/m^2 in treatment predicts a blood lead mean of 12.2 µg/dL. (See Figure 14 on page 39.) However, even after adjusting for initial blood lead, the difference in baseline floor lead between groups remains, which suggests a possible measurement bias.

Figure 15 on page 39 shows the changes in microvac floor lead compared against changes in HEPA vac floor lead. From pre-intervention to mid-project, the microvac and HEPA vac lead loadings for the treatment group decline at about the same rate. From mid-project to post-intervention, the microvac lead loadings remained constant, while the HEPA vac lead continued

Figure 14 – Initial Blood Lead vs. Initial Floor Lead

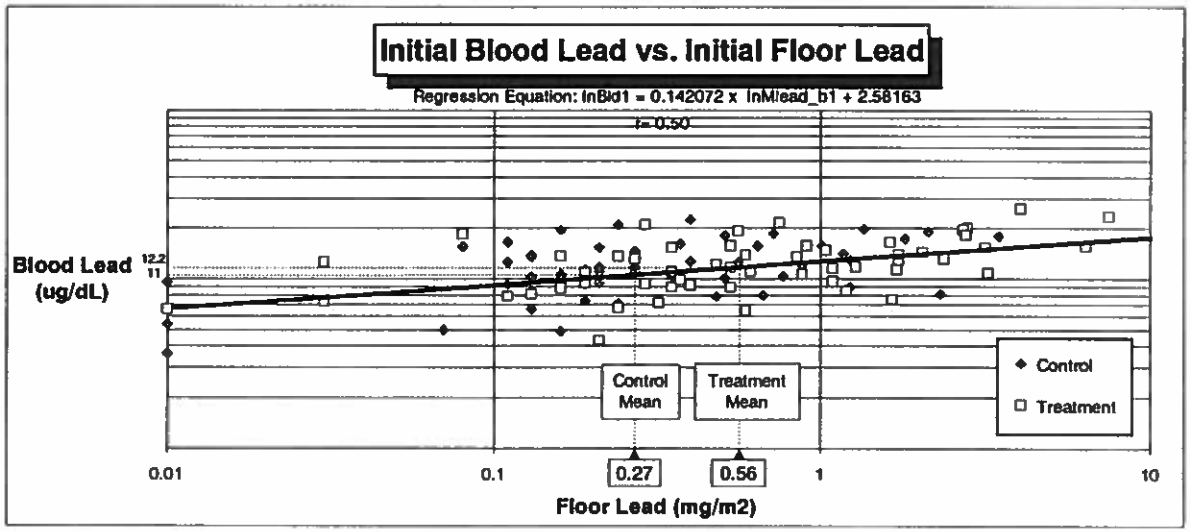
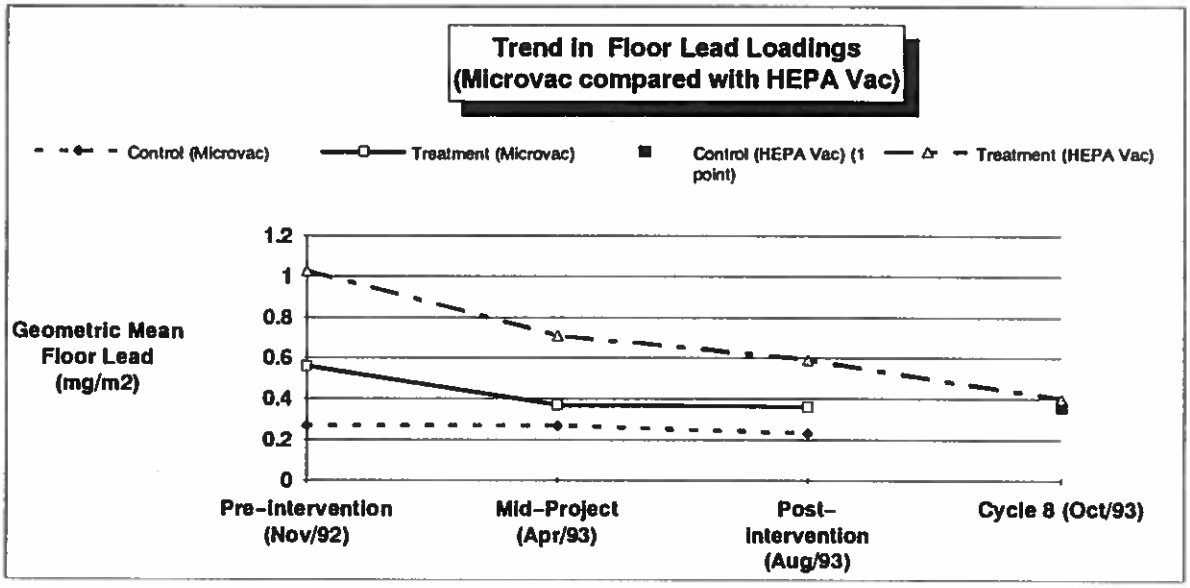


Figure 15 – Trend in Floor Lead Loading – Microvac compared with HEPA vac



treatment homes and 33 control homes after the collection of final blood lead samples. The group of families that participated in this extra vacuuming had a mean microvac floor lead loading in Cycle 7 that was the same as the mean for the overall study group (0.29 mg/m^2). Also, the mean HEPA vac lead in cycle 7 for the 37 treatment homes was not significantly different from the mean for all treatment homes. The results of the additional vacuuming show that the treatment group HEPA vac lead declined further to a mean of 0.40 mg/m^2. The mean for the control group,

which had not received any HEPA vacuuming previously, was not significantly different (0.36 mg/m^2). The fact that HEPA vac lead loadings for the treatment and control groups were the same at the end of the project supports the hypothesis that floor lead loadings really were higher in the treatment group at baseline. The further decline in HEPA vac lead after cycle 7 seems to conflict with the evidence in section 3.4 that carpet surfaces were recontaminating rapidily during this period. However, the amount of lead removed from carpets by HEPA vacuuming may be independent of carpet surface loadings. It is possible that carpet surface lead as measured by the microvac rebounded while the amount of lead extracted by the HEPA vacuums declined.

Even if the difference in baseline microvac lead loadings is real, the decline in the treatment group was not sufficient to meet the study design criterion for clinical significance. In order to ultimately effect a decline in mean blood lead of 1.5 $\mu g/dL$, the geometric mean floor lead loading would have to decline by an estimated 0.30 mg/m^2 (if the relationship observed between initial blood lead and initial floor lead in section 3.1 is assumed to be causal). The net difference between treatment and control groups was only 0.16 mg/m^2. This achieved difference in floor lead loading might ultimately result in a blood lead difference of about 0.6 $\mu g/dL$.

4.0 DISCUSSION

This study's failure to show a measurable impact on blood lead due to regular HEPA vacuuming is understandable. Although the study was carefully designed, there were a number of factors which limited its ability to find an effect. Firstly, reduced lead exposure in children with an average age of 32 months may not effect a change in blood lead level for some time. The chance of finding an impact on blood lead might improve if the vacuuming and blood lead monitoring were continued for a longer time. It is also possible that the HEPA vacuuming might have greater impact as a primary prevention measure, that is, if used to maintain a low lead exposure for infants as yet unexposed.

Since 1991, families in both study groups had received educational messages and materials and/or risk reduction counselling from the Lead Program, depending on their children's blood lead levels. The families' responses to this advice may have resulted in decreased differences between groups due to the HEPA vacuuming.

This study looked for a difference between groups due to a solitary action taken to mitigate just one of many exposure pathways. While levels of indoor house dust were being controlled, nothing particular to the treatment group was being done to reduce children's exposure to sources outside the home. Pan (1993) conducted an analysis of environmental, behavioural and blood lead data collected in Trail in 1992. Pan's analysis by structural equations modelling indicates that floor dust lead loading is the only environmental parameter contributing directly to blood lead. Soil lead concentration and other outdoor parameters were found to contribute only indirectly to blood lead through house dust. However, time spent outdoors daily *was* a direct contributor to blood lead. Table 29 on page 41 shows the effect that time spent outdoors appears to have on blood lead.

These data suggest that although indoor floor lead loadings may be stronger statistical determinants of blood lead, outdoor soil and dust may present an equal or greater risk due to their sheer volume. It is possible that outdoor sources would be stronger determinants of blood lead if the *amount* rather than the *concentration* of lead available to children in these sources

Table 29 – Effect of Time Spent Outdoors on Blood Lead Level

(Data from Pan (1993))

Time Outdoors Daily	n	Geometric Mean Blood Lead (μg/dL)
Less than 2 hours	71	9.4
2 – 4 hours	101	10.6
More than 4 hours	68	12.8

p-value for difference between groups = 0.0001 (highly significant)

were quantified.

The one study in the literature that documented an impact on blood lead due to indoor dust control alone was a 1981 study by Charney et. al. In that study, a treatment group of 14 homes in Baltimore received wet-mopping twice-monthly, while a control group of 35 homes did not. In addition to the cleaning, the treatment group parents were advised to wash their children's hands frequently, to wet-mop frequently between visits and to keep their children away from lead paint or dust "hot spots". The average blood lead in the treatment group fell from 38.6 μg/dL to 31.7 μg/dL (a drop of 6.9 μg/dL), while the control group fell by only 0.7 μg/dL. This remarkable drop occurred over one year and was possible only because of the high average initial blood leads. The researchers concluded that the drop was due to some unknown combination of house cleaning by the study team, improved house cleaning by the householders, regular hand washing and avoidance of high lead areas.

Mielke et. al. (1992) found that a combination of interior painted surface cleanup, house cleanup with a HEPA vacuum, mopping with high phosphate detergent, some carpet removal, covering of bare soil with sod or bark, provision of clean sand boxes, provision of household cleaning supplies and provision of dust control information was effective in reducing blood lead levels.

The finding of a modest effect on floor lead loading, albeit confounded by the possible measurement bias at baseline, is encouraging. The ancillary investigation of recontamination suggests that the HEPA vacuuming strategy might be more effective if applied more frequently.

5.0 CONCLUSIONS

1. Correlations between blood lead and environmental lead are of approximately the same magnitude as have been observed elsewhere, which provides assurance of quality data. Blood lead is most strongly correlated with vacuum bag dust loading and lead loading, which suggests that the whole-house sample obtained by vacuuming may be more representative of overall exposure risk than are samples from a few areas of carpet.

2. The vacuuming achieved immediate reductions in the surface lead loading of carpeted floor areas. The magnitude of the reductions (39% in Cycle 1, 37% in Cycle 4 and 46% in Cycle 7) and their statistical significance ($p<0.001$) provide evidence that HEPA vacuuming is effective in reducing lead exposure, at least in the short term.

3. Throughout all cycles of the project, the amount of dust on floors was very strongly related to the amount of lead in floor dust. In other words, homes within the limited study area having high amounts of *dust* on their floors also have high amounts of *lead* on their floors.

4. Based on analyses of vacuum bag contents, significant reductions in the amount of lead removed from homes occurred over the course of the project. The average amount of lead recovered from vacuum bags declined by 43% from the first vacuuming to the final vacuuming.

5. Re-sampling in a subset of the treatment group homes during August/September indicated that recontamination of carpets to previous levels occurred within about 2.5 to 3 weeks of HEPA vacuuming.

6. The HEPA vacuuming did not result in any statistically significant or clinically meaningful impact on blood lead.

7. Hand lead increased by 36% in the treatment group and fell by 40% in the control group. This significant difference between groups is not consistent with the effect of HEPA vacuuming in reducing floor lead loadings. It is hypothesized that perhaps some of the treatment group families relaxed their hygiene habits due to a perceived reduction in exposure risk as their homes were being HEPA vacuumed regularly.

8. The treatment group homes experienced significant declines in carpet surface dust loading (32%) and lead loading (38%) from pre-intervention to post-intervention. In the control group, dust loading and lead loading were unchanged. The difference between groups (0.20 mg/m^2) fell short of the estimated 0.30 mg/m^2 required for clinical significance.

9. The survey completed by participants, analyzed in conjunction with measured parameters, showed that:

   (a) Vacuum cleaner use among parents of young children in Trail is quite high. All study participants had regular use of vacuum cleaners and report that they used them frequently.

(b) The use of vacuum cleaner power nozzle attachments is effective in reducing carpet dust loadings.

(c) Those who vacuum frequently (once per week, or more often) with their own vacuum cleaners did not benefit as much from the HEPA vacuuming as those who vacuum less frequently.

(d) Frequent vacuuming by the householders' did not insure that their carpet lead loadings would be low. Other factors affecting the "cleanability" of the carpets (such as carpet age or rapid recontamination) must limit some householders' efforts to achieve very low lead loadings.

(e) There was no evidence to suggest that frequent vacuuming with domestic vacuum cleaners results in increased lead concentration in household dust.

(f) Carpet age was not strongly related to initial floor lead loadings. However, those who reported that they did not know how old their carpets were had significantly higher lead loadings.

(g) Removing shoes at the door can be an important factor in the fight against lead contamination of interior floors.

(h) Children with a dog or cat indoors tended to have higher levels of lead in their blood and on their carpets.

This study failed to demonstrate that thorough HEPA vacuuming of floor areas once every six weeks results in a significant reduction in children's indoor exposure risk. However, it has provided much useful insight into the factors that influence indoor lead exposure and an indication that more frequent HEPA vacuuming might be beneficial in some cases.

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TRAIL LEAD PROGRAM

HEPA HOUSE CLEANING PILOT PROJECT

APPENDIX A

Survey Form and Compiled Results

January 17, 1994

Steve Hilts, Environmental Coordinator

Hepa Survey

1. **Do you own or have regular use of a vacuum cleaner?** ☐ Yes ☐ No **(If no, skip to question 5.)**

2. **Before the Hepa vacuuming study started (November 1992) how often did you vacuum?**
   (a)☐ Every Day (b)☐ Every Second Day (c)☐ Twice per Week (d)☐ Once per Week
   (e)☐ Every Second Week (f)☐ Less Than Every 2nd Week

3. **How often did you vacuum during the study?**
   (a)☐ Every Day (b)☐ Every Second Day (c)☐ Twice per Week (d)☐ Once per Week
   (e)☐ Every Second Week (f)☐ Less Than Every Second Week

4. **Does your vacuum cleaner have a power nozzle with revolving brush?** ☐ Yes ☐ No

5. **About how old are your carpets on average?**
   (a)☐ Less Than 1 Year (b)☐ 1-3 Years (c)☐ 4-5 Years (d)☐ 6-10 Years
   (e)☐ More Than 10 Years (f)☐ Don't Know

6. **Have you steam cleaned your carpets since the study began?** ☐ Yes ☐ No

7. **How often do you wet mop your smooth floors?**
   (a)☐ Every Day (b)☐ Every Second Day (c)☐ Twice per Week (d)☐ Once per Week
   (e)☐ Every Second Week (f)☐ Less Than Every 2nd Week

8. **Do you have a dog or cat indoors?** ☐ Yes ☐ No

9. **How many people of all ages have lived in your house during our Hepa study?**

(a)☐ 2 (b)☐ 3 (c)☐ 4 (d)☐ 5 (e)☐ 6 (f)☐ More than 6

10. **Does everyone in your house leave shoes at the door?** ☐ Yes ☐ No

11. **What is the primary heating source in your home?**

(a)☐ Forced Air (Includes Gas, Oil or Electric Furnace)

(b)☐ Radiator (Includes Hot Water, Electric Baseboard or Wood Stove)

(c)☐ Not Sure

If you have forced air heating,

12. **How often do you replace the air filter?**

(a)☐ Every Month (b)☐ Every Second Month (c)☐ Twice per Year (d)☐ Once per Year

(e)☐ Less Than Once per Year (f)☐ Don't Know

13. **Which type of filter do you use?**

(a)☐ Electrostatic (b)☐ Pleated High Efficiency (c)☐ Regular (d)☐ Don't Know

14. **How long ago were your heating ducts last cleaned?**

(a)☐ Within Past Year (b)☐ One Year Ago (c)☐ 2-3 Years Ago (d)☐ 4-6 Years Ago

(e)☐ More Than 6 Years Ago (f)☐ Don't Know

15. **Have you done renovations since our study began?** ☐ Yes ☐ No

If yes, did this involve:

16. **Sanding painted surfaces?** ☐ Yes ☐ No

17. **Removal of walls or ceilings?** ☐ Yes ☐ No

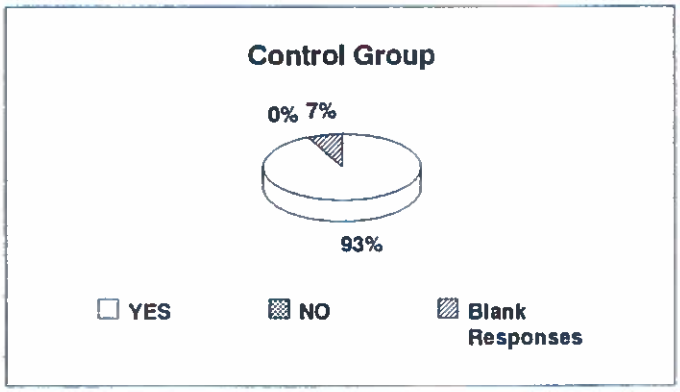
18. **New flooring?** ☐ Yes ☐ No

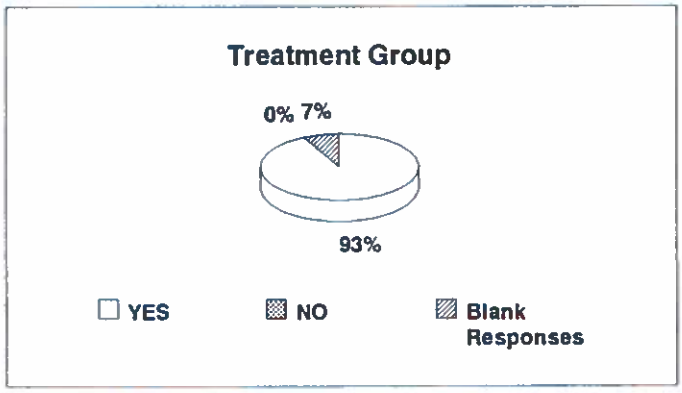
19. **Other** _____

Thank you for your time. 

Do you use a vacuum cleaner?

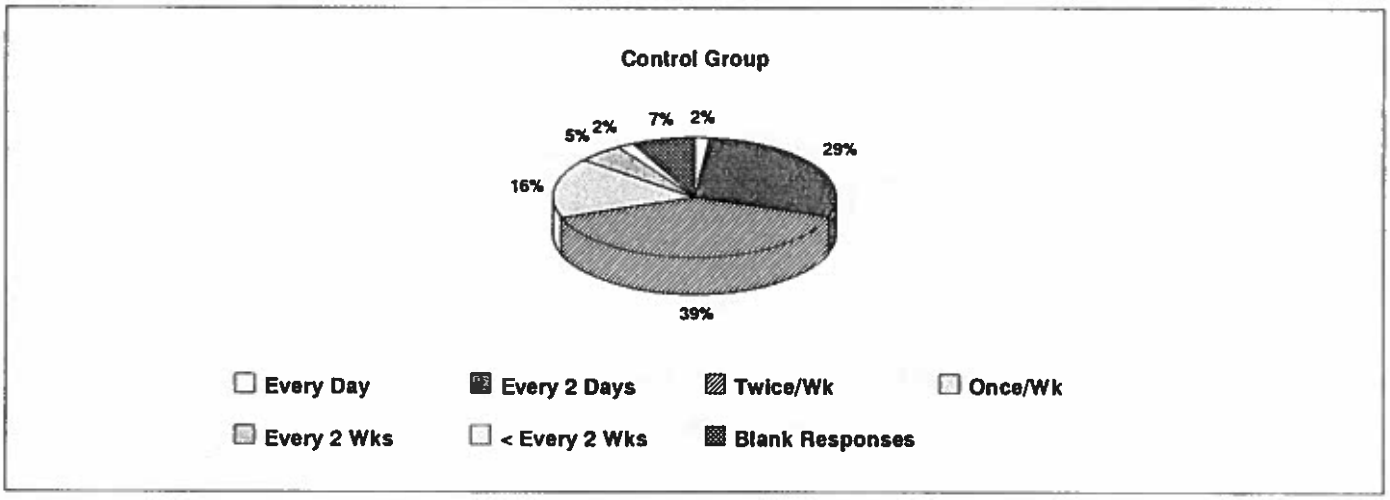
	All homes		Control homes		Treatment homes	
	Count	%	Count	%	Count	%
YES	103	93	52	93	51	93
NO	0	0	0	0	0	0
Blank Responses	8	7	4	7	4	7
TOTAL	111	100	56	100	55	100

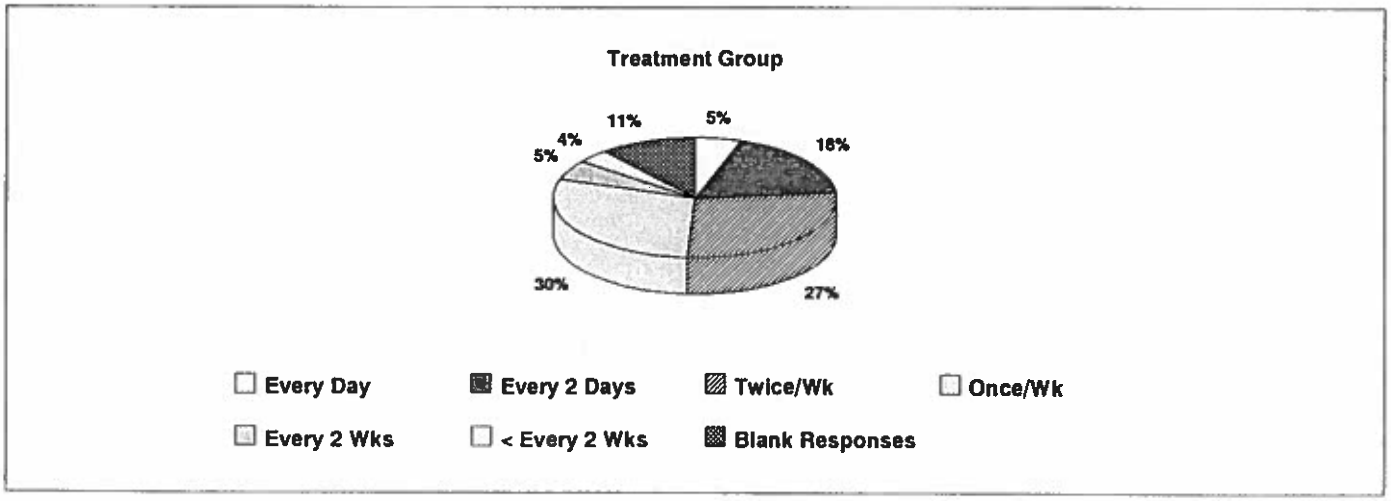




Vacuum how often before study?

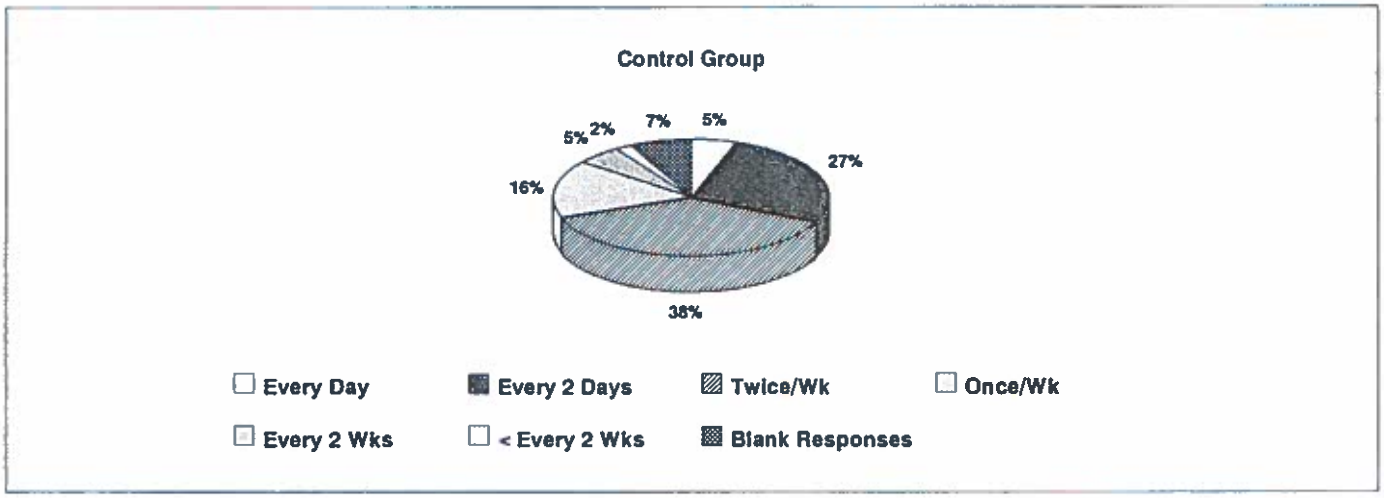
	All homes		Control homes		Treatment homes	
	Count	%	Count	%	Count	%
Every Day	4	4	1	2	3	6
Every 2 Days	26	23	16	29	10	18
Twice/Wk	37	33	22	39	15	27
Once/Wk	25	23	9	16	16	29
Every 2 Wks	6	5	3	5	3	6
< Every 2 Wks	3	3	1	2	2	4
Blank Responses	10	9	4	7	6	11
TOTAL	111	100	56	100	55	100

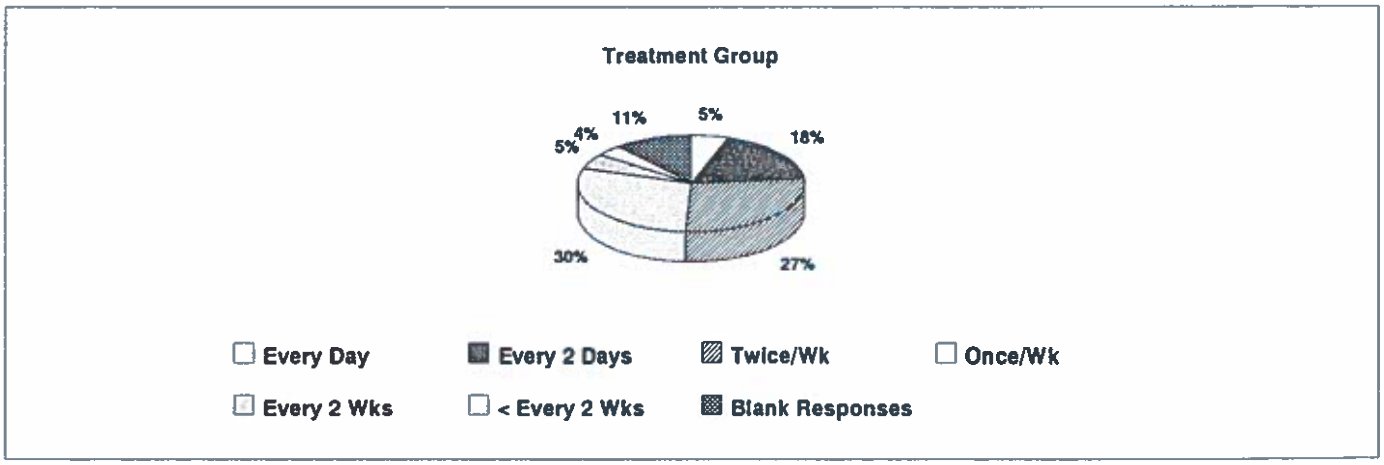




Vacuum how often during study?

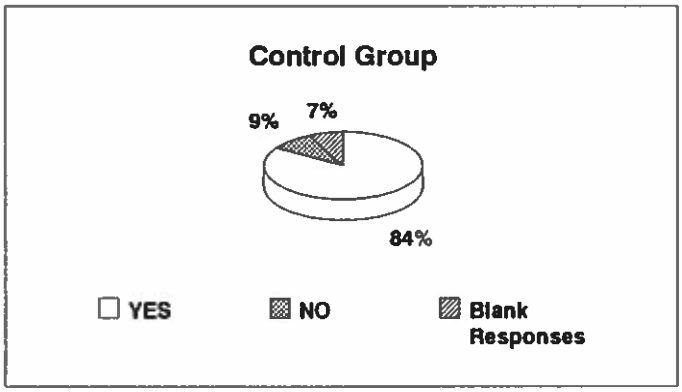
	All homes		Control homes		Treatment homes	
	Count	%	Count	%	Count	%
Every Day	6	5	3	5	3	6
Every 2 Days	25	23	15	27	10	18
Twice/Wk	36	32	21	38	15	27
Once/Wk	27	24	9	16	18	33
Every 2 Wks	6	5	3	5	3	6
< Every 2 Wks	3	3	1	2	2	4
Blank Responses	8	7	4	7	4	7
TOTAL	111	100	56	100	55	100

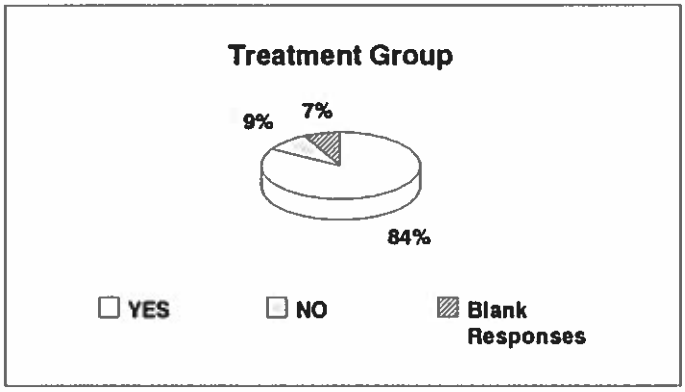




Does vacuum have power nozzle?

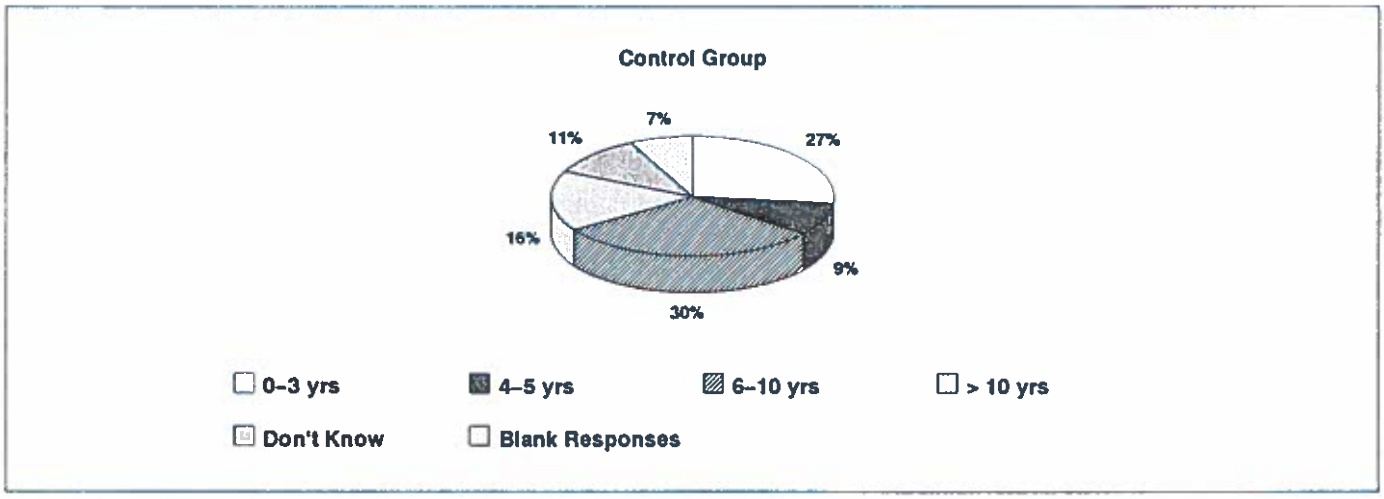
	All homes		Control homes		Treatment homes	
	Count	%	Count	%	Count	%
YES	93	84	47	84	46	84
NO	10	9	5	9	5	9
Blank Responses	8	7	4	7	4	7
TOTAL	111	100	56	100	55	100

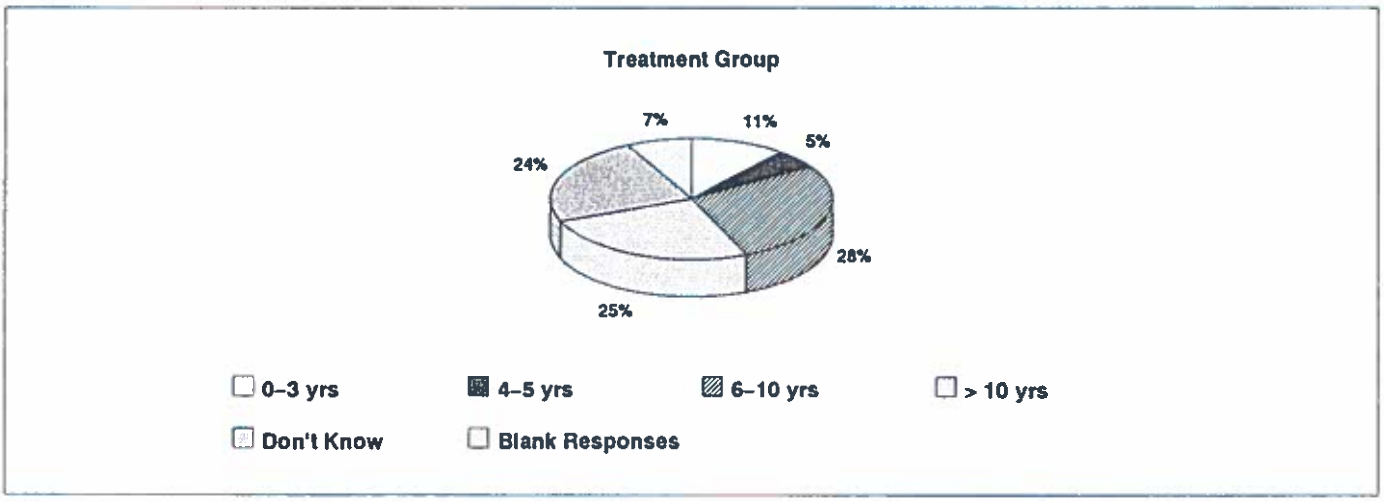




How old are carpets on average?

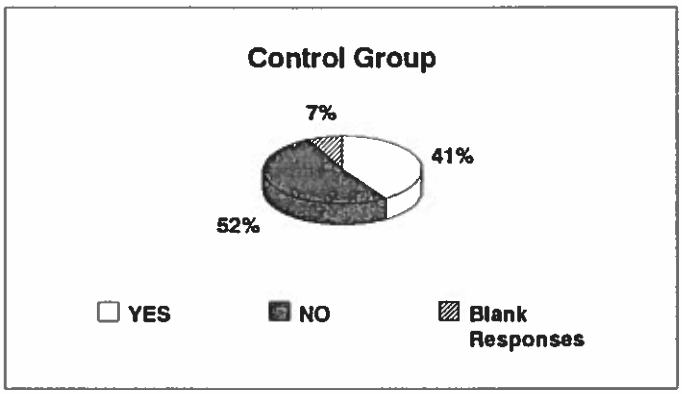
	All homes		Control homes		Treatment homes	
	Count	%	Count	%	Count	%
0–3 yrs	21	19	15	27	6	11
4–5 yrs	8	7	5	9	3	6
6–10 yrs	32	29	17	30	15	27
> 10 yrs	23	21	9	16	14	26
Don't Know	19	17	6	11	13	24
Blank Responses	8	7	4	7	4	7
TOTAL	111	100	56	100	55	100

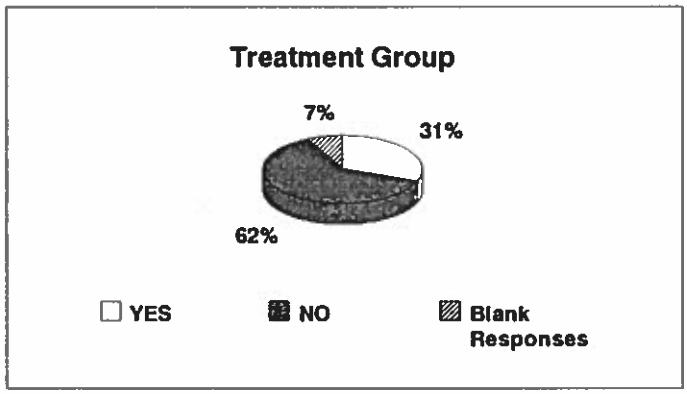




Steam cleaned carpets during study?

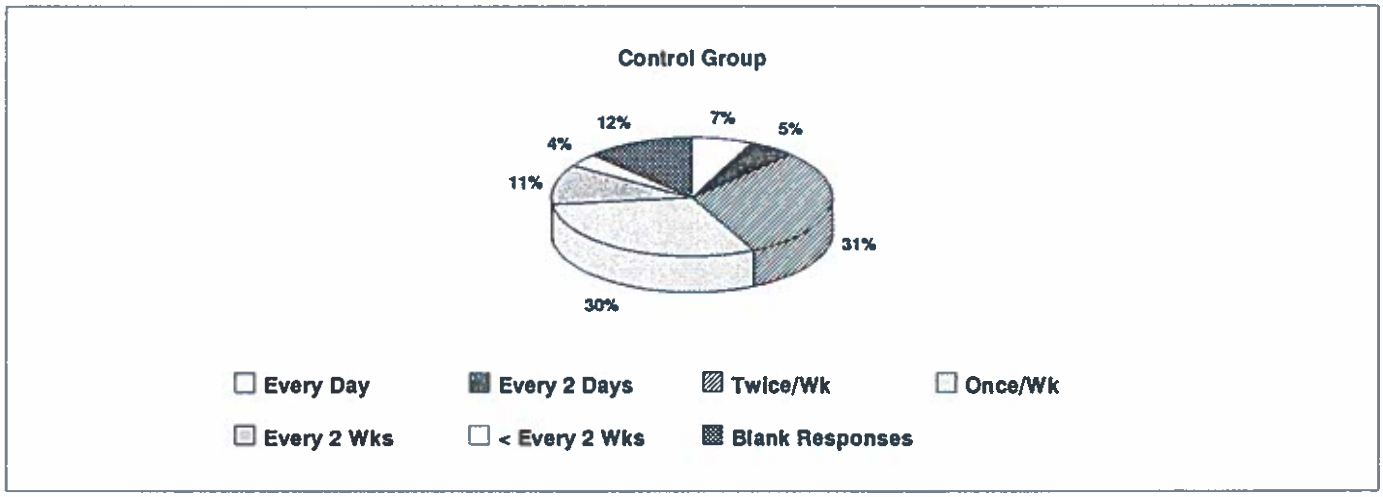
	All homes		Control homes		Treatment homes	
	Count	%	Count	%	Count	%
YES	40	36	23	41	17	31
NO	63	57	29	52	34	62
Blank Responses	8	7	4	7	4	7
TOTAL	111	100	56	100	55	100

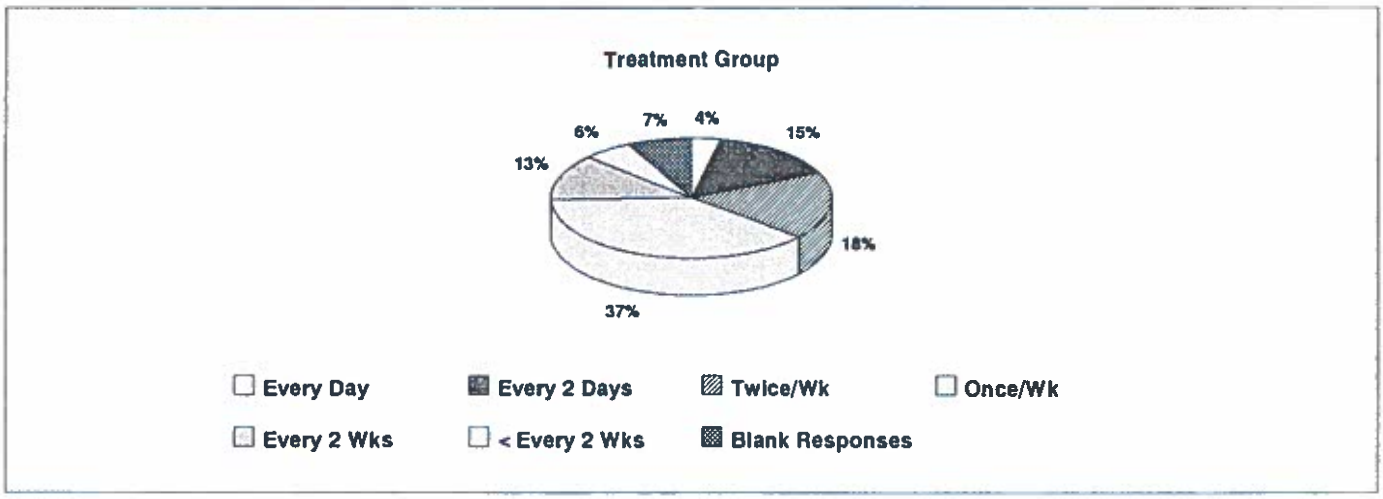




How often do you wet mop?

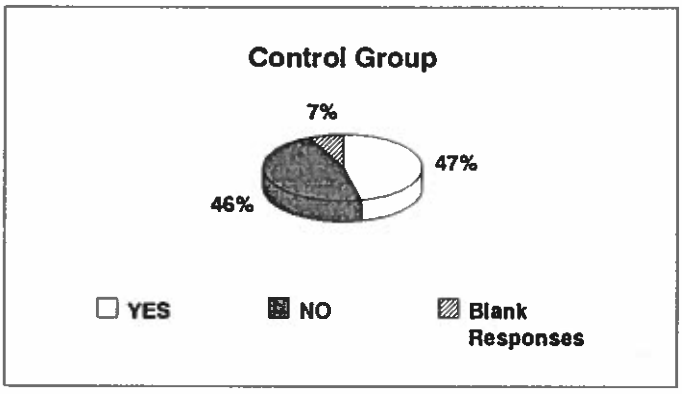
	All homes		Control homes		Treatment homes	
	Count	%	Count	%	Count	%
Every Day	6	5	4	7	2	4
Every 2 Days	11	10	3	5	8	15
Twice/Wk	27	24	17	30	10	18
Once/Wk	38	34	17	30	21	38
Every 2 Wks	13	12	6	11	7	13
< Every 2 Wks	5	5	2	4	3	6
Blank Responses	11	10	7	13	4	7
TOTAL	111	100	56	100	55	100

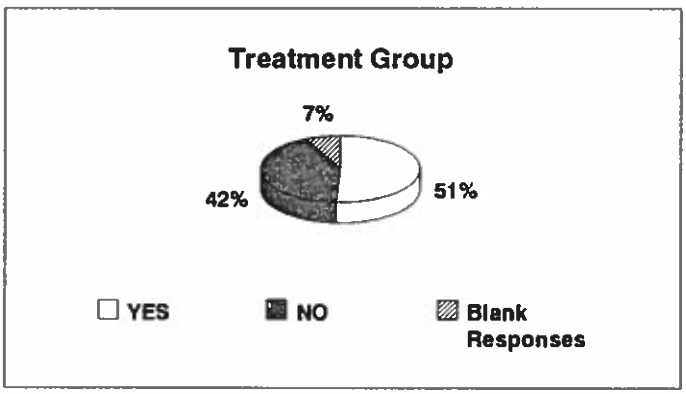




Dog or cat indoors?

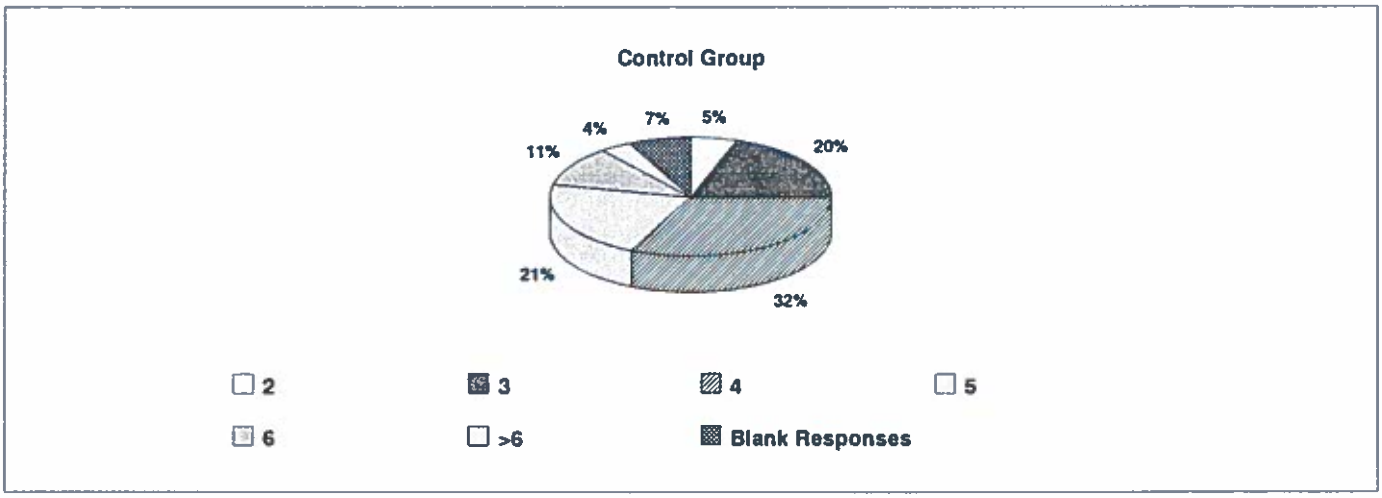
	All homes		Control homes		Treatment homes	
	Count	%	Count	%	Count	%
YES	54	49	26	46	28	51
NO	49	44	26	46	23	42
Blank Responses	8	7	4	7	4	7
TOTAL	111	100	56	100	55	100

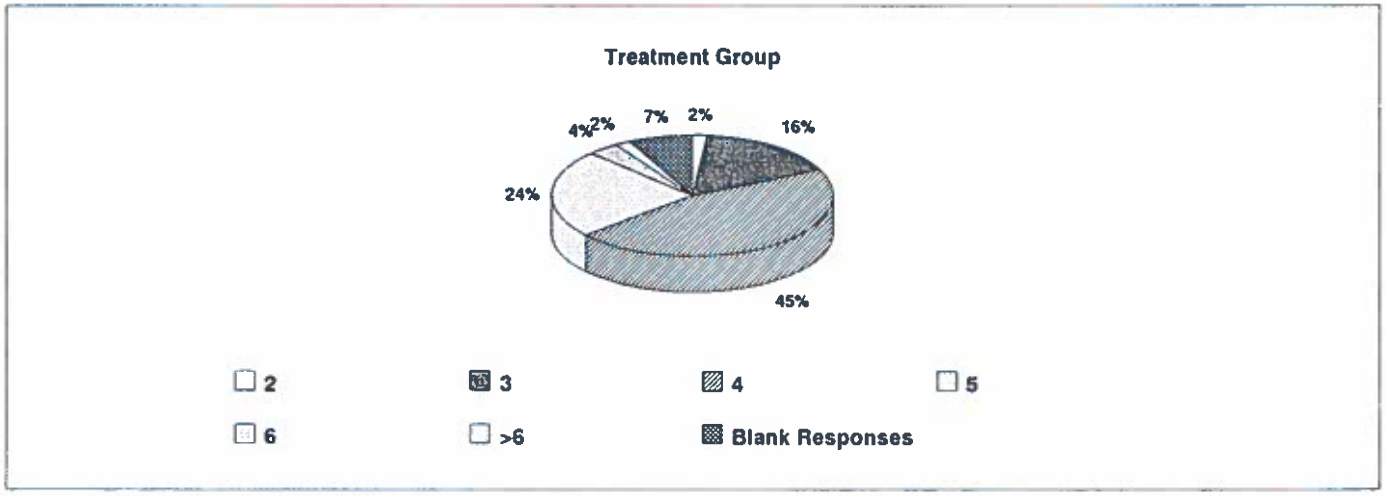




Number of people living in house?

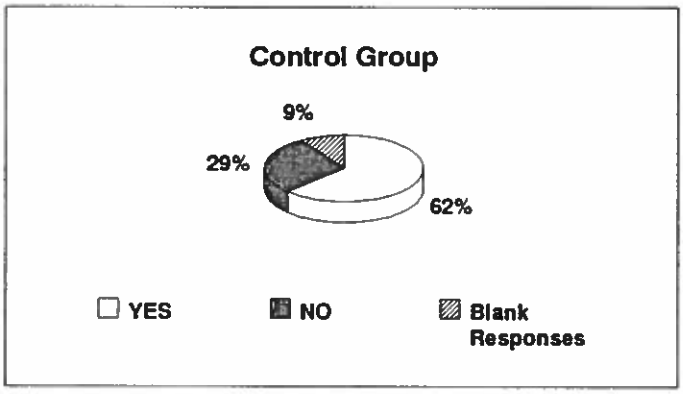
	All homes		Control homes		Treatment homes	
	Count	%	Count	%	Count	%
2	4	4	3	5	1	2
3	20	18	11	20	9	16
4	43	39	18	32	25	46
5	25	23	12	21	13	24
6	8	7	6	11	2	4
>6	3	3	2	4	1	2
Blank Responses	8	7	4	7	4	7
TOTAL	111	100	56	100	55	100

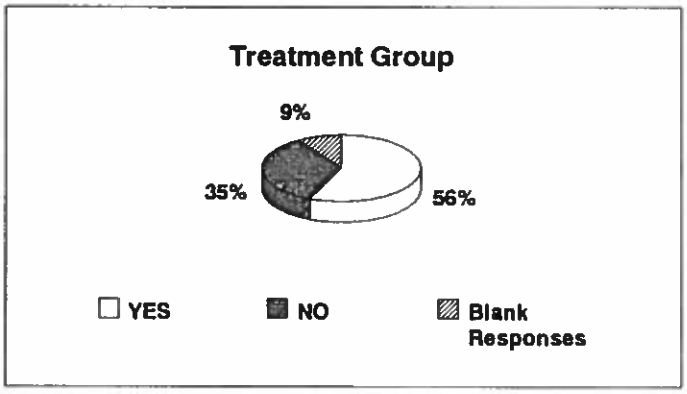




Everyone leaves shoes at door?

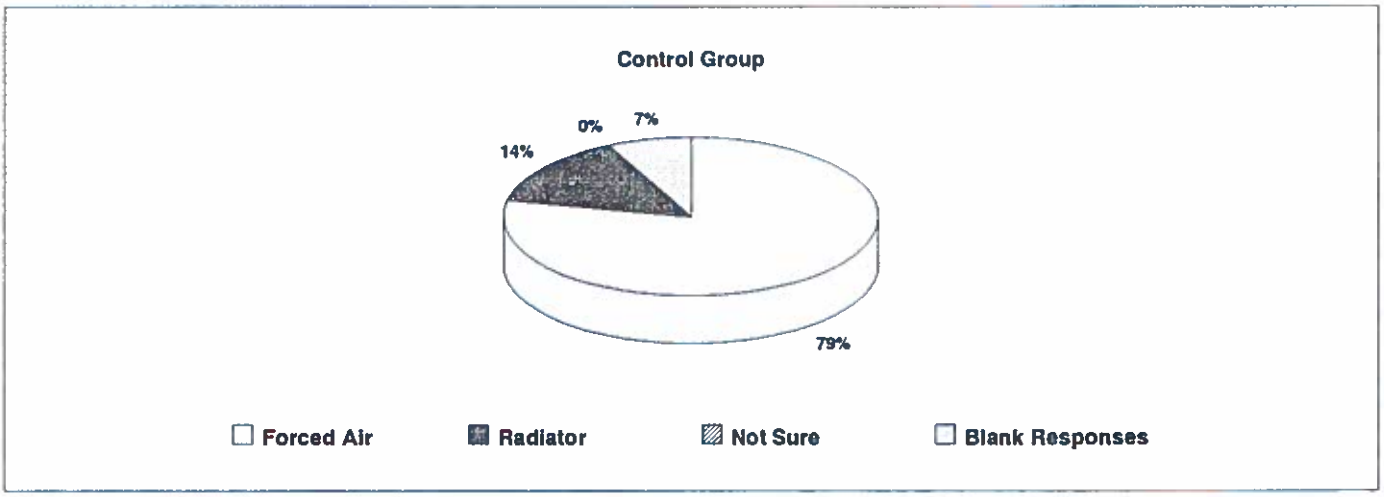
	All homes		Control homes		Treatment homes	
	Count	%	Count	%	Count	%
YES	66	60	35	63	31	56
NO	35	32	16	29	19	35
Blank Responses	10	9	5	9	5	9
TOTAL	111	100	56	100	55	100

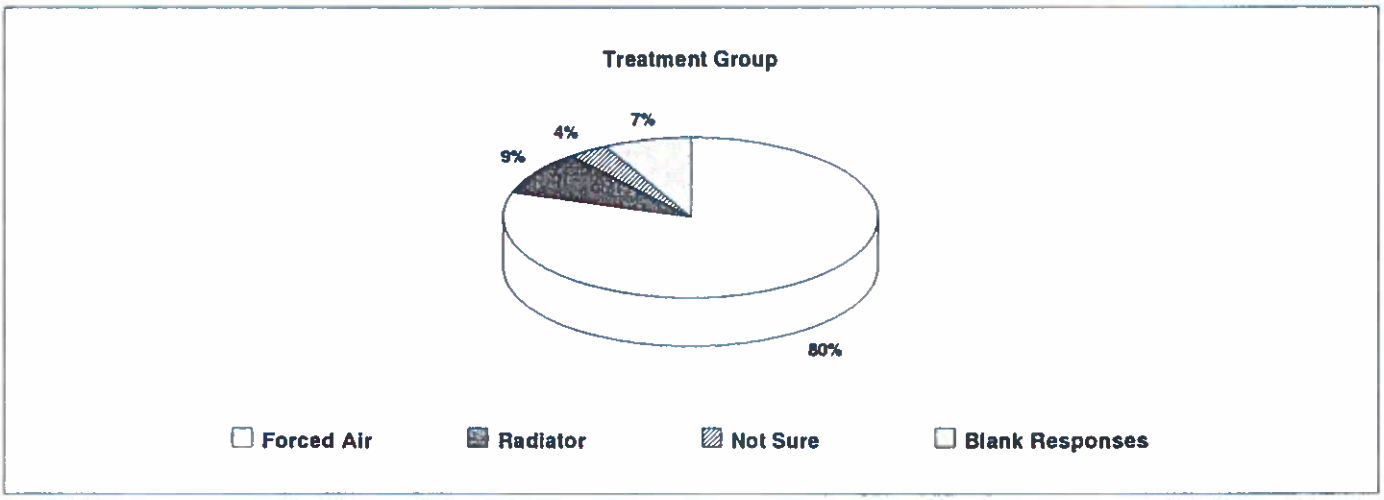




Type of heating source?

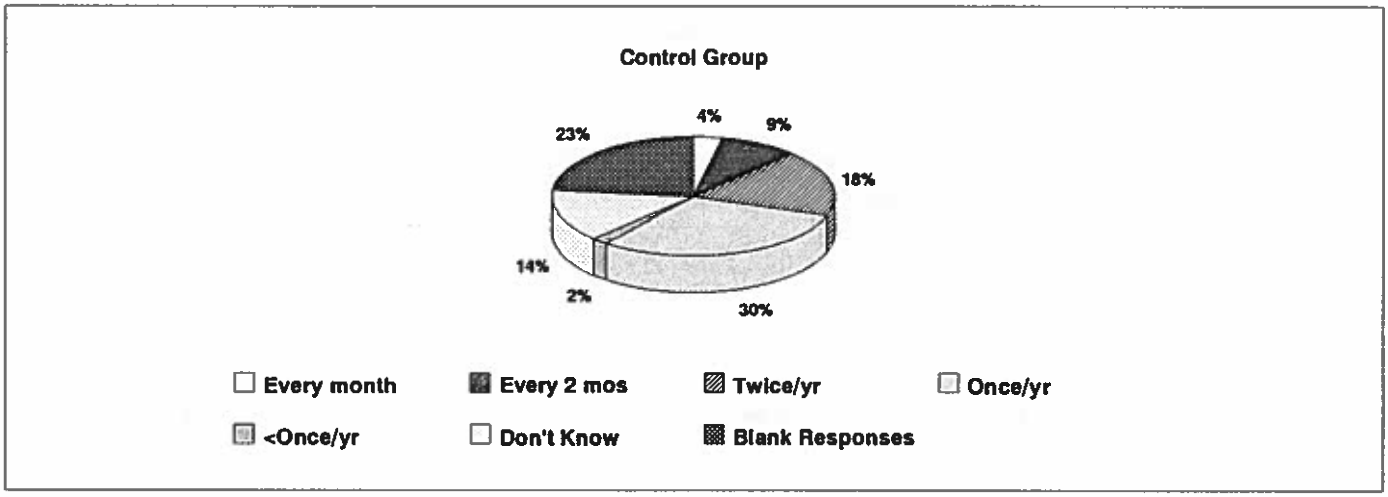
	All homes		Control homes		Treatment homes	
	Count	%	Count	%	Count	%
Forced Air	88	79	44	79	44	80
Radiator	13	12	8	14	5	9
Not Sure	2	2	0	0	2	4
Blank Responses	8	7	4	7	4	7
TOTAL	111	100	56	100	55	100

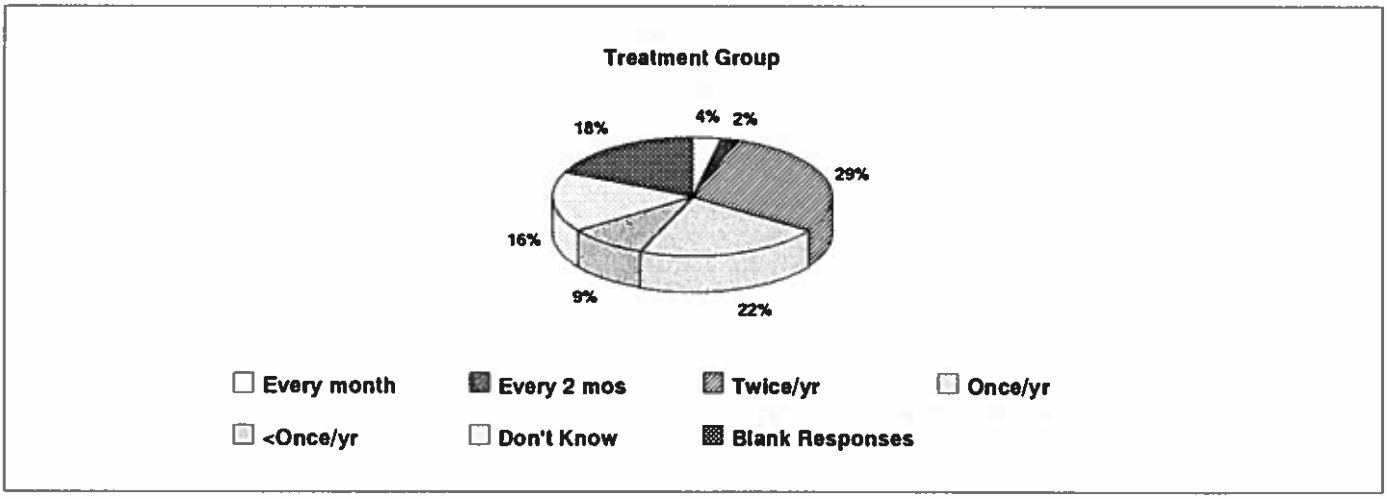




How often is filter replaced?

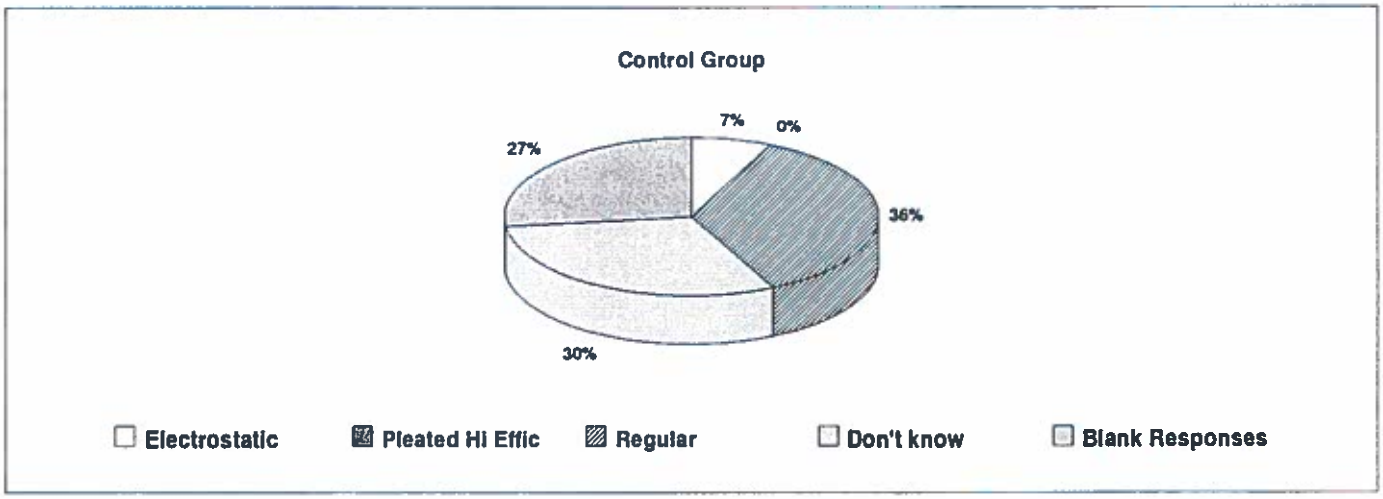
	All homes		Control homes		Treatment homes	
	Count	%	Count	%	Count	%
Every month	4	4	2	4	2	4
Every 2 mos	6	5	5	9	1	2
Twice/yr	26	23	10	18	16	29
Once/yr	29	26	17	30	12	22
<Once/yr	6	5	1	2	5	9
Don't Know	17	15	8	14	9	16
Blank Responses	23	21	13	23	10	18
TOTAL	111	100	56	100	55	100

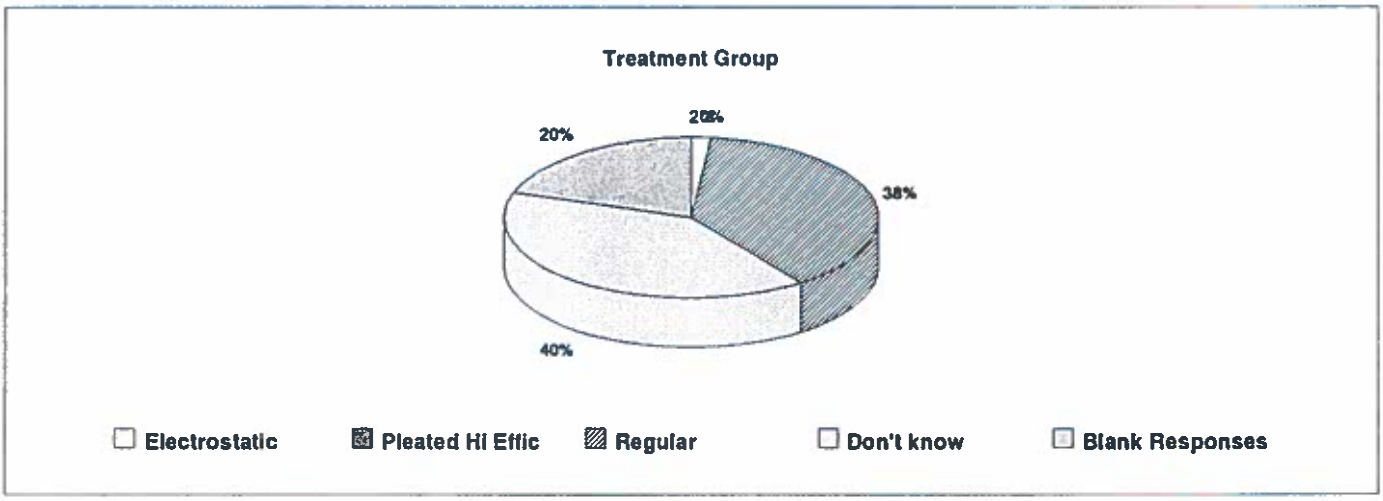




What type of air filter?

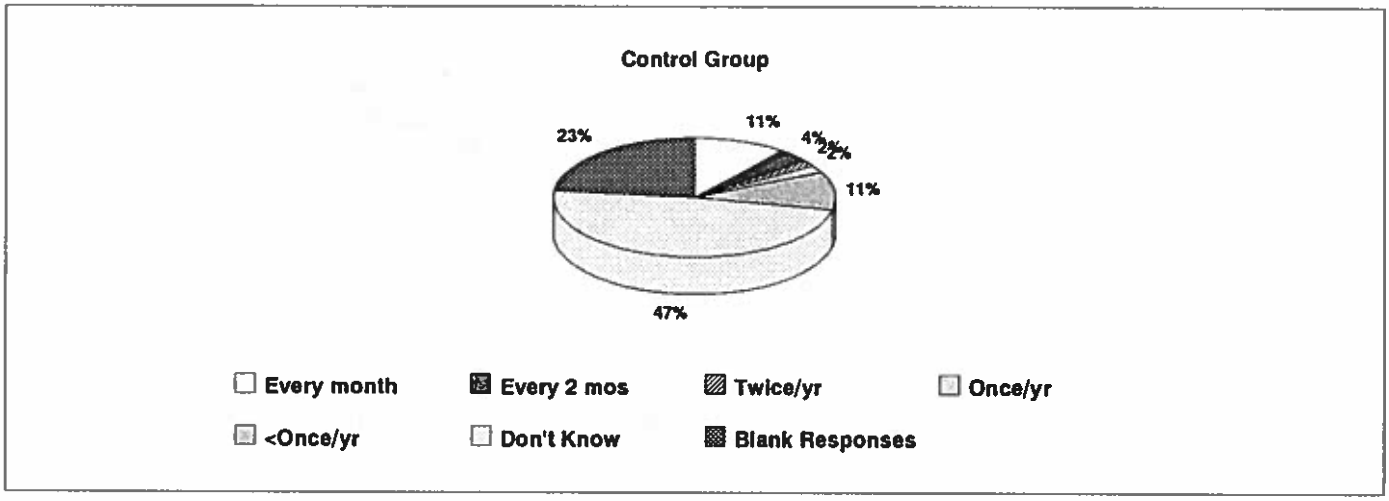
	All homes		Control homes		Treatment homes	
	Count	%	Count	%	Count	%
Electrostatic	5	5	4	7	1	2
Pleated Hi Effic	0	0	0	0	0	0
Regular	41	37	20	36	21	38
Don't know	39	35	17	30	22	40
Blank Responses	26	23	15	27	11	20
TOTAL	111	100	56	100	55	100

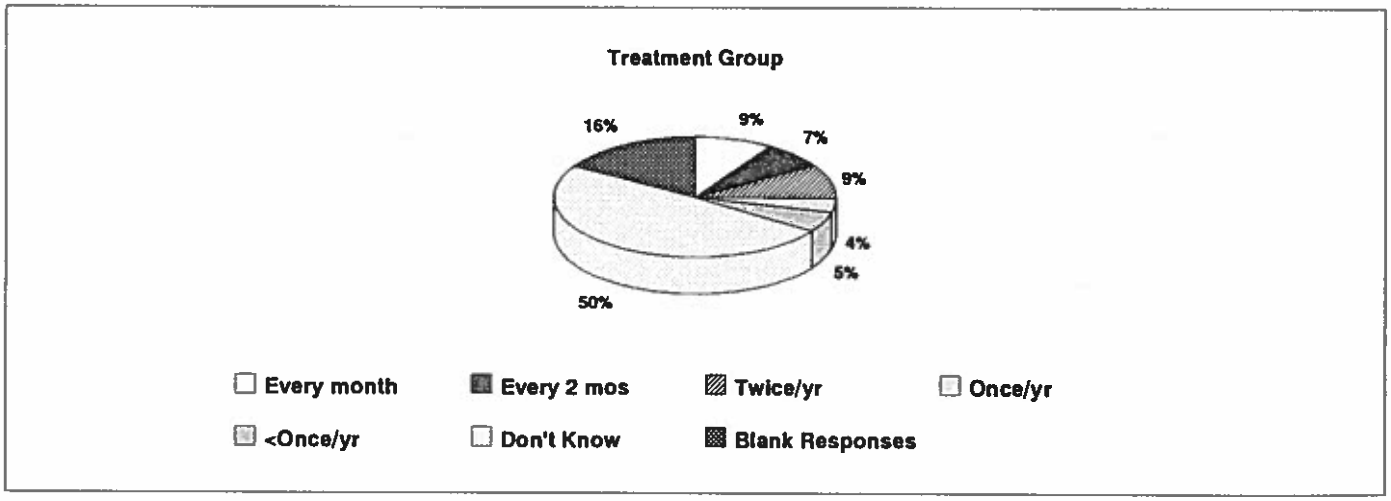




When were ducts last cleaned?

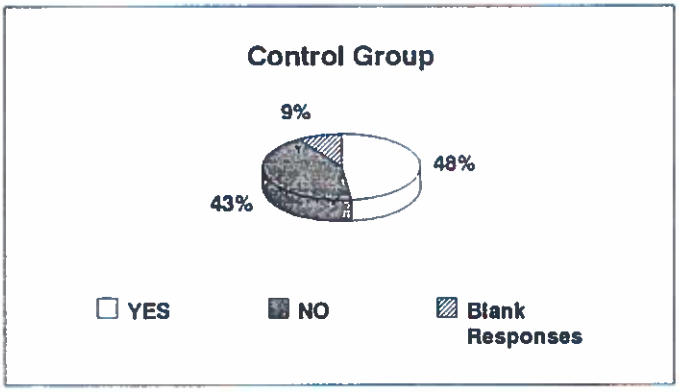
	All homes		Control homes		Treatment homes	
	Count	%	Count	%	Count	%
<1 yr	11	10	6	11	5	9
1 yr	6	5	2	4	4	7
2–3 yrs	6	5	1	2	5	9
4–6 yrs	3	3	1	2	2	4
> 6 yrs	9	8	6	11	3	6
Don't Know	54	49	27	48	27	49
Blank Responses	22	20	13	23	9	16
TOTAL	111	100	56	100	55	100

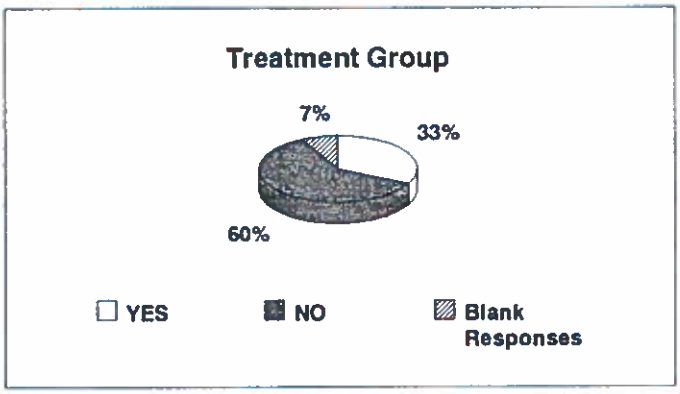




Any renos during study?

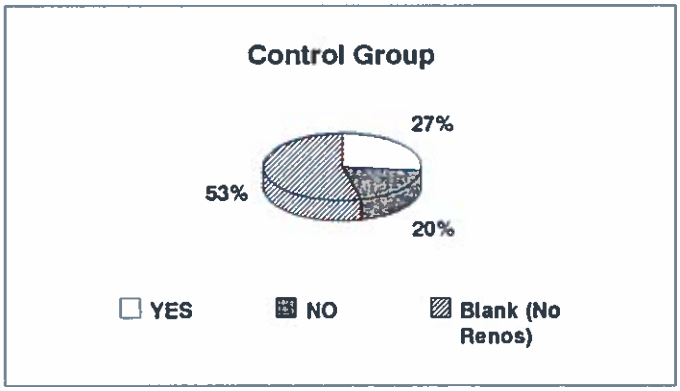
	All homes		Control homes		Treatment homes	
	Count	%	Count	%	Count	%
YES	45	41	27	48	18	33
NO	57	51	24	43	33	60
Blank Responses	9	8	5	9	4	7
TOTAL	111	100	56	100	55	100

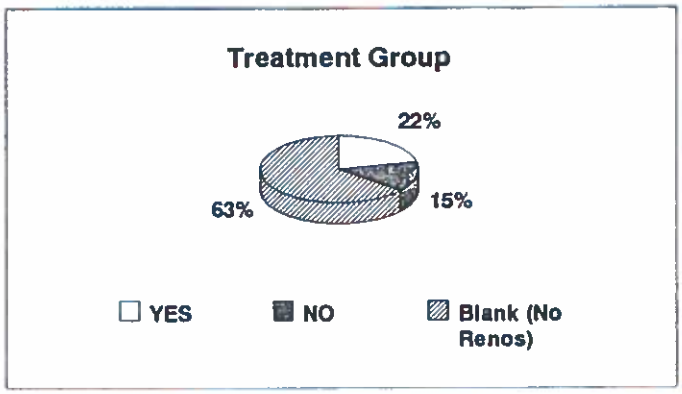




Sanding painted surfaces

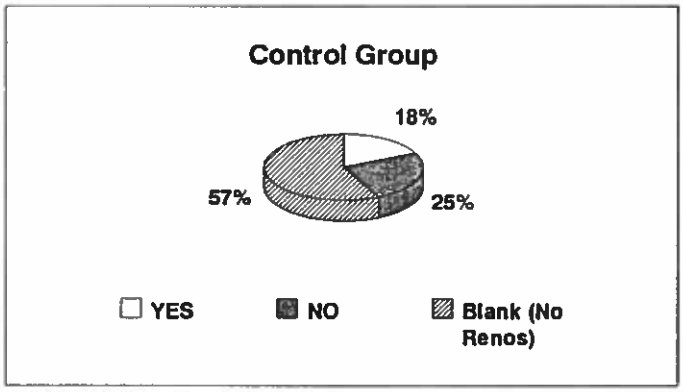
	All homes		Control homes		Treatment homes	
	Count	%	Count	%	Count	%
YES	27	24	15	27	12	22
NO	19	17	11	20	8	15
Blank (No Renos)	65	59	30	54	35	64
TOTAL	111	100	56	100	55	100

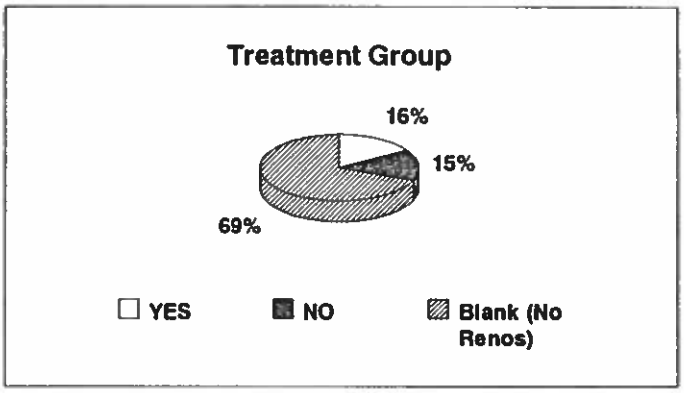




Removal of walls/ceilings?

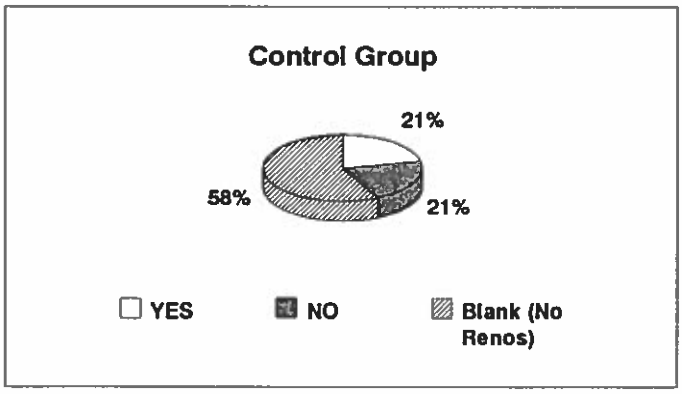
	All homes		Control homes		Treatment homes	
	Count	%	Count	%	Count	%
YES	19	17	10	18	9	16
NO	22	20	14	25	8	15
Blank (No Renos)	70	63	32	57	38	69
TOTAL	111	100	56	100	55	100

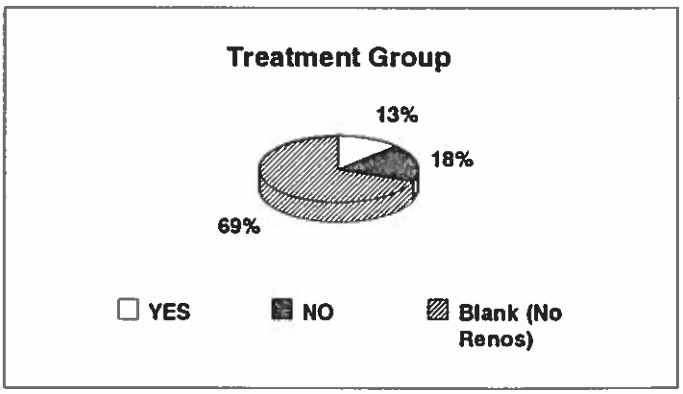




New flooring?

	All homes		Control homes		Treatment homes	
	Count	%	Count	%	Count	%
YES	19	17	12	21	7	13
NO	22	20	12	21	10	18
Blank (No Renos)	70	63	32	57	38	69
TOTAL	111	100	56	100	55	100





TRAIL LEAD PROGRAM

HEPA HOUSE CLEANING PILOT PROJECT

APPENDIX B

Statistical Outputs

January 17, 1994

Steve Hilts, Environmental Coordinator

APPENDIX B – Statisical Outputs

TABLE OF CONTENTS

Command: DESC Missing Value Treatment: Varwise
Selection: GROUP<>'Blank' and LOST<>'T'
Breakdown on variable GROUP = Ctrl

***** Descriptive Statistics for Control Group ***** **Baseline Measures**

Current file is e:\hepa\data\hepa_win.abd
There are 116 variables and 120 records in this data file
56 Records (46.7%) are in this subset
56 Records (100.0%) are valid

Variable	Mean	Std.Dev.	Variance	Std Error of mean	Coeff of variation
AGE	31.93	17.58	309.20	2.35	55.07
BLOOD1	12.1	4.35	18.94	0.58	36.03

Variable	Minimum	Maximum	Range	Total
AGE	6	69	63	1788
BLOOD1	3.6	22.4	18.8	676.3

Command: DESC Missing Value Treatment: Varwise
Selection: GROUP<>'Blank' and LOST<>'T'
Breakdown on variable GROUP = Treat

***** Descriptive Statistics for Treatment Group ***** **Baseline Measures**

Current file is e:\hepa\data\hepa_win.abd
There are 116 variables and 120 records in this data file
55 Records (45.8%) are in this subset
55 Records (100.0%) are valid

Variable	Mean	Std.Dev.	Variance	Std Error of mean	Coeff of variation
AGE	32.95	16.31	266.05	2.20	49.51
BLOOD1	12.7	4.63	21.42	0.62	36.51

Variable	Minimum	Maximum	Range	Total
AGE	6	70	64	1812
BLOOD1	4.3	26	21.7	697.2

Command: DESC Missing Value Treatment: Varwise
Selection: GROUP<>'Blank' and LOST<>'T'
Breakdown on variable GROUP = Ctrl

***** Descriptive Statistics for Control Group ***** **Baseline Measures**

Current file is e:\hepa\data\hepa_win.abd
There are 116 variables and 120 records in this data file
56 Records (46.7%) are in this subset

Variable	Valid Records	Number Missing	% Missing
MDUST_B1	56	0	0
MLEAD_B1	56	0	0
MCONC_B1	56	0	0
HAND1	55	1	1.8

(could not wipe one child's hands)

Variable	Mean	Std.Dev.	Variance	Std Error of mean	Coeff of variation
MDUST_B1	693	1194.23	1426183.00	159.59	172.35
MLEAD_B1	0.51	0.65	0.43	0.09	128.16
MCONC_B1	888	481.99	232317.00	64.41	54.25
HAND1	14	13.23	175.02	1.78	94.86

Variable	Minimum	Maximum	Range	Total
MDUST_B1	20	8252	8232	38804
MLEAD_B1	0.01	3.49	3.48	28.59
MCONC_B1	58	2336	2278	49750
HAND1	2	73	71	767

Command: DESC Missing Value Treatment: Varwise
Selection: GROUP<>'Blank' and LOST<>'T'
Breakdown on variable GROUP = Treat

***** Descriptive Statistics for Treatment Group ***** **Baseline Measures**

Current file is e:\hepa\data\hepa_win.abd
There are 116 variables and 120 records in this data file
55 Records (45.8%) are in this subset
55 Records (100.0%) are valid

Variable	Mean	Std.Dev.	Variance	Std Error of mean	Coeff of variation
MDUST_B1	1213	1923.94	3701539.00	259.42	158.62
MLEAD_B1	1.16	1.49	2.22	0.20	128.06
MCONC_B1	1301	1731.28	2997313.00	233.45	133.05
HAND1	15	15.86	251.55	2.14	105.99

Variable	Minimum	Maximum	Range	Total
MDUST_B1	21	12972	12951	66712
MLEAD_B1	0.01	7.47	7.46	63.92
MCONC_B1	300	12931	12631	71567
HAND1	2	100	98	823

Test for Difference in Mean Baseline Blood Lead Between Groups

Command: TIND Missing Value Treatment: Listwise
Selection: LOST<>T and GROUP<>'Blank'

*** **INDEPENDENT T TEST** *** **Baseline Measures**

For Variable: lnBld1
Subsets in Variable GROUP
With Values Ctrl and Treat

For Subsets:	Geometric Mean	Geometric Std. Dev.	n
Ctrl	11.3	1.48	56
Treat	11.9	1.44	55

t Statistic = 0.740469
Degrees of Freedom = 109
One-Tailed Prob = 0.2303
Two-Tailed Prob = 0.4606

No significant difference in mean baseline blood lead between groups.

Test for Difference in Baseline Blood Lead Distribution Between Groups

Command: KS2 Missing Value Treatment: Pairwise
Selection: LOST<>T and GROUP<>'Blank'

*** **Kolmogorov-Smirnov 2-Sample Test** *** **Baseline Measures**

Scores Var = lnBld1
Codes Var = GROUP
56 cases coded Ctrl (labelled "A" below)
55 cases coded Treat (labelled "B" below)

	A-B	B-A
Maximum Difference	0.0795455	0.024026
Numerator of Difference	245	74
One-Tailed Chi Square (DF=2)	0.702293	0.0640693
Probability	0.7039	0.9685
Two-Tailed Large Sample Approximation =	0.419015	

No significant difference in blood lead distribution between groups.

Selection: LOST<>T and GROUP<>'Blank'
Frequency Report of Bloodcode

	Control Group		Treatment Group	
Value	Freq	%	Freq	%
ELEV	15	26.8	15	27.3
LOW	18	32.1	19	34.5
MOD	23	41.1	21	38.2
Total	56	100	55	100

Test for Difference in Mean Age Between Groups

Command: TIND Missing Value Treatment: Listwise
Selection: LOST<>T and GROUP<>'Blank'

***** INDEPENDENT T TEST ***** **Baseline Measures**

For Variable: AGE (in months)
Subsets in Variable GROUP
With Values Ctrl and Treat

For Subsets:	Mean	Std. Dev.	n
Ctrl	31.9	17.6	56
Treat	32.9	16.3	55

t Statistic = 0.315735
Degrees of Freedom = 109
One-Tailed Prob = 0.3764
Two-Tailed Prob = 0.7528

No significant difference in mean age between groups.

Test for Difference in Age Distribution Between Groups

Command: KS2 Missing Value Treatment: Pairwise
Selection: LOST<>T and GROUP<>'Blank'

***** Kolmogorov-Smirnov 2-Sample Test ***** **Baseline Measures**

Scores Var = AGE
Codes Var = GROUP
56 cases coded Ctrl (labelled "A" below)
55 cases coded Treat (labelled "B" below)

	A-B	B-A
Maximum Difference	0.137987	0.05
Numerator of Difference	425	154
One-Tailed Chi Square (DF=2)	2.11331	0.277477
Probability	0.3476	0.8705
Two-Tailed Large Sample Approximation =	0.726862	

No significant difference in age distribution between groups.

Test for Difference In Sex Distribution Between Groups

Command: TIND Missing Value Treatment: Listwise
Selection: LOST<>T and GROUP<>'Blank'

***** INDEPENDENT T TEST ***** **Baseline Measures**

For Variable: SEX_n (Sex coded Male=1, Female=2)
Subsets in Variable GROUP
With Values Ctrl and Treat

For Subsets:	Mean	Std. Dev.	n
Ctrl	1.6	0.5	56
Treat	1.5	0.5	55

t Statistic = -0.46576
Degrees of Freedom = 109
One-Tailed Prob = 0.3212
Two-Tailed Prob = 0.6423

No significant difference in sex distribution between groups.

Command: FREQ Missing Value Treatment: Varwise
Selection: LOST<>T and GROUP<>'Blank'

Frequency Report of SEX

	Control Group		Treatment Group	
Value	Freq	%	Freq	%
F	31	55.4	28	50.9
M	25	44.6	27	49.1
Total	56	100	55	100

Test for Difference in Mean Baseline Blood Lead by Sex

Command: TIND Missing Value Treatment: Listwise
Selection: LOST<>T and GROUP<>'Blank'

***** INDEPENDENT T TEST ***** **Baseline Measures**

For Variable: lnBld1
Subsets in Variable SEX
With Values M and F

For Subsets:	Geometric Mean	Geometric Std. Dev.	n
M	12.2	1.41	52
F	11.0	1.50	59

t Statistic = -1.45829
Degrees of Freedom = 109
One-Tailed Prob = 0.0738
Two-Tailed Prob = 0.1476

No significant difference in mean blood lead by sex

Test for Difference in Mean Baseline Hand Lead Between Groups

Command: TIND Missing Value Treatment: Listwise
Selection: LOST<>T and GROUP<>'Blank'

***** INDEPENDENT T TEST ***** **Baseline Measures**

For Variable: lnHand1
Subsets in Variable GROUP
With Values Ctrl and Treat

For Subsets:	Geometric Mean	Geometric Std. Dev.	n
Ctrl	10.1	2.22	55
Treat	11.0	2.09	55

t Statistic = 0.624205
Degrees of Freedom = 108
One-Tailed Prob = 0.2669
Two-Tailed Prob = 0.5338

No significant difference in mean baseline hand lead between groups

Test for Difference in Baseline Hand Lead Distribution Between Groups

Command: KS2 Missing Value Treatment: Pairwise
Selection: LOST<>T and GROUP<>'Blank'

***** Kolmogorov-Smirnov 2-Sample Test ***** **Baseline Measures**

Scores Var = lnHand1
Codes Var = GROUP
55 cases coded Ctrl (labeled "A" below)
55 cases coded Treat (labeled "B" below)

	A-B	B-A
Maximum Difference	0.109091	0.0727273
Numerator of Difference	6	4
One-Tailed Chi Square (DF=2)	1.30909	0.581818
Probability	0.5197	0.7476
Two-Tailed Large Sample Approximation =	0.572078	

No significant difference in hand lead distribution between groups.

Test for Difference in Mean Baseline Carpet Sample Lead Between Groups

Command: TIND Missing Value Treatment: Listwise
Selection: LOST<>T and GROUP<>'Blank'

***** INDEPENDENT T TEST ***** **Baseline Measures**

For Variable: lnMlead_b1
Subsets in Variable GROUP
With Values Ctrl and Treat

For Subsets:	Geometric Mean	Geometric Std. Dev.	n
Ctrl	0.27	3.37	56
Treat	0.56	3.83	55

t Statistic = 2.99586
Degrees of Freedom = 109
One-Tailed Prob = 0.0017
Two-Tailed Prob = 0.0034

Treatment had significantly higher carpet lead loadings than control

Test for Difference in Mean Baseline Carpet Sample Dust Between Groups

Command: TIND Missing Value Treatment: Listwise
Selection: LOST<>T and GROUP<>'Blank'

***** INDEPENDENT T TEST ***** **Baseline Measures**

For Variable: lnMdust_b1
Subsets in Variable GROUP
With Values Ctrl and Treat

For Subsets:	Geometric Mean	Geometric Std. Dev.	n
Ctrl	364	3	56
Treat	578	4	55

t Statistic = 1.98295
Degrees of Freedom = 109
One-Tailed Prob = 0.0249
Two-Tailed Prob = 0.0499

Treatment had significantly higher carpet dust loadings than control

Test for Difference In Mean Baseline Carpet Sample Concentration Between Groups

Command: TIND Missing Value Treatment: Listwise
Selection: LOST<>T and GROUP<>'Blank'

***** INDEPENDENT T TEST ***** **Baseline Measures**

For Variable: lnMconc_b1
Subsets in Variable GROUP
With Values Ctrl and Treat

For Subsets:	Geometric Mean	Geometric Std. Dev.	n
Ctrl	748	2	56
Treat	971	2	55

t Statistic =	2.08724
Degrees of Freedom =	109
One-Tailed Prob =	0.0196
Two-Tailed Prob =	**0.0392**

Treatment had significantly higher carpet lead concentrations than control

Test for Bias in Baseline Carpet Lead Sampling by Microvac

Command: REGR Missing Value Treatment: Listwise
Selection: LOST<>'TRUE' and GROUP<>'Blank'

***** Multiple Linear Regression ***** **Baseline Measures**

*** Stepwise Regression – Backward Elimination
Variables Selected: lnBld1,Group_n (Initital blood lead & group code – Ctrl=0, Treat=1)
Prob Value to add/remove: 0.05

Dependent Variable: **LNMLEAD_B1** 111 Valid Records
Coeff of Determ: 0.305086
Adjusted R Square: 0.292217 Estimated constant term: -5.36469
Multiple Corr Coeff: 0.552346 Standard Err of Estimate: 1.1152

Analysis of Variance for the Regression:

Source of Variance	Degrees of Freedom	Sum of Squares	Mean of Squares	F Test	Prob
Regression	2	58.9683	29.4841	23.7074	0
Residuals	108	134.316	1.24367		
Total	110	193.284			

Variable	Regression Coefficient	Standardized Coefficient	Standard Error	t	Prob
LNBLD1	1.67782	0.479751	0.281237	5.96585	0
GROUP_N	0.638386	0.24188	0.21224	3.00785	0.0033

Significant bias – Treatment group carpet leads would have to be multiplied by ***0.53***

Test for Difference in Mean Baseline Carpet Lead by Microvac and by HEPA Vac

Command: TPAIR Missing Value Treatment: Pairwise
Selection: LOST<>T and GROUP<>'Blank'

Baseline Measures

***** Paired t Test *****

		Geometric Mean	Geometric Std. Dev.	n
For Variables:	lnMlead_b1	0.56	3.83	55
and	lnVlead1	1.16	3.01	55

t Statistic =	-5.19942
Degrees of Freedom =	54
One-Tailed Prob =	0.0000
Two-Tailed Prob =	0.0000

HEPA Vac lead loadings are significantly greater than Microvac lead loadings

Command: REGR Missing Value Treatment: Listwise
Selection: GROUP<>'Blank' and LOST<>'T'

***** Multiple Linear Regression ***** **Blood Lead and Microvac Samples**

Dependent Variable:	**lnBld1**	111 Valid Records	
Coeff of Determ:	0.25		
Adjusted R Square:	0.24	Estimated constant term:	2.58163
Multiple Corr Coeff:	**0.50**	Standard Err of Estimate:	0.330438

Analysis of Variance for the Regression:

Source of Variance	Degrees of Freedom	Sum of Squares	Mean of Squares	F Test	Prob
Regression	1	3.90132	3.90132	35.7299	0
Residuals	109	11.9016	0.109189		
Total	110	15.803			

Variable	Regression Coefficient	Standardized Coefficient	Standard Error	t	**Prob**
lnMlead_b1	0.142072	0.496863	0.023768	5.97745	**0**

Command: REGR Missing Value Treatment: Listwise
Selection: GROUP<>'Blank' and LOST<>'T'

***** Multiple Linear Regression ***** **Blood Lead and Microvac Samples**

Dependent Variable:	**lnBld1**	111 Valid Records	
Coeff of Determ:	0.16		
Adjusted R Square:	0.15	Estimated constant term:	1.70741
Multiple Corr Coeff:	**0.40**	Standard Err of Estimate:	0.349422

Analysis of Variance for the Regression:

Source of Variance	Degrees of Freedom	Sum of Squares	Mean of Squares	F Test	Prob
Regression	1	2.49456	2.49456	20.4312	0
Residuals	109	13.3084	0.122096		
Total	110	15.803			

Variable	Regression Coefficient	Standardized Coefficient	Standard Error	t	**Prob**
lnMdust_b1	0.120885	0.397308	0.026744	4.52009	**0**

Command: REGR Missing Value Treatment: Listwise
Selection: GROUP<>'Blank' and LOST<>'TRUE'
Breakdown on variable GROUP = Ctrl

***** Multiple Linear Regression ***** **Blood Lead and Microvac Samples**

Dependent Variable: **lnBld1** 56 Valid Records
Coeff of Determ: 0.25
Adjusted R Square: 0.23 Estimated constant term: 2.62996
Multiple Corr Coeff: **0.50** Standard Err of Estimate: 0.342781

Analysis of Variance for the Regression:

Source of Variance	Degrees of Freedom	Sum of Squares	Mean of Squares	F Test	Prob
Regression	1	2.08126	2.08126	17.713	0
Residuals	54	6.34494	0.117499		
Total	55	8.4262			

Variable	Regression Coefficient	Standardized Coefficient	Standard Error	t	Prob
lnMlead_b1	0.160155	0.49699	0.0380534	4.20869	0

Command: REGR Missing Value Treatment: Listwise
Selection: GROUP<>'Blank' and LOST<>'TRUE'
Breakdown on variable GROUP = Treat

***** Multiple Linear Regression ***** **Blood Lead and Microvac Samples**

Dependent Variable: **lnBld1** 55 Valid Records
Coeff of Determ: 0.25
Adjusted R Square: 0.24 Estimated constant term: 2.55369
Multiple Corr Coeff: **0.50** Standard Err of Estimate: 0.320923

Analysis of Variance for the Regression:

Source of Variance	Degrees of Freedom	Sum of Squares	Mean of Squares	F Test	Prob
Regression	1	1.8391	1.8391	17.8568	0
Residuals	53	5.45857	0.102992		
Total	54	7.29767			

Variable	Regression Coefficient	Standardized Coefficient	Standard Error	t	Prob
lnMlead_b1	0.137385	0.502008	0.0325116	4.22573	0

Command: REGR Missing Value Treatment: Listwise
Selection: GROUP<>'Blank' and LOST<>'T'
Breakdown on variable GROUP = Ctrl

***** Multiple Linear Regression ***** **Blood Lead and Microvac Samples**

Dependent Variable:	**lnBld1**	56 Valid Records	
Coeff of Determ:	0.12		
Adjusted R Square:	0.11	Estimated constant term:	1.69815
Multiple Corr Coeff:	**0.35**	Standard Err of Estimate:	0.369918

Analysis of Variance for the Regression:

Source of Variance	Degrees of Freedom	Sum of Squares	Mean of Squares	F Test	Prob
Regression	1	1.03687	1.03687	7.5773	0.008
Residuals	54	7.38933	0.136839		
Total	55	8.4262			

Variable	Regression Coefficient	Standardized Coefficient	Standard Error	t	Prob
lnMdust_b1	0.12267	0.35079	0.044564	2.75269	**0.008**

Command: REGR Missing Value Treatment: Listwise
Selection: GROUP<>'Blank' and LOST<>'T'
Breakdown on variable GROUP = Treat

***** Multiple Linear Regression ***** **Blood Lead and Microvac Samples**

Dependent Variable:	**lnBld1**	55 Valid Records	
Coeff of Determ:	0.19		
Adjusted R Square:	0.17	Estimated constant term:	1.7121
Multiple Corr Coeff:	**0.43**	Standard Err of Estimate:	0.334173

Analysis of Variance for the Regression:

Source of Variance	Degrees of Freedom	Sum of Squares	Mean of Squares	F Test	Prob
Regression	1	1.37907	1.37907	12.3494	0.0009
Residuals	53	5.9186	0.111672		
Total	54	7.29767			

Variable	Regression Coefficient	Standardized Coefficient	Standard Error	t	Prob
lnMdust_b1	0.119945	0.434712	0.034132	3.51417	**0.0009**

Command: REGR Missing Value Treatment: Listwise
Selection: GROUP<>'Blank' and LOST<>'T'
Breakdown on variable GROUP = Ctrl

***** Multiple Linear Regression ***** **Blood Lead and Microvac Samples**

Dependent Variable: **lnBld1** 56 Valid Records
Coeff of Determ: 0.10
Adjusted R Square: 0.09 Estimated constant term: 1.15584
Multiple Corr Coeff: **0.32** Standard Err of Estimate: 0.374342

Analysis of Variance for the Regression:

Source of Variance	Degrees of Freedom	Sum of Squares	Mean of Squares	F Test	Prob
Regression	1	0.859068	0.859068	6.13042	0.0165
Residuals	54	7.56714	0.140132		
Total	55	8.4262			

Variable	Regression Coefficient	Standardized Coefficient	Standard Error	t	Prob
lnMconc_b1	0.191261	0.319299	0.077247	2.47597	**0.0165**

Command: REGR Missing Value Treatment: Listwise
Selection: GROUP<>'Blank' and LOST<>'T'
Breakdown on variable GROUP = Treat

***** Multiple Linear Regression ***** **Blood Lead and Microvac Samples**

Dependent Variable: **lnBld1** 55 Valid Records
Coeff of Determ: 0.02
Adjusted R Square: 0.00 Estimated constant term: 1.91596
Multiple Corr Coeff: **0.15** Standard Err of Estimate: 0.367064

Analysis of Variance for the Regression:

Source of Variance	Degrees of Freedom	Sum of Squares	Mean of Squares	F Test	Prob
Regression	1	0.15668	0.15668	1.16287	0.2858
Residuals	53	7.14099	0.134736		
Total	54	7.29767			

Variable	Regression Coefficient	Standardized Coefficient	Standard Error	t	Prob
lnMconc_b1	0.081256	0.146526	0.075352	1.07836	**0.2858**

Command: REGR Missing Value Treatment: Listwise
Selection: GROUP<>'Blank' and LOST<>'T' and TECH1='Dave'

***** Multiple Linear Regression ***** **Blood Lead and Microvac Samples**

Dependent Variable:	**lnBld1**	37 Valid Records	
Coeff of Determ:	0.34		
Adjusted R Square:	0.32	Estimated constant term:	2.64429
Multiple Corr Coeff:	**0.58**	Standard Err of Estimate:	0.314102

Analysis of Variance for the Regression:

Source of Variance	Degrees of Freedom	Sum of Squares	Mean of Squares	F Test	Prob
Regression	1	1.78408	1.78408	18.0831	0.0001
Residuals	35	3.4531	0.09866		
Total	36	5.23717			

Variable	Regression Coefficient	Standardized Coefficient	Standard Error	t	Prob
lnMlead_b1	0.168678	0.583658	0.039666	4.25242	**0.0001**

Command: REGR Missing Value Treatment: Listwise
Selection: GROUP<>'Blank' and LOST<>'T' and TECH1='Shelley'

***** Multiple Linear Regression *****

Dependent Variable:	**lnBld1**	31 Valid Records	
Coeff of Determ:	0.32		
Adjusted R Square:	0.30	Estimated constant term:	2.48103
Multiple Corr Coeff:	**0.57**	Standard Err of Estimate:	0.321809

Analysis of Variance for the Regression:

Source of Variance	Degrees of Freedom	Sum of Squares	Mean of Squares	F Test	Prob
Regression	1	1.42384	1.42384	13.7488	0.0009
Residuals	29	3.00326	0.103561		
Total	30	4.42711			

Variable	Regression Coefficient	Standardized Coefficient	Standard Error	t	Prob
lnMlead_b1	0.203989	0.567115	0.055014	3.70794	**0.0009**

Command: REGR Missing Value Treatment: Listwise
Selection: GROUP<>'Blank' and LOST<>'T' and TECH1='Shelley' and GROUP='Treat'

***** Multiple Linear Regression ***** **Blood Lead and Microvac Samples**

Dependent Variable:	**lnBld1**	28 Valid Records	
Coeff of Determ:	0.29		
Adjusted R Square:	0.26	Estimated constant term:	2.47567
Multiple Corr Coeff:	**0.54**	Standard Err of Estimate:	0.331154

Analysis of Variance for the Regression:

Source of Variance	Degrees of Freedom	Sum of Squares	Mean of Squares	F Test	Prob
Regression	1	1.17692	1.17692	10.7322	0.003
Residuals	26	2.85124	0.109663		
Total	27	4.02816			

Variable	Regression Coefficient	Standardized Coefficient	Standard Error	t	Prob
lnMlead_b1	0.214255	0.540531	0.065402	3.276	**0.003**

Command: REGR Missing Value Treatment: Listwise
Selection: GROUP<>'Blank' and LOST<>'T' and TECH1='Dave' and GROUP='Treat'

***** Multiple Linear Regression *****

Dependent Variable:	**lnBld1**	25 Valid Records	
Coeff of Determ:	0.27		
Adjusted R Square:	0.24	Estimated constant term:	2.61634
Multiple Corr Coeff:	**0.52**	Standard Err of Estimate:	0.283076

Analysis of Variance for the Regression:

Source of Variance	Degrees of Freedom	Sum of Squares	Mean of Squares	F Test	Prob
Regression	1	0.679646	0.679646	8.4816	0.0078
Residuals	23	1.84303	0.080132		
Total	24	2.52268			

Variable	Regression Coefficient	Standardized Coefficient	Standard Error	t	Prob
lnMlead_b1	0.131293	0.519051	0.045082	2.91232	**0.0078**

Command: REGR Missing Value Treatment: Listwise
Selection: GROUP<>'Blank' and LOST<>'T' and TECH1='Dave' and GROUP='Ctrl'

***** Multiple Linear Regression ***** **Blood Lead and Microvac Samples**

Dependent Variable: **lnBld1** 12 Valid Records
Coeff of Determ: 0.42
Adjusted R Square: 0.36 Estimated constant term: 2.69991
Multiple Corr Coeff: **0.65** Standard Err of Estimate: 0.380391

Analysis of Variance for the Regression:

Source of Variance	Degrees of Freedom	Sum of Squares	Mean of Squares	F Test	Prob
Regression	1	1.05643	1.05643	7.30097	0.0222
Residuals	10	1.44697	0.144697		
Total	11	2.5034			

Variable	Regression Coefficient	Standardized Coefficient	Standard Error	t	**Prob**
lnMlead_b1	0.223894	0.649614	0.082861	2.70203	**0.0222**

Command: REGR Missing Value Treatment: Listwise
Selection: GROUP<>'Blank' and LOST<>'T' and TECH1='Cheryl' and GROUP='Ctrl'

***** Multiple Linear Regression ***** **Blood Lead and Microvac Samples**

Dependent Variable: **lnBld1** 15 Valid Records
Coeff of Determ: 0.04
Adjusted R Square: -0.03 Estimated constant term: 2.76347
Multiple Corr Coeff: **0.20** Standard Err of Estimate: 0.280521

Analysis of Variance for the Regression:

Source of Variance	Degrees of Freedom	Sum of Squares	Mean of Squares	F Test	Prob
Regression	1	0.042867	0.042867	0.544741	0.4736
Residuals	13	1.02299	0.078692		
Total	14	1.06586			

Variable	Regression Coefficient	Standardized Coefficient	Standard Error	t	**Prob**
lnMlead_b1	0.054211	0.200544	0.07345	0.738066	**0.4736**

(Cheryl only sampled at homes with elevated kids)

Command: REGR Missing Value Treatment: Listwise
Selection: GROUP<>'Blank' and LOST<>'T' and TECH1='Leona' and GROUP='Ctrl'

***** Multiple Linear Regression ***** **Blood Lead and Microvac Samples**

Dependent Variable:	**lnBld1**	16 Valid Records	
Coeff of Determ:	0.47		
Adjusted R Square:	0.43	Estimated constant term:	2.7406
Multiple Corr Coeff:	**0.69**	Standard Err of Estimate:	0.285586

Analysis of Variance for the Regression:

Source of Variance	Degrees of Freedom	Sum of Squares	Mean of Squares	F Test	Prob
Regression	1	1.01781	1.01781	12.4794	0.0033
Residuals	14	1.14183	0.081559		
Total	15	2.15964			

Variable	Regression Coefficient	Standardized Coefficient	Standard Error	t	Prob
lnMlead_b1	0.291157	0.686503	0.08242	3.53261	**0.0033**

Command: REGR Missing Value Treatment: Listwise
Selection: GROUP<>'Blank' and LOST<>'T' and TECH1='Leona' and GROUP='Ctrl'

***** Multiple Linear Regression ***** **Blood Lead and Hand Wipes**

Dependent Variable:	**lnBld1**	16 Valid Records	
Coeff of Determ:	0.15		
Adjusted R Square:	0.09	Estimated constant term:	1.93943
Multiple Corr Coeff:	**0.39**	Standard Err of Estimate:	0.362294

Analysis of Variance for the Regression:

Source of Variance	Degrees of Freedom	Sum of Squares	Mean of Squares	F Test	Prob
Regression	1	0.322046	0.322046	2.45356	0.1396
Residuals	14	1.83759	0.131257		
Total	15	2.15964			

Variable	Regression Coefficient	Standardized Coefficient	Standard Error	t	Prob
lnHand1	0.189684	0.386161	0.121097	1.56638	**0.1396**

Command: REGR Missing Value Treatment: Listwise
Selection: GROUP<>'Blank' and LOST<>'T' and TECH1='Dave' and GROUP='Ctrl'

***** Multiple Linear Regression ***** **Blood Lead and Hand Wipes**

Dependent Variable: **lnBld1** 12 Valid Records

Coeff of Determ:	0.38		
Adjusted R Square:	0.32	Estimated constant term:	1.6265
Multiple Corr Coeff:	**0.62**	Standard Err of Estimate:	0.393352

Analysis of Variance for the Regression:

Source of Variance	Degrees of Freedom	Sum of Squares	Mean of Squares	F Test	Prob
Regression	1	0.956142	0.956142	6.17959	0.0322
Residuals	10	1.54726	0.154726		
Total	11	2.5034			

Variable	Regression Coefficient	Standardized Coefficient	Standard Error	t	**Prob**
lnHand1	0.273142	0.618011	0.109877	2.48588	**0.0322**

Command: REGR Missing Value Treatment: Listwise
Selection: GROUP<>'Blank' and LOST<>'T' and TECH1='Cheryl' and GROUP='Ctrl'

***** Multiple Linear Regression ***** **Blood Lead and Hand Wipes**

Dependent Variable: **lnBld1** 15 Valid Records

Coeff of Determ:	0.08		
Adjusted R Square:	0.01	Estimated constant term:	3.02204
Multiple Corr Coeff:	**0.29**	Standard Err of Estimate:	0.274418

Analysis of Variance for the Regression:

Source of Variance	Degrees of Freedom	Sum of Squares	Mean of Squares	F Test	Prob
Regression	1	0.086892	0.086892	1.15387	0.3023
Residuals	13	0.978968	0.075305		
Total	14	1.06586			

Variable	Regression Coefficient	Standardized Coefficient	Standard Error	t	**Prob**
lnHand1	-0.11748	-0.28552	0.109371	-1.07418	**0.3023**

Command: REGR Missing Value Treatment: Listwise
Selection: GROUP<>'Blank' and LOST<>'T' and TECH1='Dave' and GROUP='Treat'

***** Multiple Linear Regression ***** **Blood Lead and Hand Wipes**

Dependent Variable:	**lnBld1**	25 Valid Records	
Coeff of Determ:	0.23		
Adjusted R Square:	0.20	Estimated constant term:	1.96986
Multiple Corr Coeff:	**0.48**	Standard Err of Estimate:	0.290246

Analysis of Variance for the Regression:

Source of Variance	Degrees of Freedom	Sum of Squares	Mean of Squares	F Test	Prob
Regression	1	0.585091	0.585091	6.94527	0.0148
Residuals	23	1.93759	0.084243		
Total	24	2.52268			

Variable	Regression Coefficient	Standardized Coefficient	Standard Error	t	Prob
lnHand1	0.206661	0.481593	0.078418	2.63539	**0.0148**

Command: REGR Missing Value Treatment: Listwise
Selection: GROUP<>'Blank' and LOST<>'T' and TECH1='Shelley' and GROUP='Treat'

***** Multiple Linear Regression ***** **Blood Lead and Hand Wipes**

Dependent Variable:	**lnBld1**	28 Valid Records	
Coeff of Determ:	0.01		
Adjusted R Square:	-0.03	Estimated constant term:	2.64059
Multiple Corr Coeff:	**0.11**	Standard Err of Estimate:	0.391398

Analysis of Variance for the Regression:

Source of Variance	Degrees of Freedom	Sum of Squares	Mean of Squares	F Test	Prob
Regression	1	0.045167	0.045167	0.294839	0.5918
Residuals	26	3.983	0.153192		
Total	27	4.02816			

Variable	Regression Coefficient	Standardized Coefficient	Standard Error	t	Prob
lnHand1	-0.05845	-0.10589	0.107651	-0.54299	**0.5918**

Command: REGR Missing Value Treatment: Listwise
Selection: GROUP<>'Blank' and LOST<>'T'
Breakdown on variable GROUP = Ctrl

***** Multiple Linear Regression ***** **Blood Lead and Hand Wipes**

Dependent Variable:	**lnBld1**	55 Valid Records	
Coeff of Determ:	0.18		
Adjusted R Square:	0.17	Estimated constant term:	1.93008
Multiple Corr Coeff:	**0.43**	Standard Err of Estimate:	0.359436

Analysis of Variance for the Regression:

Source of Variance	Degrees of Freedom	Sum of Squares	Mean of Squares	F Test	Prob
Regression	1	1.52756	1.52756	11.8237	0.0011
Residuals	53	6.8473	0.129194		
Total	54	8.37486			

Variable	Regression Coefficient	Standardized Coefficient	Standard Error	t	**Prob**
lnHand1	0.211095	0.427081	0.06139	3.43856	**0.0011**

Command: REGR Missing Value Treatment: Listwise
Selection: GROUP<>'Blank' and LOST<>'T'
Breakdown on variable GROUP = Treat

***** Multiple Linear Regression ***** **Blood Lead and Hand Wipes**

Dependent Variable:	**lnBld1**	55 Valid Records	
Coeff of Determ:	0.05		
Adjusted R Square:	0.03	Estimated constant term:	2.21126
Multiple Corr Coeff:	**0.22**	Standard Err of Estimate:	0.361994

Analysis of Variance for the Regression:

Source of Variance	Degrees of Freedom	Sum of Squares	Mean of Squares	F Test	Prob
Regression	1	0.352549	0.352549	2.69039	0.1069
Residuals	53	6.94512	0.13104		
Total	54	7.29767			

Variable	Regression Coefficient	Standardized Coefficient	Standard Error	t	**Prob**
lnHand1	0.10984	0.219795	0.066966	1.64024	**0.1069**

Command: REGR Missing Value Treatment: Listwise
Selection: GROUP<>'Blank' and LOST<>'T'

***** Multiple Linear Regression ***** **Blood Lead and HEPA Vac Samples**

Dependent Variable:	**lnBld1**	55 Valid Records	
Coeff of Determ:	0.37		
Adjusted R Square:	0.35	Estimated constant term:	0.704327
Multiple Corr Coeff:	**0.61**	Standard Err of Estimate:	0.295437

Analysis of Variance for the Regression:

Source of Variance	Degrees of Freedom	Sum of Squares	Mean of Squares	F Test	Prob
Regression	1	2.67166	2.67166	30.6091	0
Residuals	53	4.62601	0.087283		
Total	54	7.29767			

Variable	Regression Coefficient	Standardized Coefficient	Standard Error	t	Prob
lnVdust1	0.240516	0.60506	0.043473	5.53255	**0**

Command: REGR Missing Value Treatment: Listwise
Selection: GROUP<>'Blank' and LOST<>'T'

***** Multiple Linear Regression ***** **Blood Lead and HEPA Vac Samples**

Dependent Variable:	**lnBld1**	55 Valid Records	
Coeff of Determ:	0.37		
Adjusted R Square:	0.36	Estimated constant term:	2.44412
Multiple Corr Coeff:	**0.61**	Standard Err of Estimate:	0.293472

Analysis of Variance for the Regression:

Source of Variance	Degrees of Freedom	Sum of Squares	Mean of Squares	F Test	Prob
Regression	1	2.733	2.733	31.7327	0
Residuals	53	4.56467	0.086126		
Total	54	7.29767			

Variable	Regression Coefficient	Standardized Coefficient	Standard Error	t	Prob
lnVlead1	0.204006	0.611967	0.036215	5.63317	**0**

Command: REGR Missing Value Treatment: Listwise
Selection: GROUP<>'Blank' and LOST<>'T'
Breakdown on variable OPER1 = Donna

***** Multiple Linear Regression ***** **Blood Lead and HEPA Vac Samples**

Dependent Variable:	**lnBld1**	3 Valid Records	
Coeff of Determ:	0.45		
Adjusted R Square:	-0.10	Estimated constant term:	2.38163
Multiple Corr Coeff:	**0.67**	Standard Err of Estimate:	0.134794

Analysis of Variance for the Regression:

Source of Variance	Degrees of Freedom	Sum of Squares	Mean of Squares	F Test	Prob
Regression	1	0.015015	0.015015	0.82639	0.5303
Residuals	1	0.01817	0.01817		
Total	2	0.033185			

Variable	Regression Coefficient	Standardized Coefficient	Standard Error	t	Prob
lnVlead1	-0.18701	-0.67266	0.205714	-0.90906	**0.5303**

Command: REGR Missing Value Treatment: Listwise
Selection: GROUP<>'Blank' and LOST<>'T'
Breakdown on variable OPER1 = Karen

***** Multiple Linear Regression ***** **Blood Lead and HEPA Vac Samples**

Dependent Variable:	**lnBld1**	20 Valid Records	
Coeff of Determ:	0.42		
Adjusted R Square:	0.39	Estimated constant term:	2.4462
Multiple Corr Coeff:	**0.65**	Standard Err of Estimate:	0.267931

Analysis of Variance for the Regression:

Source of Variance	Degrees of Freedom	Sum of Squares	Mean of Squares	F Test	Prob
Regression	1	0.943955	0.943955	13.1494	0.0019
Residuals	18	1.29217	0.071787		
Total	19	2.23612			

Variable	Regression Coefficient	Standardized Coefficient	Standard Error	t	Prob
lnVlead1	0.184943	0.649722	0.051002	3.62621	**0.0019**

Command: REGR Missing Value Treatment: Listwise
Selection: GROUP<>'Blank' and LOST<>'T'
Breakdown on variable OPER1 = Kevin

***** Multiple Linear Regression ***** **Blood Lead and HEPA Vac Samples**

Dependent Variable:	**lnBld1**	30 Valid Records	
Coeff of Determ:	0.38		
Adjusted R Square:	0.35	Estimated constant term:	2.45979
Multiple Corr Coeff:	**0.61**	Standard Err of Estimate:	0.320202

Analysis of Variance for the Regression:

Source of Variance	Degrees of Freedom	Sum of Squares	Mean of Squares	F Test	Prob
Regression	1	1.7364	1.7364	16.9357	0.0003
Residuals	28	2.87082	0.102529		
Total	29	4.60723			

Variable	Regression Coefficient	Standardized Coefficient	Standard Error	t	**Prob**
lnVlead1	0.21726	0.613911	0.052793	4.1153	**0.0003**

Command: REGR Missing Value Treatment: Listwise
Selection: GROUP<>'Blank' and LOST<>'T'
Breakdown on variable OPER1 = Donna

***** Multiple Linear Regression ***** **Blood Lead and HEPA Vac Samples**

Dependent Variable:	**lnBld1**	3 Valid Records	
Coeff of Determ:	0.17		
Adjusted R Square:	-0.66	Estimated constant term:	2.98966
Multiple Corr Coeff:	**0.41**	Standard Err of Estimate:	0.165848

Analysis of Variance for the Regression:

Source of Variance	Degrees of Freedom	Sum of Squares	Mean of Squares	F Test	Prob
Regression	1	0.005679	0.005679	0.206476	0.7285
Residuals	1	0.027506	0.027506		
Total	2	0.033185			

Variable	Regression Coefficient	Standardized Coefficient	Standard Error	t	**Prob**
lnVdust1	-0.08372	-0.41369	0.184253	-0.4544	**0.7285**

Command: REGR Missing Value Treatment: Listwise
Selection: GROUP<>'Blank' and LOST<>'T'
Breakdown on variable OPER1 = Karen

***** Multiple Linear Regression ***** **Blood Lead and HEPA Vac Samples**

Dependent Variable:	**lnBld1**	20 Valid Records	
Coeff of Determ:	0.38		
Adjusted R Square:	0.35	Estimated constant term:	0.913113
Multiple Corr Coeff:	**0.62**	Standard Err of Estimate:	0.276795

Analysis of Variance for the Regression:

Source of Variance	Degrees of Freedom	Sum of Squares	Mean of Squares	F Test	Prob
Regression	1	0.857048	0.857048	11.1864	0.0036
Residuals	18	1.37907	0.076615		
Total	19	2.23612			

Variable	Regression Coefficient	Standardized Coefficient	Standard Error	t	Prob
lnVdust1	0.211226	0.619091	0.063154	3.34461	**0.0036**

Command: REGR Missing Value Treatment: Listwise
Selection: GROUP<>'Blank' and LOST<>'T'
Breakdown on variable OPER1 = Kevin

***** Multiple Linear Regression ***** **Blood Lead and HEPA Vac Samples**

Dependent Variable:	**lnBld1**	30 Valid Records	
Coeff of Determ:	0.42		
Adjusted R Square:	0.40	Estimated constant term:	0.487935
Multiple Corr Coeff:	**0.64**	Standard Err of Estimate:	0.309985

Analysis of Variance for the Regression:

Source of Variance	Degrees of Freedom	Sum of Squares	Mean of Squares	F Test	Prob
Regression	1	1.91669	1.91669	19.9466	0.0001
Residuals	28	2.69054	0.096091		
Total	29	4.60723			

Variable	Regression Coefficient	Standardized Coefficient	Standard Error	t	Prob
lnVdust1	0.27286	0.644994	0.061095	4.46616	**0.0001**

Command: CORR Missing Value Treatment: Pairwise Selection: LOST<>T and GROUP<>'Blank'

***** Correlation Matrix *****

Variables:

lnBld1	1					
lnMdust_b1	0.40	1				
Prob	0					
n	111					
lnMlead_b1	0.50	0.87	1			
Prob	0	0				
n	111	111				
lnMconc_b1	0.24	-0.14	0.38	1		
Prob	0.0098	0.1492	0			
n	111	111	111			
lnHand1	0.33	0.27	0.38	0.25	1	
Prob	0.0004	0.0048	0	0.0086		
n	110	110	110	110		
lnVdust1	0.61	0.60	0.61	0.04	0.47	1
Prob	0	0	0	0.7654	0.0003	
n	55	55	55	55	55	
lnVlead1	0.61	0.58	0.66	0.17	0.46	0.92
Prob	0	0	0	0.2025	0.0005	0
n	55	55	55	55	55	55
lnVleadc1	0.27	0.20	0.37	0.36	0.16	0.22
Prob	0.0483	0.1416	0.0052	0.0073	0.2431	0.1071
n	55	55	55	55	55	55
	lnBld1	**lnMdust_b1**	**lnMlead_b1**	**lnMconc_b1**	**lnHand1**	**lnVdust1**

Significant Correlations between Baseline:	**r**
HEPA Vac Dust Loading and HEPA Vac Lead Loading	0.92
Microvac Dust Loading and Microvac Lead Loading	0.87
Microvac Lead Loading and HEPA Vac Lead Loading	0.66
Blood Lead and HEPA Vac Dust Loading	0.61
Blood Lead and HEPA Vac Lead Loading	0.61
Blood Lead and Microvac Lead Loading	0.50
Blood Lead and Microvac Dust Loading	0.40
Blood Lead and Hand Lead Loading	0.33
Blood Lead and HEPA Vac Lead Concentration	0.27
Blood Lead and Microvac Lead Concentration	0.24
Microvac Lead Loading and HEPA Vac Dust Loading	0.61
Microvac Dust Loading and HEPA Vac Dust Loading	0.60
HEPA Vac Lead Loading and HEPA Vac Lead Concentration	0.58
Microvac Dust Loading and HEPA Vac Lead Loading	0.58
Hand Lead Loading and HEPA Vac Dust Loading	0.47
Hand Lead Loading and HEPA Vac Lead Loading	0.46
Microvac Lead Loading and Hand Lead Loading	0.38
Microvac Lead Loading and Microvac Lead Concentration	0.38
Microvac Lead Loading and HEPA Vac Lead Concentration	0.37
Microvac Lead Concentration and HEPA Vac Lead Concentration	0.36
Microvac Dust Loading and Hand Lead Loading	0.27
Microvac Lead Concentration and Hand Lead Loading	0.25

Command: DESC Missing Value Treatment: Varwise CYCLE 1
Selection: GROUP<>'Blank' and LOST<>'T'

***** Descriptive Statistics ***** **Microvac Samples as a Measure of Vacuuming Effect**

Current file is e:\hepa\data\hepa_win.abd
There are 116 variables and 120 records in this data file
111 Records (92.5%) are in this subset
55 Records (49.5%) are valid

Variable	Mean	Std.Dev.	Variance	Std Error of mean	Coeff of variation
MDUST_A1	840	1260.55	1588974	169.972	150.133
MLEAD_A1	0.77	1.03568	1.07263	0.139651	134.95
MCONC_A1	1206	1496.27	2238822	201.757	124.076

Variable	Minimum	Maximum	Range	Total
MDUST_A1	6	8381	8375	46179
MLEAD_A1	0.01	5.15	5.14	42.21
MCONC_A1	327	10299	9972	66326

Test for difference between Microvac Sample Dust before and after Vacuuming

Command: TPAIR Missing Value Treatment: Pairwise CYCLE 1
Selection: GROUP<>'Blank' and LOST<>'T'

***** Paired t Test *****

		Geometric Mean	Geometric Std Deviation	n
For Variables:	lnMdust_b1	578	3.79	55
and	lnMdust_a1	382	4.32	55
	% change	-34%		

t Statistic = 3.79765
Degrees of Freedom = 54
One-Tailed Prob = 0.0002
Two-Tailed Prob = 0.0004

Microvac dust loadings were significantly lower after vacuuming

Test for difference between Microvac Sample Lead before and after Vacuuming

Command: TPAIR Missing Value Treatment: Pairwise **CYCLE 1**
Selection: GROUP<>'Blank' and LOST<>'T'

***** Paired t Test *****

		Geometric Mean	Geometric Std Deviation	n
For Variables:	lnMlead_b1	0.56	3.83	55
and	lnMlead_a1	0.34	4.08	55
	% change	-39%		

t Statistic =	6.28976
Degrees of Freedom =	54
One-Tailed Prob =	0
Two-Tailed Prob =	**0**

Microvac lead loadings were significantly lower after vacuuming

Test for difference between Microvac Sample Concentration before and after Vacuuming

Command: TPAIR Missing Value Treatment: Pairwise **CYCLE 1**
Selection: GROUP<>'Blank' and LOST<>'T'

***** Paired t Test *****

		Geometric Mean	Geometric Std Deviation	n
For Variables:	lnMconc_b1	971	1.94	55
and	lnMconc_a1	895	1.94	55
	% change	-8%		

t Statistic =	0.832263
Degrees of Freedom =	54
One-Tailed Prob =	0.2045
Two-Tailed Prob =	**0.4089**

Microvac lead concentrations did not change significantly

Command: DESC Missing Value Treatment: Varwise **CYCLE 4**
Selection: GROUP<>'Blank' and LOST<>'T'

***** Descriptive Statistics ***** **Microvac Samples as a Measure of Vacuuming Effect**

Current file is e:\hepa\data\hepa_win.abd
There are 116 variables and 120 records in this data file
111 Records (92.5%) are in this subset
52 Records (46.8%) are valid

Variable	Mean	Std.Dev.	Variance	Std Error of mean	Coeff of variation
MDUST_A4	449	405.066	164079	56.1726	90.1959
MLEAD_A4	0.39	0.401614	0.161294	0.055694	102.978
MCONC_A4	988	1048.62	1099608	145.418	106.177

Variable	Minimum	Maximum	Range	Total
MDUST_A4	37	1755	1718	23353
MLEAD_A4	0.01	2.32	2.31	20.28
MCONC_A4	127	6842	6715	51356

Test for difference between Microvac Sample Dust before and after Vacuuming

Command: TPAIR Missing Value Treatment: Pairwise **CYCLE 4**
Selection: GROUP<>'Blank' and LOST<>'T'

***** Paired t Test *****

		Geometric Mean	Geometric Std Deviation	n
For Variables:	lnMdust_b4	443	2.33	52
and	lnMdust_a4	295	2.68	52
	% change	-34%		

t Statistic =	4.41295
Degrees of Freedom =	51
One-Tailed Prob =	0
Two-Tailed Prob =	**0**

Microvac dust loadings were significantly lower after vacuuming

Test for difference between Microvac Sample Lead before and after Vacuuming

Command: TPAIR Missing Value Treatment: Pairwise **CYCLE 4**
Selection: GROUP<>'Blank' and LOST<>'T'

***** Paired t Test *****

		Geometric Mean	Geometric Std Deviation	n
For Variables:	lnMlead_b4	0.35	3.42	52
and	lnMlead_a4	0.22	3.45	52
	% change	-35%		

t Statistic =	4.62016
Degrees of Freedom =	51
One-Tailed Prob =	0
Two-Tailed Prob =	**0**

Microvac lead loadings were significantly lower after vacuuming

Test for difference between Microvac Sample Concentration before and after Vacuuming

Command: TPAIR Missing Value Treatment: Pairwise **CYCLE 4**
Selection: GROUP<>'Blank' and LOST<>'T'

***** Paired t Test *****

		Geometric Mean	Geometric Std Deviation	n
For Variables:	lnMconc_b4	778	2.29	52
and	lnMconc_a4	755	2.00	52
	% change	-3%		

t Statistic =	0.345884
Degrees of Freedom =	51
One-Tailed Prob =	0.3654
Two-Tailed Prob =	**0.7309**

Microvac lead concentrations did not change significantly

Command: DESC Missing Value Treatment: Varwise **CYCLE 7**
Selection: GROUP<>'Blank' and LOST<>'TRUE'

***** Descriptive Statistics ***** **Microvac Samples as a Measure of Vacuuming Effect**

Current file is e:\hepa\data\hepa_win.abd
There are 164 variables and 120 records in this data file

111 Records (92.5%) are in this subset

Variable	Valid Records	Number Missing	% Missing
MDUST_A7	52	59	53.2
MLEAD_A7	52	59	53.2
MCONC_A7	49	62	55.9

Variable	Mean	Std.Dev.	Variance	Std Error of mean	Coeff of variation
MDUST_A7	429.885	638.048	407105	88.4813	148.423
MLEAD_A7	0.372115	0.577433	0.333429	0.0800755	155.176
MCONC_A7	1322.61	1114.83	1242852	159.262	84.2902

Variable	Minimum	Maximum	Range	Total
MDUST_A7	5	3902	3897	22354
MLEAD_A7	0.02	3.84	3.82	19.35
MCONC_A7	93	5000	4907	64808

Test for difference between Microvac Sample Lead before and after Vacuuming

Command: TPAIR Missing Value Treatment: Pairwise **CYCLE 7**
Selection: GROUP<>'Blank' and LOST<>'TRUE'

***** Paired t Test *****

		Geometric Mean	Geometric Std Deviation	n
For Variables:	lnMlead_b7	0.37	2.73	52
and	lnMlead_a7	0.20	3.10	52
	% change	-47%		

t Statistic =	5.74311
Degrees of Freedom =	51
One-Tailed Prob =	0
Two-Tailed Prob =	**0**

Microvac lead loadings were significantly lower after vacuuming

Test for difference between Microvac Sample Dust before and after Vacuuming

Command: TPAIR Missing Value Treatment: Pairwise **CYCLE 7**
Selection: GROUP<>'Blank' and LOST<>'TRUE'

***** Paired t Test *****

		Geometric Mean	Geometric Std Deviation	n
For Variables:	lnMdust_b7	339	3.82	52
and	lnMdust_a7	184	4.60	52
	% change	-46%		

t Statistic =	3.5184
Degrees of Freedom =	51
One-Tailed Prob =	0.0005
Two-Tailed Prob =	**0.0009**

Microvac dust loadings were significantly lower after vacuuming

Test for difference between Microvac Sample Concentration before and after Vacuuming

Command: TPAIR Missing Value Treatment: Pairwise **CYCLE 7**
Selection: GROUP<>'Blank' and LOST<>'TRUE'

***** Paired t Test *****

		Geometric Mean	Geometric Std Deviation	n
For Variables:	lnMconc_b7	997	2.09	48
and	lnMconc_a7	999	2.22	48
	% change	0%		

t Statistic =	-0.0129092
Degrees of Freedom =	47
One-Tailed Prob =	0.4949
Two-Tailed Prob =	**0.9898**

Microvac lead concentrations did not change after vacuuming

Analysis of Vacuum Bag Results - CYCLE 1

Command: FREQ Missing Value Treatment: Varwise
Selection: GROUP<>'Blank' and LOST<>'T'

Frequency Report of	OPER1	
Value	Freq	%
Donna	3	6
Karen	20	36
Kevin	30	55
Ulrike	2	4
Total	55	100

Tests for Differences Between Operators
Command: TIND Missing Value Treatment: Listwise
Selection: GROUP<>'Blank' and LOST<>'T'

***** INDEPENDENT T TEST *****

For Variable: **lnVlead1**
Subsets in Variable OPER1
With Values Kevin and Karen

For Subsets:	Geometric Mean	Geometric Std Deviation	n
Kevin	1.29	3.08	30
Karen	1.02	3.34	20

t Statistic = -0.69985
Degrees of Freedom = 48
One-Tailed Prob = 0.2437
Two-Tailed Prob = 0.4874

Command: TIND Missing Value Treatment: Listwise
Selection: GROUP<>'Blank' and LOST<>'T'

***** INDEPENDENT T TEST *****

For Variable: **lnVdust1**
Subsets in Variable OPER1
With Values Kevin and Karen

For Subsets:	Geometric Mean	Geometric Std Deviation	n
Kevin	1687	2.57	30
Karen	1448	2.73	20

t Statistic = -0.54803
Degrees of Freedom = 48
One-Tailed Prob = 0.2931
Two-Tailed Prob = 0.5862

No significant differences between operators

Analysis of Vacuum Bag Results - CYCLE 2

Command: FREQ Missing Value Treatment: Varwise
Selection: GROUP<>'Blank' and LOST<>'T'

Frequency Report of	OPER2	
Value	Freq	%
Donna	3	6
Karen	23	43
Kevin	28	52
Total	54	100

Tests for Differences Between Operators
Command: TIND Missing Value Treatment: Listwise
Selection: GROUP<>'Blank' and LOST<>'T'

***** INDEPENDENT T TEST *****

For Variable: **lnVlead2**
Subsets in Variable OPER2
With Values Kevin and Karen

For Subsets:	Geometric Mean	Geometric Std Deviation	n
Kevin	0.75	2.79	28
Karen	0.63	2.92	23

t Statistic = -0.56748
Degrees of Freedom = 49
One-Tailed Prob = 0.2865
Two-Tailed Prob = 0.573

Command: TIND Missing Value Treatment: Listwise
Selection: GROUP<>'Blank' and LOST<>'T'

***** INDEPENDENT T TEST *****

For Variable: **lnVdust2**
Subsets in Variable OPER2
With Values Kevin and Karen

Kevin	1283	2.29	28
Karen	1204	2.30	23

t Statistic = -0.27102
Degrees of Freedom = 49
One-Tailed Prob = 0.3938
Two-Tailed Prob = 0.7875

No significant differences between operators

Analysis of Vacuum Bag Results – CYCLE 3

Command: FREQ Missing Value Treatment: Varwise
Selection: GROUP<>'Blank' and LOST<>'T'

Frequency Report of	OPER3	
Value	Freq	%
Karen	28	51
Kevin	27	49
Total	55	100

Tests for Differences Between Operators
Command: TIND Missing Value Treatment: Listwise
Selection: GROUP<>'Blank' and LOST<>'T'

***** INDEPENDENT T TEST *****

For Variable: **lnVlead3**
Subsets in Variable OPER3
With Values Kevin and Karen

For Subsets:	Geometric Mean	Geometric Std Deviation	n
Kevin	0.70	3.56	27
Karen	0.63	3.03	28

t Statistic = -0.31115
Degrees of Freedom = 53
One-Tailed Prob = 0.3785
Two-Tailed Prob = 0.7569

Command: TIND Missing Value Treatment: Listwise
Selection: GROUP<>'Blank' and LOST<>'T'

***** INDEPENDENT T TEST *****

For Variable: **lnVdust3**
Subsets in Variable OPER3
With Values Kevin and Karen

For Subsets:	Geometric Mean	Geometric Std Deviation	n
Kevin	1091	2.33	27
Karen	1244	2.30	28

t Statistic = 0.58001
Degrees of Freedom = 53
One-Tailed Prob = 0.2822
Two-Tailed Prob = 0.5644

No significant differences between operators

Analysis of Vacuum Bag Results – CYCLE 4

Command: FREQ Missing Value Treatment: Varwise
Selection: GROUP<>'Blank' and LOST<>'T'

Frequency Report of	OPER4	
Value	Freq	%
Karen	25	47
Kevin	26	49
Ulrike	2	4
Total	53	100

Tests for Differences Between Operators
Command: TIND Missing Value Treatment: Listwise
Selection: GROUP<>'Blank' and LOST<>'T'

***** INDEPENDENT T TEST *****

For Variable: **lnVlead4**
Subsets in Variable OPER4
With Values Kevin and Karen

For Subsets:	Geometric Mean	Geometric Std Deviation	n
Kevin	0.67	3.23	26
Karen	0.76	3.19	25

t Statistic = 0.358713
Degrees of Freedom = 49
One-Tailed Prob = 0.3607
Two-Tailed Prob = 0.7214

Command: TIND Missing Value Treatment: Listwise
Selection: GROUP<>'Blank' and LOST<>'T'

***** INDEPENDENT T TEST *****

For Variable: **lnVdust4**
Subsets in Variable OPER4
With Values Kevin and Karen

For Subsets:	Geometric Mean	Geometric Std Deviation	n
Kevin	1092	2.53	26
Karen	1094	2.73	25

t Statistic = 0.006329
Degrees of Freedom = 49
One-Tailed Prob = 0.4975
Two-Tailed Prob = 0.995

No significant differences between operators

Analysis of Vacuum Bag Results – CYCLE 5

Command: FREQ Missing Value Treatment: Varwise
Selection: GROUP<>'Blank' and LOST<>'T'

Frequency Report of	OPER5	
Value	Freq	%
Karen	26	48
Kevin	27	50
Ulrike	1	2
Total	54	100

Tests for Differences Between Operators
Command: TIND Missing Value Treatment: Listwise
Selection: GROUP<>'Blank' and LOST<>'T'

***** INDEPENDENT T TEST *****

For Variable: **lnVlead5**
Subsets in Variable OPER5
With Values Kevin and Karen

For Subsets:	Geometric Mean	Geometric Std Deviation	n
Kevin	0.70	2.66	27
Karen	0.53	2.77	26

t Statistic = −1.05517
Degrees of Freedom = 51
One-Tailed Prob = 0.1482
Two-Tailed Prob = 0.2963

Command: TIND Missing Value Treatment: Listwise
Selection: GROUP<>'Blank' and LOST<>'T'

***** INDEPENDENT T TEST *****

For Variable: **lnVdust5**
Subsets in Variable OPER5
With Values Kevin and Karen

For Subsets:	Geometric Mean	Geometric Std Deviation	n
Kevin	966	2.29	27
Karen	858	2.79	26

t Statistic = −0.462
Degrees of Freedom = 51
One-Tailed Prob = 0.323
Two-Tailed Prob = 0.646

No significant differences between operators

Analysis of Vacuum Bag Results – CYCLE 6

Command: FREQ Missing Value Treatment: Varwise
Selection: GROUP<>'Blank' and LOST<>'T'

Frequency Report of	OPER6	
Value	Freq	%
Karen	25	47
Kevin	28	53
Total	53	100

Tests for Differences Between Operators
Command: TIND Missing Value Treatment: Listwise
Selection: GROUP<>'Blank' and LOST<>'T'

***** INDEPENDENT T TEST *****

For Variable: **lnVlead6**
Subsets in Variable OPER6
With Values Kevin and Karen

For Subsets:	Geometric Mean	Geometric Std Deviation	n
Kevin	0.43	2.86	28
Karen	0.27	3.45	25

t Statistic = -1.43687
Degrees of Freedom = 51
One-Tailed Prob = 0.0784
Two-Tailed Prob = 0.1569

Command: TIND Missing Value Treatment: Listwise
Selection: GROUP<>'Blank' and LOST<>'T'

***** INDEPENDENT T TEST *****

For Variable: **lnVdust6**
Subsets in Variable OPER6
With Values Kevin and Karen

For Subsets:	Geometric Mean	Geometric Std Deviation	n
Kevin	703	2.28	28
Karen	553	2.64	25

t Statistic = -0.974661
Degrees of Freedom = 51
One-Tailed Prob = 0.1672
Two-Tailed Prob = 0.3343

No significant differences between operators

Analysis of Vacuum Bag Results – CYCLE 7

Command: FREQ Missing Value Treatment: Varwise
Selection: LOST<>'TRUE' and GROUP<>'Blank'

Frequency Report of	OPER7	
Value	Freq	%
Karen	27	53
Kevin	24	47
Total	51	100

Tests for Differences Between Operators
Command: TIND Missing Value Treatment: Listwise
Selection: LOST<>'TRUE' and GROUP<>'Blank'

***** INDEPENDENT T TEST *****

For Variable: **LNVLEAD7**
Subsets in Variable OPER7
With Values Kevin and Karen

For Subsets:	Geometric Mean	Geometric Std Deviation	n
Kevin	0.59	2.87	24
Karen	0.17	2.95	25

t Statistic = -4.08255
Degrees of Freedom = 47
One-Tailed Prob = 0.0001
Two-Tailed Prob = 0.0002

Command: TIND Missing Value Treatment: Listwise
Selection: LOST<>'TRUE' and GROUP<>'Blank'

*** INDEPENDENT T TEST ***

For Variable: **LNVDUST7**
Subsets in Variable OPER7
With Values Kevin and Karen

For Subsets:	Geometric Mean	Geometric Std Deviation	n
Kevin	750	2.84	24
Karen	308	3.47	25

t Statistic = -2.70768
Degrees of Freedom = 47
One-Tailed Prob = 0.0047
Two-Tailed Prob = 0.0094

Highly significant difference between operators

Analysis of Vacuum Bag Results - CYCLE 8

Command: FREQ Missing Value Treatment: Varwise
Selection: LOST<>'TRUE' and GROUP<>'Blank'

Frequency Report of	OPER8	
Value	Freq	%
Karen	29	41
Kevin	41	59
Total	70	100

Tests for Differences Between Operators
Command: TIND Missing Value Treatment: Listwise
Selection: LOST<>'TRUE' and GROUP<>'Blank'

*** **INDEPENDENT T TEST** ***

For Variable: **LNVLEAD8**
Subsets in Variable OPER8
With Values Karen and Kevin

For Subsets:	Geometric Mean	Geometric Std Deviation	n
Karen	0.36	4.43	29
Kevin	0.40	2.93	41

t Statistic = 0.300414
Degrees of Freedom = 68
One-Tailed Prob = 0.3824
Two-Tailed Prob = 0.7648

Command: TIND Missing Value Treatment: Listwise
Selection: LOST<>'TRUE' and GROUP<>'Blank'

*** INDEPENDENT T TEST ***

For Variable: **LNVDUST8**
Subsets in Variable OPER8
With Values Karen and Kevin

For Subsets:	Geometric Mean	Geometric Std Deviation	n
Karen	467	3.61	29
Kevin	463	2.10	41

t Statistic = -0.0311179
Degrees of Freedom = 68
One-Tailed Prob = 0.4876
Two-Tailed Prob = 0.9753

No significant difference between operators

Test for Difference in Vacuum Bag Dust – Cycle 1 to Cycle 2 (With both operators)

Command: TPAIR Missing Value Treatment: Pairwise
Selection: GROUP<>'Blank' and LOST<>'T'

***** Paired t Test *****

		Geometric Mean	Geometric Std Deviation	n
For Variables:	lnVdust1	1573	2.54	54
and	lnVdust2	1245	2.38	54

t Statistic =	3.88862
Degrees of Freedom =	53
One-Tailed Prob =	0.0001
Two-Tailed Prob =	**0.0003**

Decrease in mean Vacuum Bag Dust from cycle 1 to cycle 2 is significant

Test for Difference in Vacuum Bag Dust – Cycle 2 to Cycle 3 (With both operators)

Command: TPAIR Missing Value Treatment: Pairwise
Selection: GROUP<>'Blank' and LOST<>'T'

***** Paired t Test *****

		Geometric Mean	Geometric Std Deviation	n
For Variables:	lnVdust2	1245	2.38	54
and	lnVdust3	1158	2.32	54

t Statistic =	1.24535
Degrees of Freedom =	53
One-Tailed Prob =	0.1092
Two-Tailed Prob =	**0.2185**

No significant change in mean Vacuum Bag Dust from cycle 2 to cycle 3

Test for Difference in Vacuum Bag Dust – Cycle 3 to Cycle 4 (With both operators)

Command: TPAIR Missing Value Treatment: Pairwise
Selection: GROUP<>'Blank' and LOST<>'T'

***** Paired t Test *****

		Geometric Mean	Geometric Std Deviation	n
For Variables:	lnVdust3	1157	2.32	53
and	lnVdust4	1126	2.60	53

t Statistic =	0.424062
Degrees of Freedom =	52
One-Tailed Prob =	0.3366
Two-Tailed Prob =	**0.6733**

No significant change in mean Vacuum Bag Dust from cycle 3 to cycle 4

Test for Difference In Vacuum Bag Dust – Cycle 4 to Cycle 5 (With both operators)

Command: TPAIR Missing Value Treatment: Pairwise
Selection: GROUP<>'Blank' and LOST<>'T'

***** Paired t Test *****

		Geometric Mean	Geometric Std Deviation	n
For Variables:	lnVdust4	1126	2.60	53
and	lnVdust5	901	2.50	53

t Statistic =	2.71937
Degrees of Freedom =	52
One-Tailed Prob =	0.0044
Two-Tailed Prob =	**0.0089**

Decrease in mean Vacuum Bag Dust from cycle 4 to cycle 5 is significant

Test for Difference In Vacuum Bag Dust – Cycle 5 to Cycle 6 (With both operators)

Command: TPAIR Missing Value Treatment: Pairwise
Selection: GROUP<>'Blank' and LOST<>'T'

***** Paired t Test *****

		Geometric Mean	Geometric Std Deviation	n
For Variables:	lnVdust5	897	2.51	53
and	lnVdust6	628	2.45	53

t Statistic =	5.34087
Degrees of Freedom =	52
One-Tailed Prob =	0.0000
Two-Tailed Prob =	**0.0000**

Decrease in mean Vacuum Bag Dust from cycle 5 to cycle 6 is significant

Test for Difference In Vacuum Bag Dust – Cycle 6 to Cycle 7 (With both operators)

Command: TPAIR Missing Value Treatment: Pairwise
Selection: LOST<>'TRUE' and GROUP<>'Blank'

***** Paired t Test *****

		Geometric Mean	Geometric Std Deviation	n
For Variables:	LNVDUST6	630	2.46	49
and	LNVDUST7	466	3.41	49

t Statistic =	2.42216
Degrees of Freedom =	48
One-Tailed Prob =	0.0096
Two-Tailed Prob =	**0.0193**

Decrease in mean Vacuum Bag Dust from cycle 6 to cycle 7 is significant

Test for Difference in Vacuum Bag Dust – Cycle 7 to Cycle 8 (With both operators)

Command: TPAIR Missing Value Treatment: Pairwise
Selection: LOST<>'TRUE' and GROUP<>'Blank'

***** Paired t Test *****

		Mean	Std Deviation	n
For Variables:	LNVDUST7	445	3.05	36
and	LNVDUST8	463	2.30	36

t Statistic =	-0.266818
Degrees of Freedom =	35
One-Tailed Prob =	0.3956
Two-Tailed Prob =	**0.7912**

No significant change in mean Vacuum Bag Dust from cycle 7 to cycle 8

Test for Difference in Vacuum Bag Lead – Cycle 1 to Cycle 2 (With both operators)

Command: TPAIR Missing Value Treatment: Pairwise
Selection: GROUP<>'Blank' and LOST<>'T'

***** Paired t Test *****

		Geometric Mean	Geometric Std Deviation	n
For Variables:	lnVlead1	1.16	3.04	54
and	lnVlead2	0.68	2.92	54

t Statistic =	7.20674
Degrees of Freedom =	53
One-Tailed Prob =	0.0000
Two-Tailed Prob =	**0.0000**

Decrease in mean vacuum bag lead from cycle 1 to cycle 2 is significant

Test for Difference in Vacuum Bag Lead – Cycle 2 to Cycle 3 (With both operators)

Command: TPAIR Missing Value Treatment: Pairwise
Selection: GROUP<>'Blank' and LOST<>'T'

***** Paired t Test *****

		Geometric Mean	Geometric Std Deviation	n
For Variables:	lnVlead2	0.68	2.92	54
and	lnVlead3	0.66	3.29	54

t Statistic =	0.287305
Degrees of Freedom =	53
One-Tailed Prob =	0.3875
Two-Tailed Prob =	**0.775**

No significant change in mean vacuum bag lead from cycle 2 to cycle 3

Test for Difference in Vacuum Bag Lead – Cycle 3 to Cycle 4 (With both operators)

Command: TPAIR Missing Value Treatment: Pairwise
Selection: GROUP<>'Blank' and LOST<>'T'

***** Paired t Test *****

		Geometric Mean	Geometric Std Deviation	n
For Variables:	lnVlead3	0.66	3.32	53
and	lnVlead4	0.75	3.20	53

t Statistic =	-1.02692
Degrees of Freedom =	52
One-Tailed Prob =	0.1546
Two-Tailed Prob =	**0.3092**

No significant change in mean vacuum bag lead from cycle 3 to cycle 4

Test for Difference in Vacuum Bag Lead – Cycle 4 to Cycle 5 (With both operators)

Command: TPAIR Missing Value Treatment: Pairwise
Selection: GROUP<>'Blank' and LOST<>'T'

***** Paired t Test *****

		Geometric Mean	Geometric Std Deviation	n
For Variables:	lnVlead4	0.75	3.20	53
and	lnVlead5	0.60	2.77	53

t Statistic =	2.05657
Degrees of Freedom =	52
One-Tailed Prob =	0.0224
Two-Tailed Prob =	0.0448

Decrease in mean vacuum bag lead from cycle 4 to cycle 5 is significant

Test for Difference in Vacuum Bag Lead – Cycle 5 to Cycle 6 (With both operators)

Command: TPAIR Missing Value Treatment: Pairwise
Selection: GROUP<>'Blank' and LOST<>'T'

***** Paired t Test *****

		Geometric Mean	Geometric Std Deviation	n
For Variables:	lnVlead5	0.59	2.75	53
and	lnVlead6	0.35	3.17	53

t Statistic =	5.89657
Degrees of Freedom =	52
One-Tailed Prob =	0.0000
Two-Tailed Prob =	**0.0000**

Decrease in mean vacuum bag lead from cycle 5 to cycle 6 is significant

Test for Difference in Vacuum Bag Lead – Cycle 6 to Cycle 7 (With both operators)

Command: TPAIR Missing Value Treatment: Pairwise
Selection: LOST<>'TRUE' and GROUP<>'Blank'

***** Paired t Test *****

		Mean	Std Deviation	n
For Variables:	LNVLEAD6	0.35	3.12	49
and	LNVLEAD7	0.30	3.41	49

t Statistic =	1.26057
Degrees of Freedom =	48
One-Tailed Prob =	0.1068
Two-Tailed Prob =	**0.2136**

No significant change in mean vacuum bag lead from cycle 6 to cycle 7

Test for Difference in Vacuum Bag Lead – Cycle 7 to Cycle 8 (With both operators)

Command: TPAIR Missing Value Treatment: Pairwise
Selection: LOST<>'TRUE' and GROUP<>'Blank'

***** Paired t Test *****

		Mean	Std Deviation	n
For Variables:	LNVLEAD7	0.29	3.35	36
and	LNVLEAD8	0.39	3.10	36

t Statistic =	-1.5488
Degrees of Freedom =	35.0000
One-Tailed Prob =	0.0652
Two-Tailed Prob =	**0.1304**

No significant change in mean vacuum bag lead from cycle 7 to cycle 8

Correlation Between Vacuum Bag Dust and Vacuum Bag Lead

Command: REGR Missing Value Treatment: Listwise
Selection: GROUP<>'Blank' and LOST<>'T'

***** Multiple Linear Regression ***** **CYCLE 1**

Dependent Variable:	**lnVdust1**	55 Valid Records	
Coeff of Determ:	0.85		
Adjusted R Square:	0.85	Estimated constant term:	7.24458
Multiple Corr Coeff:	**0.92**	Standard Err of Estimate:	0.355958

Analysis of Variance for the Regression:

Source of Variance	Degrees of Freedom	Sum of Squares	Mean of Squares	F Test	Prob
Regression	1	39.4687	39.4687	311.497	0
Residuals	53	6.71544	0.126706		
Total	54	46.1841			

Variable	Regression Coefficient	Standardized Coefficient	Standard Error	t	Prob
lnVlead1	0.775265	0.924443	0.0439261	17.6493	**0**

***** Multiple Linear Regression ***** **CYCLE 2**

Dependent Variable:	**lnVdust2**	54 Valid Records	
Coeff of Determ:	0.81		
Adjusted R Square:	0.81	Estimated constant term:	7.41058
Multiple Corr Coeff:	**0.90**	Standard Err of Estimate:	0.376637

Analysis of Variance for the Regression:

Source of Variance	Degrees of Freedom	Sum of Squares	Mean of Squares	F Test	Prob
Regression	1	32.4909	32.4909	229.042	0
Residuals	52	7.37649	0.141856		
Total	53	39.8674			

Variable	Regression Coefficient	Standardized Coefficient	Standard Error	t	Prob
lnVlead2	0.731564	0.902759	0.0483387	15.1341	**0**

***** Multiple Linear Regression ***** **CYCLE 3**

Dependent Variable:	**lnVdust3**	55 Valid Records	
Coeff of Determ:	0.79		
Adjusted R Square:	0.79	Estimated constant term:	7.31846
Multiple Corr Coeff:	**0.89**	Standard Err of Estimate:	0.382958

Analysis of Variance for the Regression:

Source of Variance	Degrees of Freedom	Sum of Squares	Mean of Squares	F Test	Prob
Regression	1	29.7459	29.7459	202.827	0
Residuals	53	7.77281	0.146657		
Total	54	37.5187			

Variable	Regression Coefficient	Standardized Coefficient	Standard Error	t	Prob
lnVlead3	0.629257	0.890409	0.044184	14.2417	**0**

***** Multiple Linear Regression ***** **CYCLE 4**

Dependent Variable:	**lnVdust4**	53 Valid Records	
Coeff of Determ:	0.78		
Adjusted R Square:	0.78	Estimated constant term:	7.23705
Multiple Corr Coeff:	**0.88**	Standard Err of Estimate:	0.449205

Analysis of Variance for the Regression:

Source of Variance	Degrees of Freedom	Sum of Squares	Mean of Squares	F Test	Prob
Regression	1	37.052	37.052	183.622	0
Residuals	51	10.291	0.201785		
Total	52	47.3431			

Variable	Regression Coefficient	Standardized Coefficient	Standard Error	t	Prob
lnVlead4	0.725212	0.884663	0.0535184	13.5507	**0**

***** Multiple Linear Regression ***** **CYCLE 5**

Dependent Variable:	**lnVdust5**	55 Valid Records	
Coeff of Determ:	0.84		
Adjusted R Square:	0.84	Estimated constant term:	7.22895
Multiple Corr Coeff:	**0.92**	Standard Err of Estimate:	0.364783

Analysis of Variance for the Regression:

Source of Variance	Degrees of Freedom	Sum of Squares	Mean of Squares	F Test	Prob
Regression	1	37.5446	37.5446	282.149	0
Residuals	53	7.05254	0.133067		
Total	54	44.5972			

Variable	Regression Coefficient	Standardized Coefficient	Standard Error	t	Prob
lnVlead5	0.83131	0.91753	0.0494908	16.7973	**0**

***** Multiple Linear Regression ***** **CYCLE 6**

Dependent Variable:	**lnVdust6**	53 Valid Records	
Coeff of Determ:	0.80		
Adjusted R Square:	0.79	Estimated constant term:	7.17071
Multiple Corr Coeff:	**0.89**	Standard Err of Estimate:	0.406912

Analysis of Variance for the Regression:

Source of Variance	Degrees of Freedom	Sum of Squares	Mean of Squares	F Test	Prob
Regression	1	33.2634	33.2634	200.894	0
Residuals	51	8.44444	0.165577		
Total	52	41.7079			

Variable	Regression Coefficient	Standardized Coefficient	Standard Error	t	Prob
lnVlead6	0.692475	0.893047	0.0488563	14.1737	**0**

***** Multiple Linear Regression ***** **CYCLE 7**

Dependent Variable:	**LNVDUST7**	50 Valid Records	
Coeff of Determ:	0.81		
Adjusted R Square:	0.81	Estimated constant term:	7.20747
Multiple Corr Coeff:	**0.90**	Standard Err of Estimate:	0.529941

Analysis of Variance for the Regression:

Source of Variance	Degrees of Freedom	Sum of Squares	Mean of Squares	F Test	Prob
Regression	1	58.8476	58.8476	209.543	0
Residuals	48	13.4802	0.280838		
Total	49	72.3278			

Variable	Regression Coefficient	Standardized Coefficient	Standard Error	t	Prob
LNVLEAD7	0.898194	0.902011	0.0620489	14.4756	0

***** Multiple Linear Regression *****

Dependent Variable:	**LNVDUST8**	70 Valid Records	
Coeff of Determ:	0.46		
Adjusted R Square:	0.45	Estimated constant term:	6.6601
Multiple Corr Coeff:	**0.68**	Standard Err of Estimate:	0.736433

Analysis of Variance for the Regression:

Source of Variance	Degrees of Freedom	Sum of Squares	Mean of Squares	F Test	Prob
Regression	1	31.4654	31.4654	58.0185	0
Residuals	68	36.8787	0.542333		
Total	69	68.3441			

Variable	Regression Coefficient	Standardized Coefficient	Standard Error	t	Prob
LNVLEAD8	0.538573	0.678525	0.0707068	7.61699	0

Test for Differences In Mean Vacuum Bag Dust by Blood Code Group – Cycle 1

Command: ANOVA Missing Value Treatment: Listwise (With both operators)
Selection: GROUP<>'Blank' and LOST<>'T'

***** 1-way Analysis of Variance with No Replications *****

Dependent Variable: lnVdust1

Factor	# Levels	Variable
A	3	Bloodcode

Source	DF	Sum of Squares	Mean of Squares	F	Prob
A	2	15.1846	7.59231	12.7357	0
Residual	52	30.9995	0.596145		
Total	54	46.1841			

Cell Means / Standard Deviations for Maximum Prob of 1

Factor: A	Geometric Mean	Geometric Std. Dev.	Cell n
LOW	848	2.43	19
MOD	1642	2.05	21
ELEV	3248	1.97	15

Scheffe test for groups with significant differences

Group One	Group Two	<.05	Mean Diff	Critical Diff
ELEV	LOW	Yes	1.34325	0.649477
ELEV	MOD	Yes	0.682552	0.649477
LOW	MOD	Yes	0.660697	0.649477

Test for Differences In Mean Vacuum Bag Dust by Blood Code Group – Cycle 2

Command: ANOVA Missing Value Treatment: Listwise (With both operators)
Selection: GROUP<>'Blank' and LOST<>'T'

***** 1-way Analysis of Variance with No Replications *****

Dependent Variable: lnVdust2

Factor	# Levels	Variable
A	3	Bloodcode

Source	DF	Sum of Squares	Mean of Squares	F	Prob
A	2	12.3441	6.17207	11.4367	0
Residual	51	27.5232	0.539671		
Total	53	39.8674			

Cell Means / Standard Deviations for Maximum Prob of 1

Factor: A	Geometric Mean	Geometric Std. Dev.	Cell n
LOW	730	2.44	19
MOD	1243	1.84	20
ELEV	2456	1.94	15

Scheffe test for groups with significant differences

Group One	Group Two	<.05	Mean Diff	Critical Diff
ELEV	LOW	Yes	1.21352	0.62234
ELEV	MOD	Yes	0.68125	0.62234
LOW	MOD	no	0.532266	0.62234

Test for Differences In Mean Vacuum Bag Dust by Blood Code Group – Cycle 3

Command: ANOVA Missing Value Treatment: Listwise (With both operators)
Selection: GROUP<>'Blank' and LOST<>'T'

***** 1-way Analysis of Variance with No Replications *****

Dependent Variable: lnVdust3

Factor	# Levels	Variable
A	3	Bloodcode

Source	DF	Sum of Squares	Mean of Squares	F	Prob
A	2	12.9488	6.47441	13.7025	0
Residual	52	24.5699	0.472499		
Total	54	37.5187			

Cell Means / Standard Deviations for Maximum Prob of 1

Factor: A	Geometric Mean	Geometric Std. Dev.	Cell n
LOW	664	2.01	19
MOD	1197	2.07	21
ELEV	2299	1.84	15

Scheffe test for groups with significant differences

Group One	Group Two	<.05	Mean Diff	Critical Diff
ELEV	LOW	Yes	1.24185	0.578213
ELEV	MOD	Yes	0.653076	0.578213
LOW	MOD	Yes	0.588769	0.578213

Test for Differences In Mean Vacuum Bag Dust by Blood Code Group – Cycle 4

Command: ANOVA Missing Value Treatment: Listwise (With both operators)
Selection: GROUP<>'Blank' and LOST<>'T'

***** 1-way Analysis of Variance with No Replications *****

Dependent Variable: lnVdust4

Factor	# Levels	Variable
A	3	Bloodcode

Source	DF	Sum of Squares	Mean of Squares	F	Prob
A	2	14.5999	7.29993	11.1473	0
Residual	50	32.7432	0.654864		
Total	52	47.3431			

Cell Means / Standard Deviations for Maximum Prob of 1

Factor: A	Geometric Mean	Geometric Std. Dev.	Cell n
LOW	607	2.01	19
MOD	1208	2.41	19
ELEV	2255	2.34	15

Scheffe test for groups with significant differences

Group One	Group Two	<.05	Mean Diff	Critical Diff
ELEV	LOW	Yes	1.31317	0.690857
ELEV	MOD	no	0.624698	0.690857
LOW	MOD	no	0.688474	0.690857

Test for Differences In Mean Vacuum Bag Dust by Blood Code Group – Cycle 5

Command: ANOVA Missing Value Treatment: Listwise (With both operators)
Selection: GROUP<>'Blank' and LOST<>'T'

***** 1-way Analysis of Variance with No Replications *****

Dependent Variable: lnVdust5

Factor	# Levels	Variable
A	3	Bloodcode

Source	DF	Sum of Squares	Mean of Squares	F	Prob
A	2	12.5437	6.27185	10.1748	0.0002
Residual	52	32.0534	0.616412		
Total	54	44.5972			

Cell Means / Standard Deviations for Maximum Prob of 1

Factor: A	Geometric Mean	Geometric Std. Dev.	Cell n
LOW	541	2.25	19
MOD	889	2.03	21
ELEV	1836	2.35	15

Scheffe test for groups with significant differences

Group One	Group Two	<.05	Mean Diff	Critical Diff
ELEV	LOW	Yes	1.22216	0.660425
ELEV	MOD	Yes	0.725219	0.660425
LOW	MOD	no	0.496942	0.660425

Test for Differences In Mean Vacuum Bag Dust by Blood Code Group - Cycle 6

Command: ANOVA Missing Value Treatment: Listwise (With both operators)
Selection: GROUP<>'Blank' and LOST<>'T'

***** 1-way Analysis of Variance with No Replications *****

Dependent Variable: lnVdust6

Factor	# Levels	Variable
A	3	Bloodcode

Source	DF	Sum of Squares	Mean of Squares	F	Prob
A	2	8.06701	4.0335	5.99495	0.0046
Residual	50	33.6409	0.672817		
Total	52	41.7079			

Cell Means / Standard Deviations for Maximum Prob of 1

LOW	413	2.34	19
MOD	612	2.33	19
ELEV	1100	2.11	15

Scheffe test for groups with significant differences

Group One	Group Two	<.05	Mean Diff	Critical Diff
ELEV	LOW	Yes	0.979874	0.700263
ELEV	MOD	no	0.586716	0.700263
LOW	MOD	no	0.393158	0.700263

Test for Differences In Mean Vacuum Bag Lead by Blood Code Group – Cycle 1

Command: ANOVA Missing Value Treatment: Listwise (With both operators)
Selection: GROUP<>'Blank' and LOST<>'T'

***** 1-way Analysis of Variance with No Replications *****

Dependent Variable: lnVlead1

Factor	# Levels	Variable
A	3	Bloodcode

Source	DF	Sum of Squares	Mean of Squares	F	Prob
A	2	21.2696	10.6348	12.4557	0
Residual	52	44.3983	0.853813		
Total	54	65.6679			

Cell Means / Standard Deviations for Maximum Prob of 1

Factor: A	Geometric Mean	Geometric Std. Dev.	Cell n
LOW	0.56	2.83	19
MOD	1.21	2.47	21
ELEV	2.75	2.19	15

Scheffe test for groups with significant differences

Group One	Group Two	<.05	Mean Diff	Critical Diff
ELEV	LOW	Yes	1.59051	0.777265
ELEV	MOD	Yes	0.81821	0.777265
LOW	MOD	no	0.772296	0.777265

Test for Differences In Mean Vacuum Bag Lead by Blood Code Group – Cycle 2

Command: ANOVA Missing Value Treatment: Listwise (With both operators)
Selection: GROUP<>'Blank' and LOST<>'T'

***** 1-way Analysis of Variance with No Replications *****

Dependent Variable: lnVlead2

Factor	# Levels	Variable
A	3	Bloodcode

Source	DF	Sum of Squares	Mean of Squares	F	Prob
A	2	20.9767	10.4884	13.4626	0
Residual	51	39.7329	0.779076		
Total	53	60.7096			

Cell Means / Standard Deviations for Maximum Prob of 1

Factor: A	Geometric Mean	Geometric Std. Dev.	Cell n
ELEV	1.54	2.15	15
LOW	0.32	2.86	19
MOD	0.75	2.19	20

Scheffe test for groups with significant differences

Group One	Group Two	<.05	Mean Diff	Critical Diff
ELEV	LOW	Yes	1.56986	0.747744
ELEV	MOD	no	0.7182	0.747744
LOW	MOD	Yes	0.851663	0.747744

Test for Differences In Mean Vacuum Bag Lead by Blood Code Group - Cycle 3

Command: ANOVA Missing Value Treatment: Listwise (With both operators)
Selection: GROUP<>'Blank' and LOST<>'T'

***** 1-way Analysis of Variance with No Replications *****

Dependent Variable: lnVlead3

Factor	# Levels	Variable
A	3	Bloodcode

Source	DF	Sum of Squares	Mean of Squares	F	Prob
A	2	28.0289	14.0144	15.4744	0
Residual	52	47.0939	0.905652		
Total	54	75.1227			

Cell Means / Standard Deviations for Maximum Prob of 1

Factor: A	Geometric Mean	Geometric Std. Dev.	Cell n
LOW	0.27	2.77	19
MOD	0.78	2.85	21
ELEV	1.65	1.97	15

Scheffe test for groups with significant differences

Group One	Group Two	<.05	Mean Diff	Critical Diff
ELEV	LOW	Yes	1.80125	0.800513
ELEV	MOD	no	0.75339	0.800513
LOW	MOD	Yes	1.04786	0.800513

Test for Differences In Mean Vacuum Bag Lead by Blood Code Group – Cycle 4

Command: ANOVA Missing Value Treatment: Listwise (With both operators)
Selection: GROUP<>'Blank' and LOST<>'T'

***** 1-way Analysis of Variance with No Replications *****

Dependent Variable: lnVlead4

Factor	# Levels	Variable
A	3	Bloodcode

Source	DF	Sum of Squares	Mean of Squares	F	Prob
A	2	20.47	10.235	10.2391	0.0002
Residual	50	49.9801	0.999601		
Total	52	70.4501			

Cell Means / Standard Deviations for Maximum Prob of 1

Factor: A	Geometric Mean	Geometric Std. Dev.	Cell n
LOW	0.36	2.60	19
MOD	0.83	3.17	19
ELEV	1.68	2.29	15

Scheffe test for groups with significant differences

Group One	Group Two	<.05	Mean Diff	Critical Diff
ELEV	LOW	Yes	1.54988	0.853544
ELEV	MOD	no	0.700463	0.853544
LOW	MOD	no	0.849421	0.853544

Test for Differences in Mean Vacuum Bag Lead by Blood Code Group – Cycle 5

Command: ANOVA Missing Value Treatment: Listwise (With both operators)
Selection: GROUP<>'Blank' and LOST<>'T'

***** 1-way Analysis of Variance with No Replications *****

Dependent Variable: lnVlead5

Factor	# Levels	Variable
A	3	Bloodcode

Source	DF	Sum of Squares	Mean of Squares	F	Prob
A	2	20.0211	10.0105	15.1734	0
Residual	52	34.3066	0.659743		
Total	54	54.3277			

Cell Means / Standard Deviations for Maximum Prob of 1

Factor: A			
A	Mean	Std. Dev.	Cell n
LOW	0.30	2.40	19
MOD	0.65	2.18	21
ELEV	1.38	2.17	15

Scheffe test for groups with significant differences

Group One	Group Two	<.05	Mean Diff	Critical Diff
ELEV	LOW	Yes	1.53988	0.683242
ELEV	MOD	Yes	0.754952	0.683242
LOW	MOD	Yes	0.784925	0.683242

Test for Differences In Mean Vacuum Bag Lead by Blood Code Group – Cycle 6

Command: ANOVA Missing Value Treatment: Listwise (With both operators)
Selection: GROUP<>'Blank' and LOST<>'T'

***** 1-way Analysis of Variance with No Replications *****

Dependent Variable: lnVlead6

Factor	# Levels	Variable
A	3	Bloodcode

Source	DF	Sum of Squares	Mean of Squares	F	Prob
A	2	17.0162	8.50808	8.12587	0.0009
Residual	50	52.3518	1.04704		
Total	52	69.368			

Cell Means / Standard Deviations for Maximum Prob of 1

Factor: A	A Mean	Std. Dev.	Cell n
LOW	0.19	2.65	19
MOD	0.34	2.92	19
ELEV	0.78	2.77	15

Scheffe test for groups with significant differences

Group One	Group Two	<.05	Mean Diff	Critical Diff
ELEV	LOW	Yes	1.42426	0.873561
ELEV	MOD	no	0.827839	0.873561
LOW	MOD	no	0.596421	0.873561

Command: DESC Missing Value Treatment: Varwise
Selection: LOST<>'TRUE' and GROUP<>'Blank' and OPER6='Kevin' and OPER7='Kevin'

***** Descriptive Statistics ***** (Exluding homes vacuumed by Karen in Cycle 6 or Cycle 7)

Current file is d:\tlp\hepa\hepa_win.abd
There are 164 variables and 120 records in this data file

21 Records (17.5%) are in this subset

Variable	Valid Records	Number Missing	% Missing
lnVlead1	21	0	0
lnVlead2	21	0	0
lnVlead3	21	0	0
lnVlead4	20	1	4.8
lnVlead5	21	0	0
lnVlead6	21	0	0
lnVlead7	21	0	0

Variable	Geometric Mean	Geometric Std.Dev.	Variance	Std Error of mean	Coeff of variation
lnVlead1	1.03	3.03	1.23	0.24	4012.28
lnVlead2	0.74	2.83	1.08	0.23	-349.97
lnVlead3	0.63	3.65	1.67	0.28	-282.05
lnVlead4	0.71	3.58	1.63	0.29	-377.09
lnVlead5	0.75	2.64	0.94	0.21	-338.71
lnVlead6	0.47	3.02	1.22	0.24	-145.53
lnVlead7	0.59	2.57	0.89	0.21	-177.29

Percentage reduction from start to end = (1.03-0.59)/1.03*100 = 43%

Variable	Minimum	Maximum
Vlead1	0.11	10.28
Vlead2	0.12	4.27
Vlead3	0.06	10.02
Vlead4	0.12	6.51
Vlead5	0.13	3.31
Vlead6	0.05	2.86
Vlead7	0.07	3.49

Test for Differences In Mean Vacuum Bag Lead by Blood Code Group – Cycle 1

Command: ANOVA Missing Value Treatment: Listwise

Selection: GROUP<>'Blank' and LOST<>'TRUE' and OPER6='Kevin' and OPER7='Kevin'

***** 1-way Analysis of Variance with No Replications *****

Dependent Variable: **lnVlead1** (Exluding homes vacuumed by Karen in Cycle 6 or Cycle 7)

Factor	# Levels	Variable
A	3	Bloodcode

Source	DF	Sum of Squares	Mean of Squares	F	Prob
A	2	7.24182	3.62091	3.76345	0.0431
Residual	18	17.3182	0.962125		
Total	20	24.5601			

Cell Means / Standard De 1

Factor: A	Geometric Mean	Geometric Std. Dev.	Cell n
LOW	0.47	2.53	7
MOD	1.17	3.41	7
ELEV	1.96	2.06	7

Duncan test for groups with significant differences

Group One	Group Two	<.05	Mean Diff	Critical Diff
LOW	MOD	no	0.905286	1.10109
LOW	ELEV	Yes	1.42071	1.1567
MOD	ELEV	no	0.515429	1.10109

Test for Differences in Mean Vacuum Bag Lead by Blood Code Group – Cycle 2

Command: ANOVA Missing Value Treatment: Listwise

Selection: GROUP<>'Blank' and LOST<>'TRUE' and OPER6='Kevin' and OPER7='Kevin'

***** 1-way Analysis of Variance with No Replications *****

Dependent Variable: **lnVlead2** (Exluding homes vacuumed by Karen in Cycle 6 or Cycle 7)

Factor	# Levels	Variable
A	3	Bloodcode

Source	DF	Sum of Squares	Mean of Squares	F	Prob
A	2	5.70468	2.85234	3.21728	0.0639
Residual	18	15.9583	0.88657		
Total	20	21.6629			

Cell Means / Standard Deviations for Maximum Prob of 1

Factor: A	Geometric Mean	Geometric Std. Dev.	Cell n
LOW	0.38	2.03	7
MOD	0.80	3.25	7
ELEV	1.35	2.41	7

Test for Differences in Mean Vacuum Bag Lead by Blood Code Group – Cycle 3

Command: ANOVA Missing Value Treatment: Listwise

Selection: GROUP<>'Blank' and LOST<>'TRUE' and OPER6='Kevin' and OPER7='Kevin'

***** 1-way Analysis of Variance with No Replications *****

Dependent Variable: **lnVlead3** (Exluding homes vacuumed by Karen in Cycle 6 or Cycle 7)

Factor	# Levels	Variable
A	3	Bloodcode

Source	DF	Sum of Squares	Mean of Squares	F	Prob
A	2	11.9182	5.95911	4.97804	0.019
Residual	18	21.5474	1.19708		
Total	20	33.4656			

Cell Means / Standard Deviations for Maximum Prob of 1

Factor: A	Geometric Mean	Geometric Std. Dev.	Cell n
LOW	0.23	2.54	7
MOD	0.74	4.78	7
ELEV	1.45	1.69	7

Duncan test for groups with significant differences

Group One	Group Two	<.05	Mean Diff	Critical Diff
LOW	MOD	no	1.15714	1.2282
LOW	ELEV	Yes	1.82343	1.29023
MOD	ELEV	no	0.666286	1.2282

Test for Differences In Mean Vacuum Bag Lead by Blood Code Group – Cycle 4

Command: ANOVA Missing Value Treatment: Listwise

Selection: GROUP<>'Blank' and LOST<>'TRUE' and OPER6='Kevin' and OPER7='Kevin'

***** 1-way Analysis of Variance with No Replications *****

Dependent Variable: **lnVlead4** (Exluding homes vacuumed by Karen in Cycle 6 or Cycle 7)

Factor	# Levels	Variable
A	3	Bloodcode

Source	DF	Sum of Squares	Mean of Squares	F	Prob
A	2	5.84155	2.92077	1.97994	0.1687
Residual	17	25.0782	1.47519		
Total	19	30.9197			

Cell Means / Standard Deviations for Maximum Prob of 1

Factor: A	Geometric Mean	Geometric Std. Dev.	Cell n
LOW	0.42	3.42	7
MOD	0.58	4.10	6
ELEV	1.45	2.73	7

Test for Differences In Mean Vacuum Bag Lead by Blood Code Group – Cycle 5

Command: ANOVA Missing Value Treatment: Listwise

Selection: GROUP<>'Blank' and LOST<>'TRUE' and OPER6='Kevin' and OPER7='Kevin'

***** 1-way Analysis of Variance with No Replications *****

Dependent Variable: **lnVlead5** (Exluding homes vacuumed by Karen in Cycle 6 or Cycle 7)

Factor	# Levels	Variable
A	3	Bloodcode

Source	DF	Sum of Squares	Mean of Squares	F	Prob
A	2	5.64648	2.82324	3.86564	0.0401
Residual	18	13.1461	0.730341		
Total	20	18.7926			

Cell Means / Standard Deviations for Maximum Prob of 1

Factor: A	Geometric Mean	Geometric Std. Dev.	Cell n
LOW	0.41	2.35	7
MOD	0.70	2.75	7
ELEV	1.46	1.94	7

Test for Differences In Mean Vacuum Bag Lead by Blood Code Group – Cycle 6

Command: ANOVA Missing Value Treatment: Listwise

Selection: GROUP<>'Blank' and LOST<>'TRUE' and OPER6='Kevin' and OPER7='Kevin'

***** 1-way Analysis of Variance with No Replications *****

Dependent Variable: **lnVlead6** (Exluding homes vacuumed by Karen in Cycle 6 or Cycle 7)

Factor	# Levels	Variable
A	3	Bloodcode

Source	DF	Sum of Squares	Mean of Squares	F	Prob
A	2	2.98523	1.49261	1.25175	0.3097
Residual	18	21.4636	1.19242		
Total	20	24.4488			

Cell Means / Standard Deviations for Maximum Prob of 1

Factor: A	Geometric Mean	Geometric Std. Dev.	Cell n
LOW	0.31	1.57	7
MOD	0.43	5.14	7
ELEV	0.77	2.30	7

Test for Differences In Mean Vacuum Bag Lead by Blood Code Group – Cycle 7

Command: ANOVA Missing Value Treatment: Listwise

Selection: GROUP<>'Blank' and LOST<>'TRUE' and OPER6='Kevin' and OPER7='Kevin'

***** 1-way Analysis of Variance with No Replications *****

Dependent Variable: **lnVlead7** (Exluding homes vacuumed by Karen in Cycle 6 or Cycle 7)

Factor	# Levels	Variable
A	3	Bloodcode

Source	DF	Sum of Squares	Mean of Squares	F	Prob
A	2	3.27509	1.63755	2.02287	0.1613
Residual	18	14.5713	0.809517		
Total	20	17.8464			

Cell Means / Standard Deviations for Maximum Prob of 1

Factor: A	Geometric Mean	Geometric Std. Dev.	Cell n
LOW	0.36	1.66	7
MOD	0.58	3.55	7
ELEV	0.95	2.13	7

Test for Difference in Mean Start and End Blood Lead, Treatment Group

Command: TPAIR Missing Value Treatment: Pairwise
Selection: LOST<>T and GROUP<>'Blank' and GROUP='Treat'

*** Paired t Test ***

		Geometric Mean	Geometric Std. Dev.	n
For Variables:	lnBld1	11.9	1.44	55
and	lnBld2	11.0	1.40	55

t Statistic =	1.90043
Degrees of Freedom =	54
One-Tailed Prob =	0.0314
Two-Tailed Prob =	0.0627

Modestly significant decline in blood lead from start to finish.

Test for Difference in Mean Start and End Blood Lead, Control Group

Command: TPAIR Missing Value Treatment: Pairwise
Selection: LOST<>T and GROUP<>'Blank' and GROUP='Ctrl'

*** Paired t Test ***

		Geometric Mean	Geometric Std. Dev.	n
For Variables:	lnBld1	11.3	1.48	56
and	lnBld2	10.7	1.43	56

t Statistic =	1.21848
Degrees of Freedom =	55
One-Tailed Prob =	0.1141
Two-Tailed Prob =	0.2282

No significant change in mean blood lead from start to finish.

Test for Difference in Mean Change in Blood Lead Between Groups

Command: TIND Missing Value Treatment: Listwise
Selection: LOST<>T and GROUP<>'Blank'

*** INDEPENDENT T TEST ***

For Variable: Bld_chg (End Blood - Start Blood)
Subsets in Variable GROUP
With Values Ctrl and Treat

For Subsets:	Mean	Std. Dev.	n
Ctrl	-0.68	4.18	56
Treat	-1.05	3.15	55

t Statistic = -0.526793
Degrees of Freedom = 109
One-Tailed Prob = 0.2997
Two-Tailed Prob = 0.5994

No significant difference in mean change in blood lead between groups
(Treatment had no effect on raw blood lead data)

Test for Difference in Mean Change in Blood Lead Between Groups
(for children under 12 months at start of study)

Command: TIND Missing Value Treatment: Listwise
Selection: LOST<>T and GROUP<>'Blank' and AGE<12

*** INDEPENDENT T TEST ***

For Variable: Bld_chg (End Blood - Start Blood)
Subsets in Variable GROUP
With Values Ctrl and Treat

For Subsets:	Mean	Std. Dev.	n
Ctrl	3.84	7.47	9
Treat	1.70	4.23	7

t Statistic = -0.676459
Degrees of Freedom = 14
One-Tailed Prob = 0.2549
Two-Tailed Prob = 0.5098

No significant difference in change in blood lead between groups.
(However, appears to be greater difference between groups for this age group - suggestive of a possible preventative effect)

List of Children Under 12 Months

Command: LIST Missing Value Treatment: Include
Selection: LOST<>T and GROUP<>'Blank' and AGE<12

GROUP	CHILD_ID	AGE	BLOOD1	BLOOD2	Bld_chg
Treat	89201-02	10	21.5	16.3	-5.2
Ctrl	91132-04	10	12.7	8.2	-4.5
Treat	92347-01	10	11.4	10.9	-0.5
Treat	92275-01	8	19.9	19.4	-0.5
Ctrl	90044-02	9	5.4	5.4	0
Ctrl	92346-01	10	7.1	7.7	0.6
Ctrl	92352-01	10	12.9	13.7	0.8
Ctrl	89266-03	11	11.4	12.7	1.3
Treat	91013-02	10	10.7	12.5	1.8
Ctrl	91107-02	7	3.6	5.5	1.9
Treat	91099-02	8	9.5	13.3	3.8
Treat	91104-02	6	6.7	11.5	4.8
Ctrl	92348-01	10	9.6	15.6	6
Ctrl	92288-01	6	7.4	14.2	6.8
Treat	92512-01	7	4.3	12	7.7
Ctrl	91047-02	7	7.4	29.1	21.7

Test for Difference in Mean Change in Blood Lead Between Groups
(for children under 12 months at start of study, with one outlier removed)

Command: TIND Missing Value Treatment: Listwise
Selection: LOST<>T and GROUP<>'Blank' and AGE<12 and CHILD_ID<>'91047-02'

*** INDEPENDENT T TEST ***

For Variable: Bld_chg (End Blood – Start Blood)
Subsets in Variable GROUP
With Values Ctrl and Treat

For Subsets:	Mean	Std Dev	n
Ctrl	1.61	3.55	8
Treat	1.70	4.23	7

t Statistic = 0.0436182
Degrees of Freedom = 13
One-Tailed Prob = 0.4829
Two-Tailed Prob = 0.9659

No significant difference in change in blood lead between groups.
(No longer appears that infants in treatment group rose less than those in control group

Test for Difference in Mean Change in Blood Lead Between Groups
(for children under 18 months at start of study)

Command: TIND Missing Value Treatment: Listwise
Selection: LOST<>T and GROUP<>'Blank' and AGE<18

*** INDEPENDENT T TEST ***

For Variable: Bld_chg (End Blood - Start Blood)
Subsets in Variable GROUP
With Values Ctrl and Treat

For Subsets:	Mean	Std. Dev.	n
Ctrl	2.51	6.28	14
Treat	1.45	4.63	10

t Statistic = -0.45101
Degrees of Freedom = 22
One-Tailed Prob = 0.3282
Two-Tailed Prob = 0.6564

No significant difference in change in blood lead between groups.

Test for Difference in Mean Change in Blood Lead Between Groups
(for children under 24 months at start of study)

Command: TIND Missing Value Treatment: Listwise
Selection: LOST<>T and GROUP<>'Blank' and AGE<24

*** INDEPENDENT T TEST ***

For Variable: Bld_chg (End Blood - Start Blood)
Subsets in Variable GROUP
With Values Ctrl and Treat

For Subsets:	Mean	Std. Dev.	n
Ctrl	0.40	5.88	23
Treat	0.33	4.43	15

t Statistic = -0.0349975
Degrees of Freedom = 36
One-Tailed Prob = 0.4861
Two-Tailed Prob = 0.9723

No significant difference in change in blood lead between groups.

Test for Difference in Mean Change in Blood Lead Between Groups
(for children with blood lead >= 15 ug/dL at start of study)

Command: TIND Missing Value Treatment: Listwise
Selection: LOST<>T and GROUP<>'Blank' and Bloodcode='ELEV'

*** INDEPENDENT T TEST ***

For Variable: Bld_chg (End Blood – Start Blood)
Subsets in Variable GROUP
With Values Ctrl and Treat

For Subsets:	Mean	Std. Dev.	n
Ctrl	-3.29	2.39	15
Treat	-3.43	2.38	15

t Statistic = -0.160769
Degrees of Freedom = 28
One-Tailed Prob = 0.4367
Two-Tailed Prob = 0.8734

No significant difference in change in blood lead between groups.

Test for Difference in Mean Change in Blood Lead Between Groups
(for children with blood lead <10 ug/dL at start of study)

Command: TIND Missing Value Treatment: Listwise
Selection: LOST<>T and GROUP<>'Blank' and Bloodcode='LOW'

*** INDEPENDENT T TEST ***

For Variable: Bld_chg (End Blood – Start Blood)
Subsets in Variable GROUP
With Values Ctrl and Treat

For Subsets:	Mean	Std Dev	n
Ctrl	2.29	5.42	18
Treat	0.86	2.96	19

t Statistic = -1.00493
Degrees of Freedom = 35
One-Tailed Prob = 0.1609
Two-Tailed Prob = 0.3218

No significant difference in change in blood lead between groups.

Test for Difference in Change in Blood Lead between Groups
(after adjustment for initial blood lead match)

Command: REGR Missing Value Treatment: Listwise
Selection: GROUP<>'Blank' and LOST<>'TRUE'

***** Multiple Linear Regression ***** 111 Valid Records

Dependent Variable: **BLD_CHG (final blood lead – initial blood lead)**
Coeff of Determ: 0.385773
Adjusted R Square: 0.232217 Estimated constant term: -2.15269
Multiple Corr Coeff: 0.621107 Standard Err of Estimate: 3.23659

Analysis of Variance for the Regression:

Source of Variance	Degrees of Freedom	Sum of Squares	Mean of Squares	F Test	Prob
Regression	22	578.978	26.3172	2.51226	0.0013
Residuals	88	921.845	10.4755		
Total	110	1500.82			

Variable	Regression Coefficient	Standardized Coefficient	Standard Error	t	Prob
CLUSTER1	4.4102	0.2488	1.8952	2.3270	0.0223
CLUSTER2	4.2746	0.2629	1.8012	2.3731	0.0198
CLUSTER3	2.5746	0.1583	1.8012	1.4293	0.1564
CLUSTER4	1.2902	0.0728	1.8952	0.6807	0.4978
CLUSTER5	2.7579	0.1696	1.8012	1.5311	0.1293
CLUSTER6	0.5912	0.0364	1.8012	0.3282	0.7435
CLUSTER7	2.8102	0.1585	1.8952	1.4828	0.1417
CLUSTER8	-0.3811	-0.0215	1.8982	-0.2008	0.8414
CLUSTER9	0.5006	0.0221	2.2343	0.2241	0.8232
CLUSTER10	7.0912	0.4361	1.8012	3.9369	0.0002
CLUSTER11	2.2746	0.1399	1.8012	1.2628	0.2100
CLUSTER12	1.4579	0.0897	1.8012	0.8094	0.4205
CLUSTER13	1.3355	0.0677	2.0386	0.6551	0.5141
CLUSTER14	0.6079	0.0374	1.8012	0.3375	0.7366
CLUSTER15	0.9789	0.0552	1.8982	0.5157	0.6073
CLUSTER16	1.4996	0.0760	2.0291	0.7390	0.4619
CLUSTER17	-0.9211	-0.0520	1.8982	-0.4852	0.6287
CLUSTER18	-1.3005	-0.0659	2.0291	-0.6409	0.5233
CLUSTER19	-0.4698	-0.0265	1.8952	-0.2479	0.8048
CLUSTER20	-2.9498	-0.1664	1.8952	-1.5564	0.1232
CLUSTER21	-5.2036	-0.1337	3.4785	-1.4959	0.1383
GROUP_N	**-0.2437**	**-0.0331**	**0.6260**	**-0.3893**	**0.6980**

CLUSTERS 1-9 : Area 2 children in ascending order of blood lead.
CLUSTERS 10-21 : Area 3 children in ascending order of blood lead.
CLUSTER 21 : 8 children with blood lead 8-26 ug/dL randomly assigned to Treat or Ctrl as one block. (Late additions to study)
GROUP_n : Numeric code for group assignment (Treat = 1, Ctrl = 0)

Test for Difference in Change in ln(Blood Lead) between Groups
(after adjustment for initial blood lead match)

Command: REGR Missing Value Treatment: Listwise
Selection: LOST<>'TRUE' and GROUP<>'Blank'

***** Multiple Linear Regression ***** 111 Valid Records

Dependent Variable: Bld_Chg_ln ({ln(final blood lead)}-{ln(initial blood lead)})

Coeff of Determ:	0.335027		
Adjusted R Square:	0.168784	Estimated constant term:	-0.15526
Multiple Corr Coeff:	0.578815	Standard Err of Estimate:	0.273635

Analysis of Variance for the Regression:

Source of Variance	Degrees of Freedom	Sum of Squares	Mean of Squares	F Test	Prob
Regression	22	3.31973	0.150897	2.01528	0.0115
Residuals	88	6.58911	0.0748762		
Total	110	9.90883			

Variable	Regression Coefficient	Standardized Coefficient	Standard Error	t	Prob
CLUSTER1	0.4828	0.3351	0.1602	3.0128	0.0034
CLUSTER2	0.3500	0.2649	0.1523	2.2981	0.0239
CLUSTER3	0.1951	0.1477	0.1523	1.2813	0.2034
CLUSTER4	0.0356	0.0247	0.1602	0.2219	0.8249
CLUSTER5	0.1696	0.1284	0.1523	1.1139	0.2684
CLUSTER6	-0.0070	-0.0053	0.1523	-0.0463	0.9632
CLUSTER7	0.1890	0.1312	0.1602	1.1792	0.2415
CLUSTER8	-0.0257	-0.0178	0.1605	-0.1602	0.8731
CLUSTER9	0.0595	0.0323	0.1889	0.3150	0.7535
CLUSTER10	0.5038	0.3813	0.1523	3.3082	0.0014
CLUSTER11	0.0930	0.0704	0.1523	0.6104	0.5432
CLUSTER12	0.0771	0.0584	0.1523	0.5064	0.6138
CLUSTER13	0.0616	0.0384	0.1724	0.3571	0.7218
CLUSTER14	-0.0064	-0.0048	0.1523	-0.0419	0.9667
CLUSTER15	0.0303	0.0210	0.1605	0.1888	0.8507
CLUSTER16	0.0851	0.0531	0.1716	0.4962	0.6210
CLUSTER17	-0.0813	-0.0564	0.1605	-0.5066	0.6137
CLUSTER18	-0.0919	-0.0573	0.1716	-0.5356	0.5936
CLUSTER19	-0.0084	-0.0059	0.1602	-0.0527	0.9581
CLUSTER20	-0.1356	-0.0942	0.1602	-0.8466	0.3995
CLUSTER21	-0.2290	-0.0724	0.2941	-0.7787	0.4382
GROUP_N	**-0.0097**	**-0.0163**	**0.0529**	**-0.1838**	**0.8546**

CLUSTERS 1-9 : Area 2 children in ascending order of blood lead.
CLUSTERS 10-21 : Area 3 children in ascending order of blood lead.
CLUSTER 21 : 8 children with blood lead 8-26 ug/dL randomly assigned to Treat or Ctrl as one block. (Late additions to study)
GROUP_n : Numeric code for group assignment (Treat = 1, Ctrl = 0)

Command: CORR Missing Value Treatment: Pairwise Selection: LOST<>T and GROUP<>'Blank'

*** Correlation Matrix *** Variables:						
lnBld1	1					
lnBld2	**0.66**	1				
Prob	**0**					
n	**111**					
lnMlead_b1	**0.50**	**0.36**	1			
Prob	**0**	**0**				
n	**111**	**111**				
lnHand1	**0.33**	0.14	**0.38**	1		
Prob	**0.0004**	0.1377	**0**			
n	**110**	110	**110**			
SEX_n	−0.14	−0.10	−0.07	**−0.24**	1	
Prob	0.1476	0.3197	0.4769	**0.0112**		
n	111	111	111	**110**		
GROUP_n	0.07	0.05	**0.28**	0.06	−0.04	1
Prob	0.4606	0.6391	**0.0034**	0.5338	0.6423	
n	111	111	**111**	110	111	
	lnBld1	**lnBld2**	**lnMlead_b1**	**lnHand1**	**SEX_n**	**GROUP_n**

Significant Correlations between:	r	
Start Blood and End Blood	0.66	
Start Blood and Initial Microvac Lead Loading	0.50	
Initial Microvac Lead and Initial Hand Wipe Lead	0.38	
End Blood and Initial Microvac Lead Loading	0.36	
Start Blood and Initial Hand Lead Loading	0.33	
Initial Microvac Lead and Group	0.28	(Higher Microvac lead in treatment)
Initial Hand Wipe Lead and Sex	−0.24	(Higher hand lead among boys)

Command: REGR Missing Value Treatment: Listwise
Selection: LOST<>T and GROUP<>'Blank'

***** Multiple Linear Regression With ln(End Blood) as Dependent Variable ******

*** Stepwise Regression – Backward Elimination
Variables Selected: lnBld1,lnMlead_b1,lnHand1,SEX_n,GROUP_n
Prob Value to add/remove: 0.1

Step	1	Removed	GROUP_n
Step	2	Removed	SEX_n
Step	3	Removed	lnMlead_b1
Step	4	Removed	lnHand1

Dependent Variable: lnBld2 110 Valid Records

Coeff of Determ:	0.43952		
Adjusted R Square:	0.43433	Estimated constant term:	0.909457
Multiple Corr Coeff:	0.662963	Standard Err of Estimate:	0.260546

Analysis of Variance for the Regression:

Source of Variance	Degrees of Freedom	Sum of Squares	Mean of Squares	F Test	Prob
Regression	1	5.74923	5.74923	84.6919	0
Residuals	108	7.33148	0.0678841		
Total	109	13.0807			

Variable	Regression Coefficient	Standardized Coefficient	Standard Error	t	Prob
lnBld1	0.603921	0.662963	0.0656235	9.20282	0

Command: REGR Missing Value Treatment: Listwise
Selection: LOST<>T and GROUP<>'Blank'

***** Multiple Linear Regression with ln(End Blood Lead) as Dependent Variable**

*** Stepwise Regression – Backward Elimination
Variables Selected: lnMlead_b1,lnHand1,SEX_n,GROUP_n
Prob Value to add/remove: 0.1

Step	1 Removed	lnHand1	(Baseline Hand Lead Loading)
Step	2 Removed	GROUP_n	(Numeric code for Treatment or Control)
Step	3 Removed	SEX_n	(Numeric code for sex)

Dependent Variable:	lnBld2	110 Valid Records	
Coeff of Determ:	0.13431		
Adjusted R Square:	0.126295	Estimated constant term:	2.47769
Multiple Corr Coeff:	0.366484	Standard Err of Estimate:	0.323806

Analysis of Variance for the Regression:

Source of Variance	Degrees of Freedom	Sum of Squares	Mean of Squares	F Test	Prob
Regression	1	1.75688	1.75688	16.756	0
Residuals	108	11.3238	0.10485		
Total	109	13.0807			

Variable	Regression Coefficient	Standardized Coefficient	Standard Error	t	Prob
lnMlead_b1	0.095641	0.366484	0.0233646	4.09341	0

With starting blood lead excluded, only sig. predictor of final blood lead is floor lead

Test for Difference in Mean Start and Mid-Project Microvac Dust, Control Group

Command: TPAIR Missing Value Treatment: Pairwise
Selection: LOST<>T and GROUP<>'Blank'
Breakdown on variable GROUP = Ctrl

***** Paired t Test *****

		Geometric Mean	Geometric Std Deviation	n
For Variables:	lnMdust_b1	364	3.06	56
and	lnMdust_b4	463	2.27	56

t Statistic =	-2.40742
Degrees of Freedom =	55
One-Tailed Prob =	0.0097
Two-Tailed Prob =	**0.0194**

Significant increase in control group floor dust at mid-project

Test for Difference in Mean Start and Mid-Project Microvac Dust, Treatment Group

Command: TPAIR Missing Value Treatment: Pairwise
Selection: LOST<>T and GROUP<>'Blank'
Breakdown on variable GROUP = Treat

***** Paired t Test *****

		Geometric Mean	Geometric Std Deviation	n
For Variables:	lnMdust_b1	569	1.35	53
and	lnMdust_b4	417	0.95	53

t Statistic =	1.78582
Degrees of Freedom =	52
One-Tailed Prob =	0.04
Two-Tailed Prob =	**0.08**

Modestly significant decrease in treatment group floor dust at mid-project

Test for Difference in Mean Start and Mid-Project Microvac Lead, Control Group

Command: TPAIR Missing Value Treatment: Pairwise
Selection: LOST<>T and GROUP<>'Blank'
Breakdown on variable GROUP = Ctrl

***** Paired t Test *****

		Geometric Mean	Geometric Std Deviation	n
For Variables:	lnMlead_b1	0.27	3.37	56
and	lnMlead_b4	0.27	3.20	56

t Statistic =	0.0444798
Degrees of Freedom =	55
One-Tailed Prob =	0.4823
Two-Tailed Prob =	**0.9647**

No significant change in control group floor lead at mid-project

Test for Difference in Mean Start and Mid-Project Microvac Lead, Treatment Group

Command: TPAIR Missing Value Treatment: Pairwise
Selection: LOST<>T and GROUP<>'Blank'
Breakdown on variable GROUP = Treat

***** Paired t Test *****

		Geometric Mean	Geometric Std Deviation	n
For Variables:	lnMlead_b1	0.55	3.90	53
and	lnMlead_b4	0.37	3.63	53

t Statistic =	2.32419
Degrees of Freedom =	52
One-Tailed Prob =	0.012
Two-Tailed Prob =	**0.0241**

Significant decrease in treatment group floor lead at mid-project

Test for Difference in Mean Change in Floor Lead Between Groups – Mid-Project

Command: TIND Missing Value Treatment: Listwise
Selection: LOST<>'TRUE' and GROUP<>'Blank'

***** INDEPENDENT T TEST *****

For Variable: Mlead_b1_4
Subsets in Variable GROUP
With Values Ctrl and Treat

For Subsets:	Mean	Std Deviation	n
Ctrl	0.04	0.51	56
Treat	-0.39	1.22	53

t Statistic =	-2.41824
Degrees of Freedom =	107
One-Tailed Prob =	0.0086
Two-Tailed Prob =	**0.0173**

Vacuuming produced a significant decline in floor lead loading to mid-project.

Test for Difference in Mean Start and End Microvac Lead, Control Group

Command: TPAIR Missing Value Treatment: Pairwise
Selection: LOST<>'TRUE' and GROUP<>'Blank'
Breakdown on variable GROUP = Ctrl

***** Paired t Test *****

		Geometric Mean	Geometric Std Deviation	n
For Variables:	lnMlead_b1	0.27	3.38	54
and	lnMlead_b7	0.23	3.29	54

t Statistic =	1.25809
Degrees of Freedom =	53
One-Tailed Prob =	0.1069
Two-Tailed Prob =	**0.2139**

Test for Difference in Mean Start and End Microvac Lead, Treatment Group

Command: TPAIR Missing Value Treatment: Pairwise
Selection: LOST<>'TRUE' and GROUP<>'Blank'
Breakdown on variable GROUP = Treat

***** Paired t Test *****

		Geometric Mean	Geometric Std Deviation	n
For Variables:	lnMlead_b1	0.55	3.91	53
and	lnMlead_b7	0.36	2.71	53

t Statistic =	2.58128
Degrees of Freedom =	52
One-Tailed Prob =	0.0064
Two-Tailed Prob =	**0.0127**

Vacuuming produced a significant decline in floor lead loading.

Test for Difference In Mean Start and End Microvac Dust, Control Group

Command: TPAIR Missing Value Treatment: Pairwise
Selection: LOST<>'TRUE' and GROUP<>'Blank'
Breakdown on variable GROUP = Ctrl

***** Paired t Test *****

		Geometric Mean	Geometric Std Deviation	n
For Variables:	lnMdust_b1	363	3.12	54
and	lnMdust_b7	444	3.27	54

t Statistic =	-1.15234
Degrees of Freedom =	53
One-Tailed Prob =	0.1272
Two-Tailed Prob =	**0.2544**

No change in floor dust loading in control group.

Test for Difference In Mean Start and End Microvac Dust, Treatment Group

Command: TPAIR Missing Value Treatment: Pairwise
Selection: LOST<>'TRUE' and GROUP<>'Blank'
Breakdown on variable GROUP = Treat

***** Paired t Test *****

		Geometric Mean	Geometric Std Deviation	n
For Variables:	lnMdust_b1	572	3.88	53
and	lnMdust_b7	326	3.75	53

t Statistic =	2.6099
Degrees of Freedom =	52
One-Tailed Prob =	0.0059
Two-Tailed Prob =	**0.0118**

Vacuuming produced a significant decline in floor dust loading.

Test for Difference In Mean Change In Floor Lead Between Groups

Command: TIND Missing Value Treatment: Listwise
Selection: LOST<>'TRUE' and GROUP<>'Blank'

***** INDEPENDENT T TEST *****

For Variable: **MLEAD_1_7**
Subsets in Variable GROUP
With Values Ctrl and Treat

For Subsets:	Mean	Std Deviation	n
Ctrl	-0.06	0.6640	54
Treat	-0.54	1.2524	53

t Statistic =	-2.46493
Degrees of Freedom =	105
One-Tailed Prob =	0.077
Two-Tailed Prob =	**0.0153**

Change in floor lead was significantly greater in treatment group than in control group

Test for Difference In Mean Start and End Microvac Lead, Treatment Group
(with homes vacuumed by Karen in Cycle 6 or 7 removed)

Command: TPAIR Missing Value Treatment: Pairwise
Selection: LOST<>'TRUE' and GROUP<>'Blank' and OPER6='Kevin' and OPER7='Kevin'

***** Paired t Test *****

		Geometric Mean	Geometric Std Deviation	n
For Variables:	lnMlead_b1	0.78	2.89	21
and	lnMlead_b7	0.39	2.20	21
	Change	-50%		

t Statistic =	3.4049
Degrees of Freedom =	20
One-Tailed Prob =	0.0014
Two-Tailed Prob =	**0.0028**

Significant decline of 50% in mean Microvac lead from start to end.

Test for Difference In Mean Start and End HEPA Vac Lead, Treatment Group
(with homes vacuumed by Karen in Cycle 6 or 7 removed)

Command: TPAIR Missing Value Treatment: Pairwise
Selection: LOST<>'TRUE' and GROUP<>'Blank' and OPER6='Kevin' and OPER7='Kevin'

***** Paired t Test *****

		Mean	Std Deviation	n
For Variables:	lnVlead1	1.03	3.03	21
and	lnVlead7	0.59	2.57	21
	Change	-43%		

t Statistic =	4.72636
Degrees of Freedom =	20
One-Tailed Prob =	0.0001
Two-Tailed Prob =	**0.0001**

Significant decline of 43% in mean HEPA Vac lead from start to end.

Test for Difference in Mean Change in Floor Lead Between Groups
(looking only at those homes with baseline floor lead above 0.50 mg/m2)

Command: TIND Missing Value Treatment: Listwise
Selection: LOST<>'TRUE' and GROUP<>'Blank' and MLEAD_B1>.5

***** INDEPENDENT T TEST *****

For Variable: **MLEAD_1_7**
Subsets in Variable GROUP
With Values Treat and Ctrl

For Subsets:	Mean	Std Deviation	n
Treat	-1.06	1.49852	29
Ctrl	-0.56	0.556501	16

t Statistic =	1.27331
Degrees of Freedom =	43
One-Tailed Prob =	0.1049
Two-Tailed Prob =	**0.2097**

No difference between groups

Test for Difference in Mean Start and Mid-Project Hand Lead, Control Group

Command: TPAIR Missing Value Treatment: Pairwise
Selection: LOST<>T and GROUP<>'Blank'
Breakdown on variable GROUP = Ctrl

***** Paired t Test *****

		Geometric Mean	Geometric Std Deviation	n
For Variables:	lnHand1	10	2.23	54
and	lnHand4	9	2.57	54

t Statistic =	1.02
Degrees of Freedom =	53
One-Tailed Prob =	0.1562
Two-Tailed Prob =	**0.3124**

No significant change in control group hand lead at mid-project

Test for Difference in Mean Start and Mid-Project Hand Lead, Treatment Group

Command: TPAIR Missing Value Treatment: Pairwise
Selection: LOST<>T and GROUP<>'Blank'
Breakdown on variable GROUP = Treat

***** Paired t Test *****

		Geometric Mean	Geometric Std Deviation	n
For Variables:	lnHand1	11	2.13	51
and	lnHand4	14	3.68	51

t Statistic =	-1.34694
Degrees of Freedom =	50
One-Tailed Prob =	0.092
Two-Tailed Prob =	**0.1841**

No significant change in treatment group hand lead at mid-project

Test for Difference in Mean Start and End Hand Lead, Control Group

Command: TPAIR Missing Value Treatment: Pairwise
Selection: LOST<>'TRUE' and GROUP<>'Blank'
Breakdown on variable GROUP = Ctrl

***** Paired t Test *****

		Geometric Mean	Geometric Std Deviation	n
For Variables:	lnHand1	10	2.18	53
and	lnHand7	6	2.68	53

t Statistic =	3.7361
Degrees of Freedom =	52
One-Tailed Prob =	0.0002
Two-Tailed Prob =	**0.0005**

Significant decrease in hand lead in control group.

Test for Difference in Mean Start and End Hand Lead, Treatment Group

Command: TPAIR Missing Value Treatment: Pairwise
Selection: LOST<>'TRUE' and GROUP<>'Blank'
Breakdown on variable GROUP = Treat

***** Paired t Test *****

		Geometric Mean	Geometric Std Deviation	n
For Variables:	lnHand1	11	2.10	51
and	lnHand7	15	2.83	51

t Statistic =	-1.78281
Degrees of Freedom =	50
One-Tailed Prob =	0.0403
Two-Tailed Prob =	**0.0807**

Marginally significant increase in hand lead in treatment group.

Test for Difference in Change in Hand Lead between Groups

Command: TIND Missing Value Treatment: Listwise
Selection: LOST<>'TRUE' and GROUP<>'Blank'

***** INDEPENDENT T TEST *****

For Variable: **HAND_1_7**
Subsets in Variable GROUP
With Values Ctrl and Treat

For Subsets:	Mean	Std Deviation	n
Ctrl	-4.2	16.89	53
Treat	10.1	35.83	51

t Statistic =	2.6198
Degrees of Freedom =	102
One-Tailed Prob =	0.0051
Two-Tailed Prob =	**0.0101**

Significant difference between groups

Test for Effect of Playing Outside on Final Hand Lead

Command: TIND Missing Value Treatment: Listwise
Selection: LOST<>'TRUE' and GROUP<>'Blank'

*** INDEPENDENT T TEST ***

For Variable: **LNHAND7**
Subsets in Variable **INSIDE7** (TRUE if child playing inside prior to hand wipe, FALSE if outside)
With Values T and F

For Subsets:	Geometric Mean	Geometric Std Deviation	n
T	9.3	2.5	56
F	14.3	2.6	30

t Statistic = 2.05708
Degrees of Freedom = 84
One-Tailed Prob = 0.0214
Two-Tailed Prob = 0.0428

Children had higher Cycle 7 hand lead if playing outside prior to hand wipe.

Test for Effect of Playing Outside on Change in Hand Lead

Command: TIND Missing Value Treatment: Listwise
Selection: LOST<>'TRUE' and GROUP<>'Blank'

*** INDEPENDENT T TEST ***

For Variable: **HAND_1_7** (Change in Hand Lead from Cycle 1 to Cycle 7)
Subsets in Variable **INSIDE7** (TRUE if child playing inside prior to hand wipe, FALSE if outside)
With Values T and F

For Subsets:	Mean	Std Deviation	n
T	-2.8	27.2	61
F	10.3	31.6	32

t Statistic = 2.09109
Degrees of Freedom = 91
One-Tailed Prob = 0.0197
Two-Tailed Prob = 0.0393

Children playing outside prior to Cycle 7 handwipe showed increase in hand lead.

Test for Difference in Cycle 7 Hand Lead between Groups
(after adjustment for differences in floor lead loading, whether child was playing outside, and gender)

Command: REGR Missing Value Treatment: Listwise
Selection: LOST<>'TRUE' and GROUP<>'Blank'

***** Multiple Linear Regression *****

*** Stepwise Regression – Backward Elimination
Variables Selected: LNMLEAD_B7,Inside7_n,SEX_N,GROUP_N
Prob Value to add/remove: 0.05
Step 1 Removed SEX_N
Step 2 Removed Inside7_n

Dependent Variable: **LNHAND7** 86 Valid Records
Coeff of Determ: 0.202939
Adjusted R Square: 0.183733 Estimated constant term: 2.28662
Multiple Corr Coeff: 0.450488 Standard Err of Estimate: 0.854697

Analysis of Variance for the Regression:

Source of Variance	Degrees of Freedom	Sum of Squares	Mean of Squares	F Test	Prob
Regression	2	15.4375	7.71875	10.5663	0
Residuals	83	60.632	0.730506		
Total	85	76.0695			

Variable	Regression Coefficient	Standardized Coefficient	Standard Error	t	Prob
LNMLEAD_B7	0.208209	0.240451	0.0870047	2.39308	0.019
GROUP_N	**0.625107**	0.331519	0.189459	3.29943	**0.0014**

Most of the difference between groups remains after adjustment for confounders.

Test for Difference in Change in Hand Lead by Sex

Command: TIND Missing Value Treatment: Listwise
Selection: GROUP<>'Blank' and LOST<>'TRUE'

***** INDEPENDENT T TEST *****

For Variable: **HAND_1_7**
Subsets in Variable **SEX**
With Values F and M

For Subsets:	Mean	Std Deviation	n
F	8.1	31.9	56
M	-3.4	23.1	48

t Statistic = -2.06472
Degrees of Freedom = 102
One-Tailed Prob = 0.0207
Two-Tailed Prob = 0.0415

Boys' hand leads declined, while girls' hand leads increased.

Test for Difference in Cycle 7 Hand Lead between Groups
(looking only at children who were playing inside prior to wipe)

Command: TIND Missing Value Treatment: Listwise
Selection: GROUP<>'Blank' and LOST<>'TRUE' and INSIDE7='T'

***** INDEPENDENT T TEST *****

For Variable: **LNHAND7**
Subsets in Variable **GROUP**
With Values Ctrl and Treat

For Subsets:	Geometric Mean	Geometric Std Deviation	n
Ctrl	6.8	2.2	29
Treat	13.0	2.6	27

t Statistic = 2.78133
Degrees of Freedom = 54
One-Tailed Prob = 0.0037
Two-Tailed Prob = 0.0074

Difference between groups, even if excluding those playing outside.

Test for Difference In Change In Hand Lead between Groups
(adjusting for differences in chg. in floor lead loading, whether child was playing outside, and gender)

Command: REGR Missing Value Treatment: Listwise
Selection: GROUP<>'Blank' and LOST<>'TRUE'

***** Multiple Linear Regression *****

Dependent Variable:	**HAND_1_7**	93 Valid Records	
Coeff of Determ:	0.152307		
Adjusted R Square:	0.113776	Estimated constant term:	-15.9771
Multiple Corr Coeff:	0.390266	Standard Err of Estimate:	27.5774

Analysis of Variance for the Regression:

Source of Variance	Degrees of Freedom	Sum of Squares	Mean of Squares	F Test	Prob
Regression	4	12024.6	3006.15	3.95281	0.0054
Residuals	88	66925	760.511		
Total	92	78949.6			

Variable	Regression Coefficient	Standardized Coefficient	Standard Error	t	Prob
MLEAD_1_7	2.5106	0.0938	2.7317	0.9191	0.3606
inside7_n	-10.9155	-0.1780	6.0897	-1.7925	0.0765
SEX_N	11.4778	0.1967	5.7538	1.9948	0.0492
GROUP_N	16.0095	0.2747	5.9526	2.6895	0.0086

Difference between groups remains after adjustment for potential confounders.

Command: CORR Missing Value Treatment: Pairwise
Selection: GROUP<>'Blank' and LOST<>'TRUE'

***** Correlation Matrix *****

Variables:

BLD_CHG	1					
SEX_N	0.02006	1				
Prob	0.8344					
n	111					
GROUP_N	-0.05039	-0.04457	1			
Prob	0.5994	0.6423				
n	111	111				
MLEAD_1_7	0.0922	-0.06729	-0.23388	1		
Prob	0.3449	0.491	0.0153			
n	107	107	107			
HAND_1_7	0.0433	0.2003	0.25109	-0.00189	1	
Prob	0.6625	0.0415	0.0101	0.9848		
n	104	104	104	104		
VLEAD_1_7	0.20217	0.04649	0	0.55211	0.38239	1
Prob	0.1591	0.7485	1	0	0.0073	
n	50	50	50	50	48	
	BLD_CHG	SEX_N	GROUP_N	MLEAD_1_7	HAND_1_7	VLEAD_1_7

Significant relationships between:

Change in Microvac lead loading and group (treatment Microvac Pb decreased)
Change in hand lead and sex (boys hand lead decreased)
Change in hand lead and group (treatment group hand lead increased)
Change in HEPA vac lead and change in Microvac lead
Change in HEPA vac lead and change in hand lead

Test for Difference In HEPA Vac Lead between Groups, Cycle 8

Command: TIND Missing Value Treatment: Listwise
Selection: LOST<>'TRUE' and GROUP<>'Blank'

***** INDEPENDENT T TEST *****

For Variable: **LNVLEAD8**
Subsets in Variable GROUP
With Values Ctrl and Treat

For Subsets:	Geometric Mean	Geometric Std Deviation	n
Ctrl	0.36	4.02	33
Treat	0.40	3.11	37

t Statistic =	0.386883
Degrees of Freedom =	68
One-Tailed Prob =	0.35
Two-Tailed Prob =	**0.7001**

No difference between groups on Cycle 8 vacuuming.

Test for Difference In HEPA Vac Dust between Groups, Cycle 8

Command: TIND Missing Value Treatment: Listwise
Selection: LOST<>'TRUE' and GROUP<>'Blank'

***** INDEPENDENT T TEST *****

For Variable: **LNVDUST8**
Subsets in Variable GROUP
With Values Ctrl and Treat

For Subsets:	Geometric Mean	Geometric Std Deviation	n
Ctrl	448	3.16	33
Treat	480	2.33	37

t Statistic =	0.281305
Degrees of Freedom =	68
One-Tailed Prob =	0.3897
Two-Tailed Prob =	**0.7793**

No difference between groups on Cycle 8 vacuuming.

Test for Difference in HEPA Vac Dust between Operators, Cycle 8

Command: TIND Missing Value Treatment: Listwise
Selection: LOST<>'TRUE' and GROUP<>'Blank'

***** INDEPENDENT T TEST *****

For Variable: **LNVDUST8**
Subsets in Variable OPER8
With Values Karen and Kevin

For Subsets:	Geometric Mean	Geometric Std Deviation	n
Karen	467	3.61	29
Kevin	463	2.10	41

t Statistic = -0.0311179
Degrees of Freedom = 68
One-Tailed Prob = 0.4876
Two-Tailed Prob = 0.9753

No difference between vacuum operators on Cycle 8

Test for Difference in Mean Initial Floor Dust by Power Nozzle Response

Command: TIND Missing Value Treatment: Listwise
Selection: LOST<>'TRUE' and GROUP<>'Blank'

***** INDEPENDENT T TEST *****

For Variable: **lnMdust_b1**
Subsets in Variable **POWERNOZL**
With Values y and n

For Subsets:	Geometric Mean	Geometric Std Deviation	n
yes	399	3.41	93
no	1299	3.92	10

t Statistic = 2.86484
Degrees of Freedom = 101
One-Tailed Prob = 0.0025
Two-Tailed Prob = 0.0051

People who use a vacuum with power nozzle have sig. lower floor dust loadings.

Test for Difference in Mean Initial Floor Lead by Power Nozzle Response

Command: TIND Missing Value Treatment: Listwise
Selection: LOST<>'TRUE' and GROUP<>'Blank'

*** INDEPENDENT T TEST ***

For Variable: **lnMlead_b1**
Subsets in Variable **POWERNOZL**
With Values y and n

For Subsets:	Geometric Mean	Geometric Std Deviation	n
yes	0.36	3.93	93
no	0.71	3.27	10

t Statistic = 1.49489
Degrees of Freedom = 101
One-Tailed Prob = 0.069
Two-Tailed Prob = 0.1381

Users of power nozzles also have lower lead loadings, but not sig.

Test for Difference in Mean Initial HEPA VAc Dust by Power Nozzle Response

Command: TIND Missing Value Treatment: Listwise
Selection: LOST<>'TRUE' and GROUP<>'Blank'

*** INDEPENDENT T TEST ***

For Variable: **lnVdust1**
Subsets in Variable **POWERNOZL**
With Values y and n

For Subsets:	Geometric Mean	Geometric Std Deviation	n
yes	1485	2.63	46
no	2076	1.87	5

t Statistic = 0.754048
Degrees of Freedom = 49
One-Tailed Prob = 0.2272
Two-Tailed Prob = 0.4544

Powernozzle users also had lower HEPA vac bag dust, but not sig. (smaller n here)

Test for Difference in Mean Initial HEPA VAc Lead by Power Nozzle Response

Command: TIND Missing Value Treatment: Listwise
Selection: LOST<>'TRUE' and GROUP<>'Blank'

***** INDEPENDENT T TEST *****

For Variable: **lnVlead1**
Subsets in Variable **POWERNOZL**
With Values y and n

For Subsets:	Geometric Mean	Geometric Std Deviation	n
yes	1.14	3.22	46
no	1.39	2.27	5

t Statistic = 0.37666
Degrees of Freedom = 49
One-Tailed Prob = 0.354
Two-Tailed Prob = 0.7081

No significant difference in HEPA vac bag lead (smaller n here)

Test for Difference in Microvac Floor Dust Loading by Carpet Age

Command: ANOVA Missing Value Treatment: Listwise
Selection: LOST<>'TRUE' and GROUP<>'Blank'

***** 1-way Analysis of Variance with No Replications *****

Dependent Variable: **lnMdust_b1**

Factor	# Levels	Variable
A	5	**CARPET_AGE**

Source	DF	Sum of Squares	Mean of Squares	F	Prob
A	4	12.1852	3.0463	1.91982	0.1131
Residual	98	155.503	1.58676		
Total	102	167.688			

Cell Means / Standard Deviations for Maximum Prob of 0.99

Factor: Age of carpets	Geometric Mean	Geometric Std. Dev.	Cell n
0-3 years	502	2.55	21
4-5 years	189	4.80	8
6-10 years	378	3.59	32
>10 years	447	4.79	23
Don't Know	749	2.57	19

No significant differences (but some trend) in initial floor dust loadings by carpet age.

Test for Difference in HEPA Vac Floor Dust Loading by Carpet Age

Command: ANOVA Missing Value Treatment: Listwise
Selection: LOST<>'TRUE' and GROUP<>'Blank'

***** 1-way Analysis of Variance with No Replications *****

Dependent Variable: **lnVdust1**

Factor	# Levels	Variable
A	5	**CARPET_AGE**

Source	DF	Sum of Squares	Mean of Squares	F	Prob
A	4	6.69081	1.6727	2.05015	0.1029
Residual	46	37.531	0.815891		
Total	50	44.2218			

Cell Means / Standard Deviations for Maximum Prob of 0.99

Factor: A	Geometric Mean	Geometric Std. Dev.	Cell n
0-3 years	893	2.47	6
4-5 years	1028	1.98	3
6-10 years	1791	2.98	15
>10 years	1150	2.62	14
Don't Know	2466	1.75	13

No significant differences (but some trend) in initial floor dust loadings by carpet age.

Test for Difference in HEPA Vac Floor Lead Loading by Carpet Age

Command: ANOVA Missing Value Treatment: Listwise
Selection: LOST<>'TRUE' and GROUP<>'Blank'

***** 1-way Analysis of Variance with No Replications *****

Dependent Variable: **lnVlead1**

Factor	# Levels	Variable
A	5	**CARPET_AGE**

Source	DF	Sum of Squares	Mean of Squares	F	Prob
A	4	9.25249	2.31312	1.92673	0.122
Residual	46	55.225	1.20054		
Total	50	64.4775			

Cell Means / Standard Deviations for Maximum Prob of 0.99

Factor: A	Geometric Mean	Geometric Std. Dev.	Cell n
0-3 years	0.49	2.91	6
4-5 years	0.65	4.20	3
6-10 years	1.37	3.42	15
>10 years	1.01	3.38	14
Don't Know	1.90	1.89	13

No significant differences (but some trend) in initial floor lead loadings by carpet age.

Test for Difference in Reduction in HEPA Vac Floor Lead Loading by Carpet Age

Command: ANOVA Missing Value Treatment: Listwise
Selection: LOST<>'TRUE' and GROUP<>'Blank'

***** 1-way Analysis of Variance with No Replications *****

Dependent Variable: **Vlead_1_7** (reduction in HEPA vac bag lead from start to finish)

Factor	# Levels	Variable
A	5	**CARPET_AGE**

Source	DF	Sum of Squares	Mean of Squares	F	Prob
A	4	4.14896	1.03724	0.274101	0.893
Residual	42	158.934	3.78415		
Total	46	163.083			

Cell Means / Standard Deviations for Maximum Prob of 0.99

Factor: A	Mean	Std. Dev.	Cell n
0-3 years	-0.55	0.66	6
4-5 years	-1.12	1.54	3
6-10 years	-1.34	1.87	14
>10 years	-1.48	2.29	13
Don't Know	-1.44	2.10	11

No significant differences, but an apparent trend.

Test for Difference in Reduction in Microvac Floor Lead Loading by Carpet Age

Command: ANOVA Missing Value Treatment: Listwise
Selection: LOST<>'TRUE' and GROUP<>'Blank'

***** 1-way Analysis of Variance with No Replications *****

Dependent Variable: Mlead_b1_7

Factor	# Levels	Variable
A	5	CARPET_AGE

Source	DF	Sum of Squares	Mean of Squares	F	Prob
A	4	2.12359	0.530899	0.471647	0.7564
Residual	96	108.06	1.12563		
Total	100	110.184			

Cell Means / Standard Deviations for Maximum Prob of 0.99

Factor: Age of carpets	Mean	Std. Dev.	Cell n
0-3 years	-0.13	0.83	21
4-5 years	-0.15	0.47	8
6-10 years	-0.28	0.93	32
>10 years	-0.54	1.29	23
Don't Know	-0.35	1.35	17

Also no significant differences, but a possible trend.

Test for Difference in Reduction in Microvac Floor Lead Loading by Vacuuming Freq.

Command: ANOVA Missing Value Treatment: Listwise
Selection: LOST<>'TRUE' and GROUP<>'Blank'

***** 1-way Analysis of Variance with No Replications *****

Dependent Variable: Mlead_b1_7

Factor	# Levels	Variable
A	6	VACFREQ_AF

Source	DF	Sum of Squares	Mean of Squares	F	Prob
A	5	13.599	2.71979	2.67517	0.0263
Residual	95	96.5847	1.01668		
Total	100	110.184			

Cell Means / Standard Deviations for Maximum Prob of 0.99

Factor: Vacuuming Frequency	Mean	Std. Dev.	Cell n
every day	-0.73	1.14	5
every 2 days	-0.15	0.69	24
twice/wk	-0.11	0.93	36
once/wk	-0.30	0.75	27
every 2 wks	-1.14	1.89	6
< every 2 wks	-1.78	2.97	3

Duncan test for groups with significant differences

Group One	Group Two	<.05	Mean Diff	Critical Diff
< every 2 wks	once/wk	Yes	1.48444	1.12888
< every 2 wks	every 2 days	Yes	1.63833	1.15429
< every 2 wks	twice/wk	Yes	1.67389	1.17647

People that vacuum less than every 2 wks saw bigger reduction.

Test for Difference in Reduction in Microvac Vac Floor Dust Loading by Vacuuming Freq.

Command: ANOVA Missing Value Treatment: Listwise
Selection: LOST<>'TRUE' and GROUP<>'Blank'

***** 1-way Analysis of Variance with No Replications *****

Dependent Variable: Mdust_b1_7

Factor	# Levels	Variable
A	6	VACFREQ_AF

Source	DF	Sum of Squares	Mean of Squares	F	Prob
A	5	50814988	10162998	5.02056	0.0004
Residual	95	192306333	2024277		
Total	100	243121321			

Cell Means / Standard Deviations for Maximum Prob of 0.99

Factor: A A	Mean	Std. Dev.	Cell n
every day	-734.40	1216.60	5
every 2 days	-8.58	670.57	24
twice/wk	-255.39	1248.58	36
once/wk	-192.85	713.29	27
every 2 wks	1029.67	1847.79	6
< every 2 wks	-3825.67	6752.04	3

Duncan test for groups with significant differences

Group One	Group Two	<.05	Mean Diff	Critical Diff
< every 2 wks	every day	Yes	3091.27	1462.5
< every 2 wks	twice/wk	Yes	3570.28	1540.74
< every 2 wks	every 2 wks	Yes	3632.81	1592.91
< every 2 wks	every 2 days	Yes	3817.08	1628.77
< every 2 wks	every 2 wks	Yes	4855.33	1660.06
every day	every 2 wks	Yes	1764.07	1628.77

Again, people who vacuumed < every 2 wks saw bigger reduction in dust

Test for Difference in Reduction in HEPA Vac Floor Dust Loading by Vacuuming Freq.

Command: ANOVA Missing Value Treatment: Listwise
Selection: LOST<>'TRUE' and GROUP<>'Blank'

***** 1-way Analysis of Variance with No Replications *****

Dependent Variable: **Vdust_1_7**

Factor	# Levels	Variable
A	6	VACFREQ_AF

Source	DF	Sum of Squares	Mean of Squares	F	Prob
A	5	4045063	809013	0.288331	0.9167
Residual	41	115039543	2805843		
Total	46	119084606			

Cell Means / Standard Deviations for Maximum Prob of 0.99

Factor: A	Mean	Std. Dev.	Cell n
every day	-958.5	1031.67	2
every 2 days	-1193.75	838.506	8
twice/wk	-1041	1519.8	15
once/wk	-1521	2088.92	17
every 2 wks	-2005.33	1277.1	3
< every 2 wks	-1765.5	1907.07	2

No significant differences, but possibly same trend

Test for Difference in Initial Microvac lead loading by Shoes at Door Responses

Command: TIND Missing Value Treatment: Listwise
Selection: LOST<>'TRUE' and GROUP<>'Blank'

***** INDEPENDENT T TEST *****

For Variable: lnMlead_b1
Subsets in Variable SHOES_DOOR
With Values n and y

For Subsets:	Geometric Mean	Geometric Std Deviation	n
n	0.46	3.20	32
y	0.33	4.18	65

t Statistic =	-1.15108
Degrees of Freedom =	95
One-Tailed Prob =	0.1263
Two-Tailed Prob =	**0.2526**

No significant difference in initial floor lead loading if shoes off at door.

Test for Difference in Mid-Project Microvac lead loading by Shoes at Door Responses

Command: TIND Missing Value Treatment: Listwise
Selection: LOST<>'TRUE' and GROUP<>'Blank'

***** INDEPENDENT T TEST *****

For Variable: lnMlead_b4
Subsets in Variable SHOES_DOOR
With Values n and y

For Subsets:	Geometric Mean	Geometric Std Deviation	n
n	0.36	3.36	32
y	0.26	3.41	65

t Statistic = -1.19236
Degrees of Freedom = 95
One-Tailed Prob = 0.118
Two-Tailed Prob = 0.2361

No significant difference in mid-project floor lead if shoes off at door.

Test for Difference in Final Microvac lead loading by Shoes at Door Responses

Command: TIND Missing Value Treatment: Listwise
Selection: LOST<>'TRUE' and GROUP<>'Blank'

***** INDEPENDENT T TEST *****

For Variable: lnMlead_b7
Subsets in Variable SHOES_DOOR
With Values n and y

For Subsets:	Geometric Mean	Geometric Std Deviation	n
n	0.41	3.05	32
y	0.23	3.05	65

t Statistic = -2.38864
Degrees of Freedom = 95
One-Tailed Prob = 0.0094
Two-Tailed Prob = 0.0189

Significantly lower floor lead at end of project if shoes off at door.

Test for Difference in Initial Blood Lead loading by Shoes at Door Responses

Command: TIND Missing Value Treatment: Listwise
Selection: LOST<>'TRUE' and GROUP<>'Blank'

***** INDEPENDENT T TEST *****

For Variable: lnBld1
Subsets in Variable SHOES_DOOR
With Values n and y

For Subsets:		Geometric Mean	Geometric Std Deviation	n
n		12.8	1.40	35
y		10.6	1.48	66
	Difference	2.2		

t Statistic =	-2.40833
Degrees of Freedom =	99
One-Tailed Prob =	0.0089
Two-Tailed Prob =	**0.0179**

Significantly lower initial blood lead if everyone leaves shoes at door.

Test for Difference in Effect of Shoes at Door on Floor Lead between Groups – Cycle 1

Command: TIND Missing Value Treatment: Listwise
Selection: GROUP<>'Blank' and LOST<>'TRUE'
Breakdown on variable GROUP = Ctrl

***** INDEPENDENT T TEST *****

For Variable: **LNMLEAD_B1**
Subsets in Variable **SHOES_DOOR**
With Values y and n

For Subsets:	Geometric Mean	Geometric Std Deviation	n
yes	0.26	3.77	35
no	0.26	2.89	16

t Statistic = -0.0412302
Degrees of Freedom = 49
One-Tailed Prob = 0.4836
Two-Tailed Prob = 0.9673

Command: TIND Missing Value Treatment: Listwise
Selection: GROUP<>'Blank' and LOST<>'TRUE'
Breakdown on variable GROUP = Treat

***** INDEPENDENT T TEST *****

For Variable: **LNMLEAD_B1**
Subsets in Variable **SHOES_DOOR**
With Values y and n

For Subsets:	Geometric Mean	Geometric Std Deviation	n
yes	0.43	4.49	31
no	0.87	2.51	19

t Statistic = 1.85169
Degrees of Freedom = 48
One-Tailed Prob = 0.0351
Two-Tailed Prob = 0.0702

No effect in control group, but some effect in treatment group.

Test for Difference in Effect of Shoes at Door on Floor Lead between Groups – Cycle 4

Command: TIND Missing Value Treatment: Listwise
Selection: GROUP<>'Blank' and LOST<>'TRUE'
Breakdown on variable GROUP = Ctrl

*** INDEPENDENT T TEST ***

For Variable: **LNMLEAD_B4**
Subsets in Variable **SHOES_DOOR**
With Values y and n

For Subsets:	Geometric Mean	Geometric Std Deviation	n
yes	-1.30563	1.0786	35
no	-1.39744	1.34051	16

t Statistic = -0.261126
Degrees of Freedom = 49
One-Tailed Prob = 0.3975
Two-Tailed Prob = 0.7951

Command: TIND Missing Value Treatment: Listwise
Selection: GROUP<>'Blank' and LOST<>'TRUE'
Breakdown on variable GROUP = Treat

*** INDEPENDENT T TEST ***

For Variable: **LNMLEAD_B4**
Subsets in Variable **SHOES_DOOR**
With Values y and n

For Subsets:	Geometric Mean	Geometric Std Deviation	n
yes	0.26	4.05	30
no	0.58	2.56	18

t Statistic = 2.15303
Degrees of Freedom = 46
One-Tailed Prob = 0.0183
Two-Tailed Prob = 0.0366

Effect in treatment group only

Test for Difference In Effect of Shoes at Door on Floor Lead between Groups – Cycle 7

Command: TIND Missing Value Treatment: Listwise
Selection: GROUP<>'Blank' and LOST<>'TRUE'
Breakdown on variable GROUP = Ctrl

***** INDEPENDENT T TEST *****

For Variable: **LNMLEAD_B7**
Subsets in Variable **SHOES_DOOR**
With Values y and n

For Subsets:	Geometric Mean	Geometric Std Deviation	n
yes	0.22	3.67	35
no	0.24	2.97	16

t Statistic = 0.210202
Degrees of Freedom = 49
One-Tailed Prob = 0.4172
Two-Tailed Prob = 0.8344

Command: TIND Missing Value Treatment: Listwise
Selection: GROUP<>'Blank' and LOST<>'TRUE'
Breakdown on variable GROUP = Treat

***** INDEPENDENT T TEST *****

For Variable: **LNMLEAD_B7**
Subsets in Variable **SHOES_DOOR**
With Values y and n

For Subsets:	Geometric Mean	Geometric Std Deviation	n
yes	0.24	2.36	31
no	0.69	2.36	17

t Statistic = 4.12374
Degrees of Freedom = 46
One-Tailed Prob = 0.0001
Two-Tailed Prob = 0.0002

Effect in treatment group only

Test for Difference in Initial Microvac lead loading by Dog/Cat Responses

Command: TIND Missing Value Treatment: Listwise
Selection: LOST<>'TRUE' and GROUP<>'Blank'

*** INDEPENDENT T TEST ***

For Variable: **lnMlead_b1**
Subsets in Variable DOG_CAT
With Values y and n

For Subsets:	Geometric Mean	Geometric Std Deviation	n
y	0.40	3.89	51
n	0.35	4.06	48

t Statistic = -0.425115
Degrees of Freedom = 97
One-Tailed Prob = 0.3358
Two-Tailed Prob = 0.6717

No significant difference in initial floor lead loading if pet in house.

Test for Difference in Mid-Project Microvac lead loading by Dog/Cat Responses

Command: TIND Missing Value Treatment: Listwise
Selection: LOST<>'TRUE' and GROUP<>'Blank'

***** INDEPENDENT T TEST *****

For Variable: lnMlead_b4
Subsets in Variable DOG_CAT
With Values y and n

For Subsets:	Geometric Mean	Geometric Std Deviation	n
y	0.38	3.15	51
n	0.23	3.70	48

t Statistic = -1.97954
Degrees of Freedom = 97
One-Tailed Prob = 0.0253
Two-Tailed Prob = 0.0506

Significantly higher floor lead loading at mid-project if pet in house.

Test for Difference in Final Microvac lead loading by Dog/Cat Responses

Command: TIND Missing Value Treatment: Listwise
Selection: LOST<>'TRUE' and GROUP<>'Blank'

*** INDEPENDENT T TEST ***

For Variable: lnMlead_b7
Subsets in Variable DOG_CAT
With Values y and n

For Subsets:	Geometric Mean	Geometric Std Deviation	n
y	0.37	3.37	51
n	0.22	2.81	48

t Statistic = -2.31721
Degrees of Freedom = 97
One-Tailed Prob = 0.0113
Two-Tailed Prob = 0.0226

Significantly higher floor lead loading at end of project if pet in house.

Test for Difference in Initial Blood Lead loading by Dog/Cat Responses

Command: TIND Missing Value Treatment: Listwise
Selection: LOST<>'TRUE' and GROUP<>'Blank'

*** INDEPENDENT T TEST ***

For Variable: lnBld1
Subsets in Variable DOG_CAT
With Values y and n

For Subsets:		Geometric Mean	Geometric Std Deviation	n
y		12.6	1.41	54
n		10.3	1.50	49
	Difference	2.3		

t Statistic = -2.76879
Degrees of Freedom = 101
One-Tailed Prob = 0.0033
Two-Tailed Prob = 0.0067

Significant higher initial blood lead if dog/cat in house.

```
Command: STRUCTURE
The Current Data Set is e:\hepa\data\hepa_win.abd Rev#83

                in use  maximum available
Variables:         192         512
Records:           120       32000
File Size:      142536    33648416
Record Size:      1051
Max Records in Memory          685

Variables Defined in Data Set are:
```

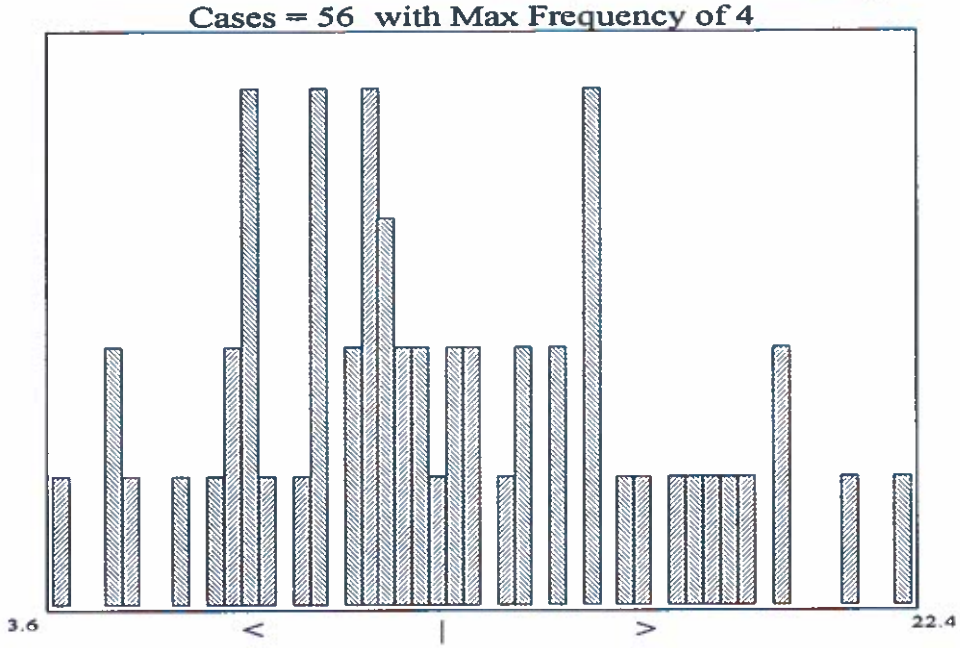
Var	Name	Type	Pos	Length	Dec	ChoiceTbl	Descrip
1	GROUP	C	1	5			Treatment or Control
2	PROPID	C	6	7			Property Identifier
3	LOST	C	13	6			Lost from study due to move
4	PARENT	C	19	20			Mother (or father) of subject child
5	CHILD	C	39	20			Subject child's name
6	CHILD_ID	C	59	8			Child identifier
7	SEX	C	67	1			M or F
8	AGE	N	68	3	0		Age in months at start of study
9	DOB	N	71	8	0		Date of birth
10	BLOOD1	N	79	5	1		Initial blood lead (ug/dL)
11	BLOOD2	N	84	5	1		End Blood Lead (ug/dL)
12	DATE1	N	89	8	0		Date of Cycle 1 vacuuming/sampling
13	TECH1	C	97	7			Technician on cycle 1
14	OPER1	C	104	8			Vacuum operator on cycle 1
15	MDUST_B1	N	112	6	0		Microvac dust loading before Cycle 1 vacuuming (mg/m2)
16	MDUST_A1	N	118	6	0		Microvac dust loading after Cycle 1 vacuuming (mg/m2)
17	MLEAD_B1	N	124	6	2		Microvac lead loading before Cycle 1 vacuuming (mg/m2)
18	MLEAD_A1	N	130	6	2		Microvac lead loading after cycle 1 vacuuming (mg/m2)
19	MCONC_B1	N	136	6	0		Microvac lead concentration before cycle 1 vacuuming (ppm)
20	MCONC_A1	N	142	6	0		Microvac lead concentration after cycle 1 vacuuming (ppm)
21	HAND1	N	148	4	0		Hand lead loading per pair of hand on cycle 1 (ug)
22	VDUST1	N	152	6	0		HEPA vac dust loading on cycle 1 (mg/m2)
23	VLEAD1	N	158	6	2		HEPA vac lead loading on cycle 1 (mg/m2)
24	PERCCARP1	N	164	6	0		Percent carpet on cycle 1
25	DATE2	N	170	8	0		Date of cycle 2 vacuuming
26	OPER2	C	178	7			Vacuum operator on cycle 2
27	VDUST2	N	185	6	0		HEPA vac dust loading on cycle 2 (mg/m2)
28	VLEAD2	N	191	6	2		HEPA vac lead loading on cycle 2 (mg/m2)
29	PERCCARP2	N	197	6	0		Percent carpet on cycle 2
30	DATE3	N	203	8	0		Date of cycle 3 vacuuming
31	OPER3	C	211	7			Vacuum operator on cycle 3
32	VDUST3	N	218	6	0		HEPA vac dust loading on cycle 3 (mg/m2)
33	VLEAD3	N	224	6	2		HEPA vac lead loading on cycle 3 (mg/m2)
34	PERCCARP3	N	230	9	0		Percent carpet on cycle 3
35	DATE4	N	239	8	0		Date of cycle 4 vacuuming/sampling
36	TECH4	C	247	7			Technician on cycle 4
37	OPER4	C	254	7			Vacuum operator on cycle 4
38	MDUST_B4	N	261	6	0		Microvac dust loading before cycle 4 vacuuming (mg/m2)
39	MDUST_A4	N	267	6	0		Microvac dust loading after cycle 4 vacuuming (mg/m2)
40	MLEAD_B4	N	273	6	2		Microvac lead loading before cycle 4 vacuuming (mg/m2)
41	MLEAD_A4	N	279	6	2		Microvac lead loading after cycle 4 vacuuming (mg/m2)
42	MCONC_B4	N	285	6	0		Microvac lead concentration before cycle 4 vacuuming (ppm)
43	MCONC_A4	N	291	6	0		Microvac lead concentration after cycle 4 vacuuming (ppm)
44	HAND4	N	297	4	0		Hand lead loading per pair of hands on cycle 4 (ug)
45	VDUST4	N	301	6	0		HEPA vac dust loading on cycle 4 (mg/m2)
46	VLEAD4	N	307	6	2		HEPA vac lead loading on cycle 4 (mg/m2)
47	PERCCARP4	N	313	6	0		Percent carpet on cycle 4
48	DATE5	N	319	8	0		Date of cycle 5 vacuuming
49	DOG_CAT_n	N	327	1	0		numeric code for PET
50	CARP_AGE_n	N	328	1	0		numeric code for carpet age
51	SPVC_INTER	N	329	2	0		Shoes, pet, vacfreq & carpet interaction term
52	sand_adj	C	331	1		yesno	sanding with all blank=no
53	walls_adj	C	332	1		yesno	wall renos with blank = n
54	floor_adj	C	333	1		yesno	new flooring with blank = no
55	OPER5	C	334	7			Vacuum operator on cycle 5
56	NEIGHBOUR	C	341	15			Neighbourhood
57	lnvconc1	N	356	6	3		ln of vacuum bag conc, cycle 1
58	FILLER	C	362	19			
59	VDUST5	N	381	6	0		HEPA vac dust loading on cycle 5 (mg/m2)
60	VLEAD5	N	387	6	2		HEPA vac lead loading on cycle 5 (mg/m2)
61	PERCCARP5	N	393	6	0		Percent carpet on cycle 5

Var	Name	Type	Pos	Length	Dec	ChoiceTbl	Descrip
62	DATE6	N	399	8	0		Date of cycle 6 vacuuming
63	OPER6	C	407	8			Vacuum operator on cycle 6
64	VDUST6	N	415	6	0		HEPA vac dust loading on cycle 6 (mg/m2)
65	VLEAD6	N	421	6	2		HEPA vac lead loading on cycle 6 (mg/m2)
66	PERCCARP6	N	427	6	0		Percent carpet on cycle 6
67	DATE7	N	433	8	0		Date of cycle 7 vacuuming/sampling
68	TECH7	C	441	7			Technician on cycle 7
69	OPER7	C	448	7			Vacuum operator on cycle 7
70	MDUST_B7	N	455	6	0		Microvac dust loading before vacuuming on cycle 7 (mg/m2)
71	MDUST_A7	N	461	6	0		Microvac dust loading after cycle 7 vacuuming (mg/m2)
72	MLEAD_B7	N	467	6	2		Microvac lead loading before cycle 7 vacuuming (mg/m2)
73	MLEAD_A7	N	473	6	2		Microvac lead loading after cycle 7 vacuuming (mg/m2)
74	MCONC_B7	N	479	6	0		Microvac lead concentration before cycle 7 vacuuming (ppm)
75	MCONC_A7	N	485	6	0		Microvac lead concentration after cycle 7 vacuuming (ppm)
76	HAND7	N	491	4	0		Hand lead loading per pair of hands on cycle 7 (ug)
77	VDUST7	N	495	6	0		HEPA vac dust loading on cycle 7 (mg/m2)
78	VLEAD7	N	501	6	2		HEPA vac lead loading on cycle 7 (mg/m2)
79	PERCCARP7	N	507	6	0		Percent carpet on cycle 7
80	DATE8	N	513	8	0		Date of extra (cycle 8) vacuuming
81	OPER8	C	521	7			Vacuum operator on cycle 8 vacuuming
82	VDUST8	N	528	6	0		HEPA vac dust loading on cycle 8 (mg/m2)
83	VLEAD8	N	534	6	2		HEPA vac lead loading on cycle 8 (mg/m2)
84	PERCARP8	N	540	6	0		Percent carpet on cycle 8
85	OWN_VACUUM	C	546	1		YESNO	Do you use a vacuum cleaner?
86	VACFREQ_BF	C	547	1		FREQ	Vacuum how often before study?
87	VACFREQ_AF	C	548	1		FREQ	Vacuum how often during study?
88	POWERNOZL	C	549	1		YESNO	Does vacuum have power nozzle?
89	CARPET_AGE	C	550	1		CARP_AGE	How old are carpets on average?
90	STEAMCLEAN	C	551	1		YESNO	Steam cleaned carpets during study?
91	MOPFREQ	C	552	1		FREQ	How often do you wet mop?
92	DOG_CAT	C	553	1		YESNO	Dog or cat indoors?
93	NO_PEOPLE	C	554	1		NO_PEOPLE	Number of people living in house?
94	SHOES_DOOR	C	555	1		YESNO	Everyone leaves shoes at door?
95	HEAT_SOURC	C	556	1		HEAT_SOURC	Type of heating source?
96	FILTER_CHG	C	557	1		FILT_FREQ	How often is filter replaced?
97	FILTER_TYP	C	558	1		FILT_TYPE	What type of air filter?
98	DUCT_CLEAN	C	559	1		DUCT_FREQ	When were ducts last cleaned?
99	RENOS	C	560	1		YESNO	Any renos during study?
100	SANDING	C	561	1		YESNO	Sanding painted surfaces
101	WALLS_CEIL	C	562	1		YESNO	Removal of walls/ceilings?
102	FLOORING	C	563	1		YESNO	New flooring?
103	LNBLD1	N	564	5	3		Ln of initial blood lead
104	LNBLD2	N	569	5	3		Ln of final blood lead
105	BLD_CHG	N	574	5	1		Change in blood lead
106	LNMDUST_B1	N	579	5	3		Ln of Cycle 1 microvac dust before HEPA
107	LNMDUST_A1	N	584	5	3		Ln of Cycle 1 microvac dust after HEPA
108	LNMLEAD_A1	N	589	6	3		Ln of Cycle 1 microvac lead after HEPA
109	LNMLEAD_B1	N	595	6	3		Ln of Cycle 1 microvac lead before HEPA
110	LNMCONC_B1	N	601	5	3		Ln of Cycle 1 microvac conc before HEPA
111	LNMCONC_A1	N	606	5	3		Ln of Cycle 1 microvac conc after HEPA
112	LNHAND1	N	611	5	2		Ln of Cycle 1 hand lead
113	MDUST_B1_4	N	616	5	0		Chg in Micro vac dust Cycle 1 to Cycle 4
114	MLEAD_B1_4	N	621	5	2		Chg in Micro vac lead Cycle 1 to Cycle 4
115	MLEAD_B_A1	N	626	5	2		Chg in Micro vac lead Cycle 1 after HEPA
116	MDUST_B_A1	N	631	5	0		Chg in Micro vac dust Cycle 1 after HEPA
117	HAND1_4	N	636	6	1		Chg in Hand lead Cycle 1 to Cycle 4
118	LNVDUST1	N	642	5	3		Ln of Cycle 1 HEPA vac dust
119	LNVLEAD1	N	647	6	3		Ln of Cycle 1 HEPA vac lead
120	LNVDUST2	N	653	5	3		Ln of Cycle 2 HEPA vac dust
121	LNVLEAD2	N	658	6	3		Ln of Cycle 2 HEPA vac lead
122	LNVDUST3	N	664	5	3		Ln of Cycle 3 HEPA vac dust
123	LNVLEAD3	N	669	6	3		Ln of Cycle 3 HEPA vac lead
124	LNMDUST_B4	N	675	5	3		Ln of Cycle 4 microvac dust before HEPA
125	LNMDUST_A4	N	680	5	3		Ln of Cycle 4 microvac dust after HEPA
126	LNMLEAD_A4	N	685	6	3		Ln of Cycle 4 microvac lead after HEPA
127	LNMLEAD_B4	N	691	6	3		Ln of Cycle 4 microvac lead before HEPA
128	LNMCONC_B4	N	697	5	3		Ln of Cycle 4 microvac conc before HEPA
129	LNMCONC_A4	N	702	5	3		Ln of Cycle 4 microvac conc after HEPA
130	LNHAND4	N	707	5	2		Ln of Cycle 4 hand lead
131	MLEAD_B_A4	N	712	5	2		Chg in Micro vac lead Cycle 4 after HEPA
132	MDUST_B_A4	N	717	5	0		Chg in Micro vac dust Cycle 4 after HEPA
133	LNVDUST4	N	722	5	3		Ln of Cycle 4 HEPA vac dust
134	LNVLEAD4	N	727	6	3		Ln of Cycle 4 HEPA vac lead
135	FILLER	C	733	47			
136	LNVDUST5	N	780	5	3		Ln of Cycle 5 HEPA vac dust

Var	Name	Type	Pos	Length	Dec	ChoiceTbl	Descrip
137	LNVLEAD5	N	785	6	3		Ln of Cycle 5 HEPA vac lead
138	FILLER	C	791	7			
139	LNVDUST6	N	798	5	3		Ln of Cycle 6 HEPA vac dust
140	LNVLEAD6	N	803	6	3		Ln of Cycle 6 HEPA vac lead
141	LNMDUST_B7	N	809	5	3		Ln of Cycle 7 microvac dust before HEPA
142	LNMDUST_A7	N	814	5	3		Ln of Cycle 7 microvac dust after HEPA
143	LNMLEAD_B7	N	819	6	3		Ln of Cycle 7 microvac lead before HEPA
144	LNMLEAD_A7	N	825	6	3		Ln of Cycle 7 microvac lead after HEPA
145	LNMCONC_B7	N	831	5	3		Ln of Cycle 7 microvac conc before HEPA
146	LNMCONC_A7	N	836	5	3		Ln of Cycle 7 microvac conc after HEPA
147	LNHAND7	N	841	5	2		Ln of Cycle 7 hand lead
148	MDUST_B_A7	N	846	6	0		Chg in Micro vac dust Cycle 7 after HEPA
149	MLEAD_B_A7	N	852	6	2		Chg in Micro vac lead Cycle 7 after HEPA
150	VDUST_1_7	N	858	5	0		Chg in HEPA vac dust Cycle 1 to Cycle 7
151	VLEAD_1_7	N	863	5	2		Chg in HEPA vac lead Cycle 1 to Cycle 7
152	HAND_1_7	N	868	5	0		Chg in hand lead Cycle 1 to Cycle 7
153	MDUST_1_7	N	873	5	0		Chg in Micro vac dust Cycle 1 to Cycle 7
154	MLEAD_1_7	N	878	5	2		Chg in Micro vac lead Cycle 1 to Cycle 7
155	LNVDUST7	N	883	5	3		Ln of Cycle 7 HEPA vac dust
156	LNVLEAD7	N	888	6	3		Ln of Cycle 7 HEPA vac lead
157	VACFREQB_n	N	894	1	0		Numeric code for vac freq before study
158	SHOES_n	N	895	1	0		Numeric code for shoes at door
159	FILLER	C	896	2			
160	LNVDUST8	N	898	5	2		ln of HEPA vac dust loading on cycle 8
161	LNVLEAD8	N	903	6	3		ln of HEPA vac lead loading on cycle 8
162	BLOODCODE	C	909	4			Classification of Initial Blood Lead
163	GROUP_N	N	913	1	0		Control=1, Treatment=2
164	SEX_N	N	914	1	0		Male=1, Female=2
165	CLUSTER1	N	915	1	0		
166	CLUSTER2	N	916	1	0		
167	CLUSTER3	N	917	1	0		
168	CLUSTER4	N	918	1	0		
169	CLUSTER5	N	919	1	0		
170	CLUSTER6	N	920	1	0		
171	CLUSTER7	N	921	1	0		
172	CLUSTER8	N	922	1	0		
173	CLUSTER9	N	923	1	0		
174	CLUSTER10	N	924	1	0		
175	CLUSTER11	N	925	1	0		
176	CLUSTER12	N	926	1	0		
177	CLUSTER13	N	927	1	0		
178	CLUSTER14	N	928	1	0		
179	CLUSTER15	N	929	1	0		
180	CLUSTER16	N	930	1	0		
181	CLUSTER17	N	931	1	0		
182	CLUSTER18	N	932	1	0		
183	CLUSTER19	N	933	1	0		
184	CLUSTER20	N	934	1	0		
185	CLUSTER21	N	935	1	0		
186	CLUSTER22	N	936	1	0		
187	TIME_OUTDR	C	937	10			Time outdoor daily (from 1992 fall questionaire)
188	FILLER	C	947	6			
189	INSIDE7	C	953	1			T=inside prior to handwipe
190	inside7_n	N	954	1	0		1=inside prior to handwipe
191	Bld_Chg_ln	N	955	6	3		change in ln blood lead
192	FILLER	C	961	90			

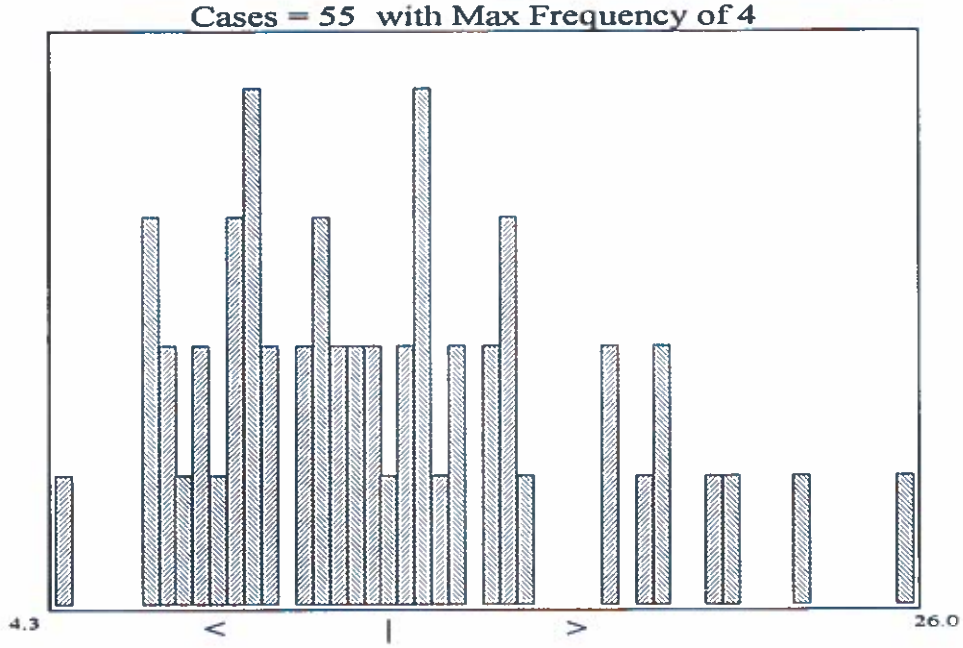
CONTROL

Variable BLOOD1 has mean = 12.0768 and stdev = 4.35172
Cases = 56 with Max Frequency of 4



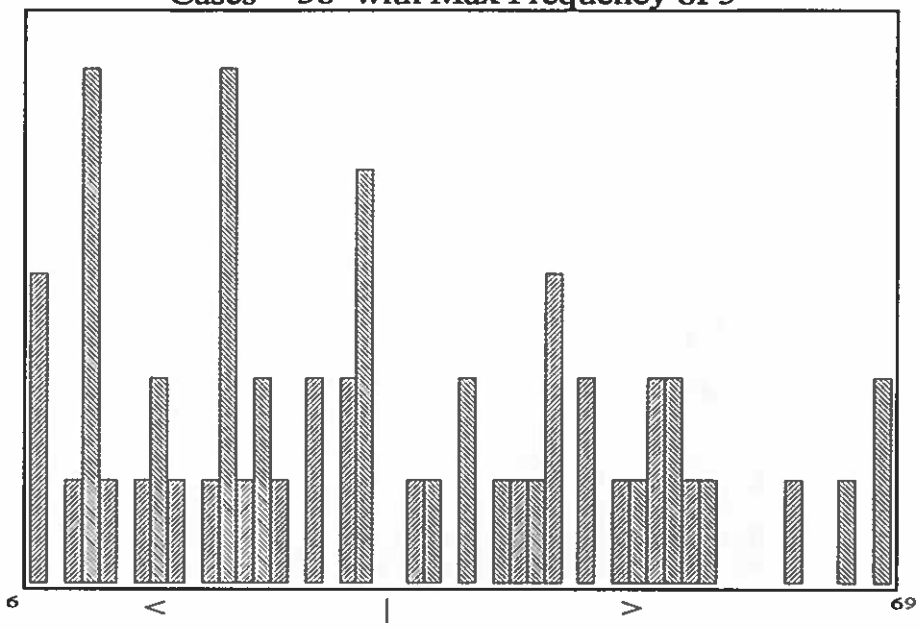
TREATMENT

Variable BLOOD1 has mean = 12.6764 and stdev = 4.62765
Cases = 55 with Max Frequency of 4



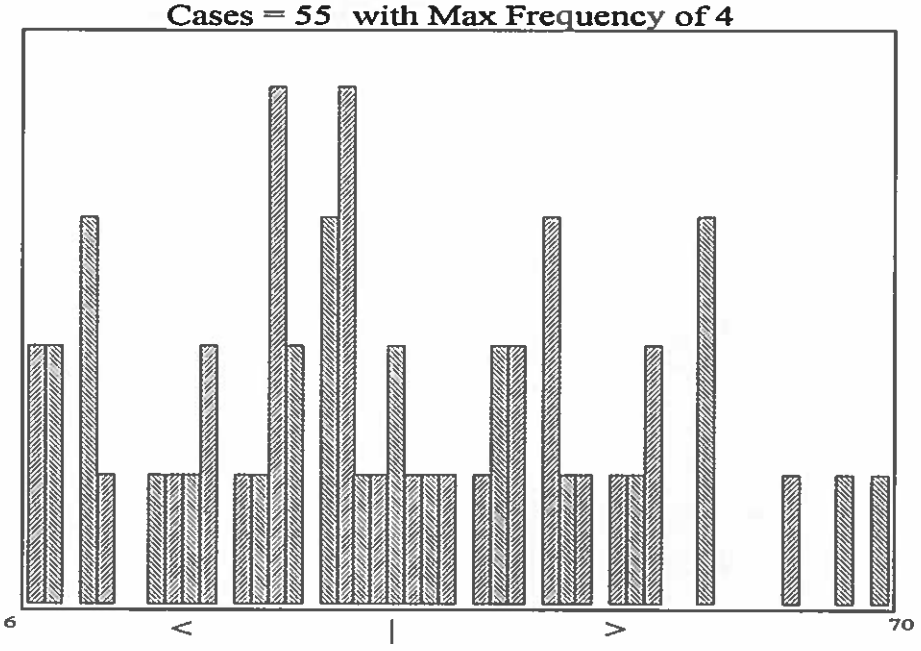
CONTROL

Variable AGE has mean = 31.9286 and stdev = 17.5839
Cases = 56 with Max Frequency of 5



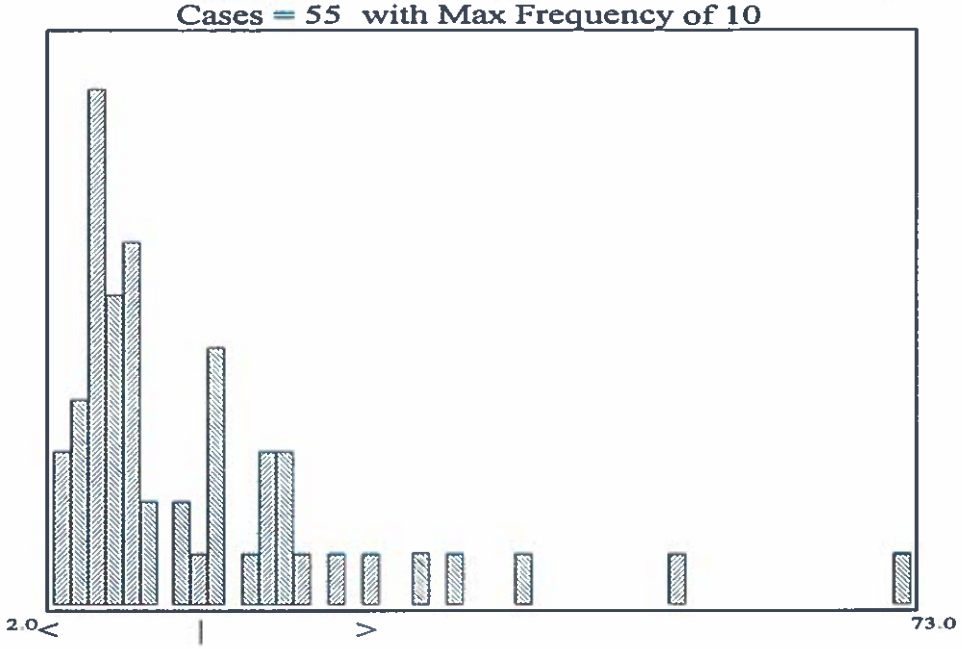
TREATMENT

Variable AGE has mean = 32.9455 and stdev = 16.3111
Cases = 55 with Max Frequency of 4



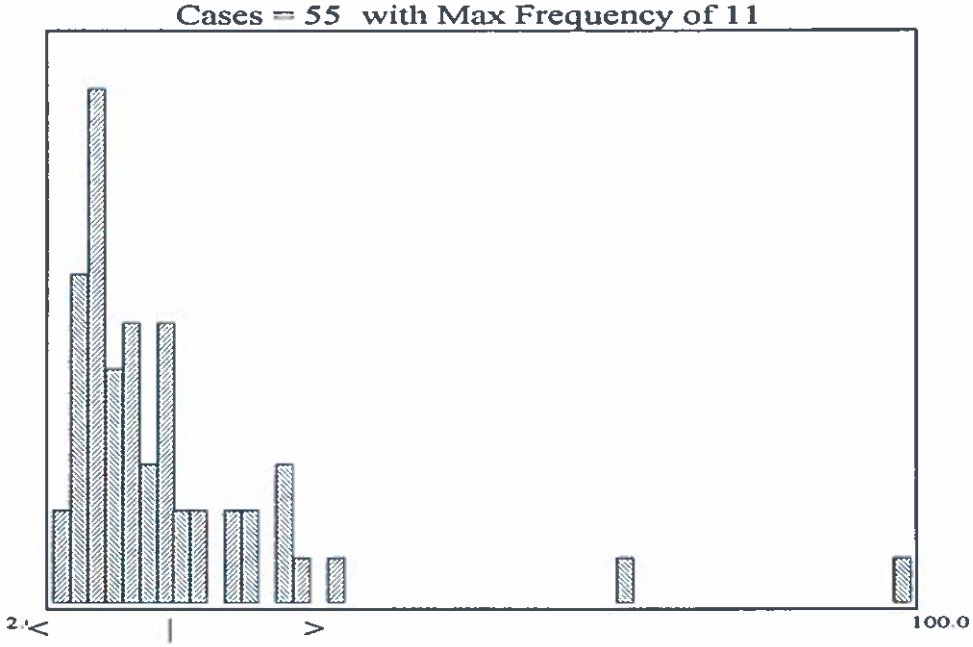
CONTROL

Variable HAND1 has mean = 13.9455 and stdev = 13.2293
Cases = 55 with Max Frequency of 10



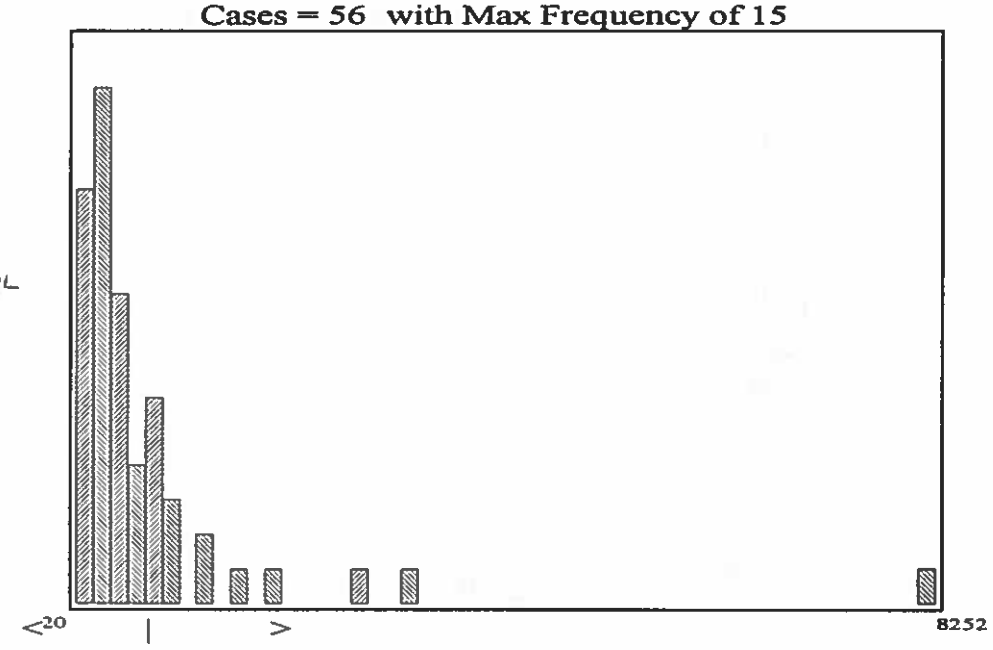
TREATMENT

Variable HAND1 has mean = 14.9636 and stdev = 15.8605
Cases = 55 with Max Frequency of 11



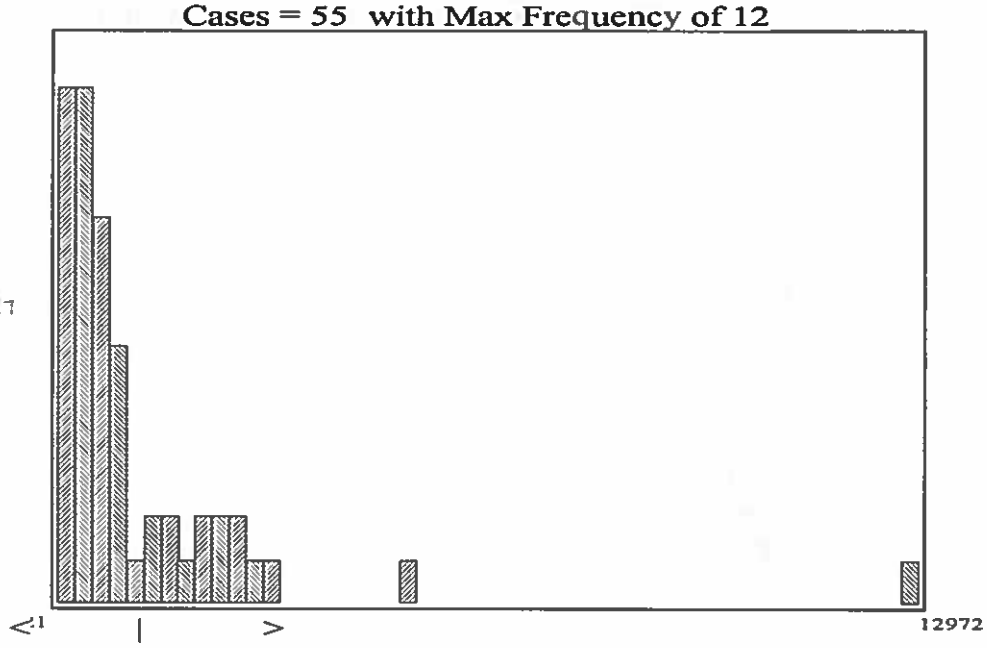
Variable MDUST_B1 has mean = 692.929 and stdev = 1194.23
Cases = 56 with Max Frequency of 15

CONTROL



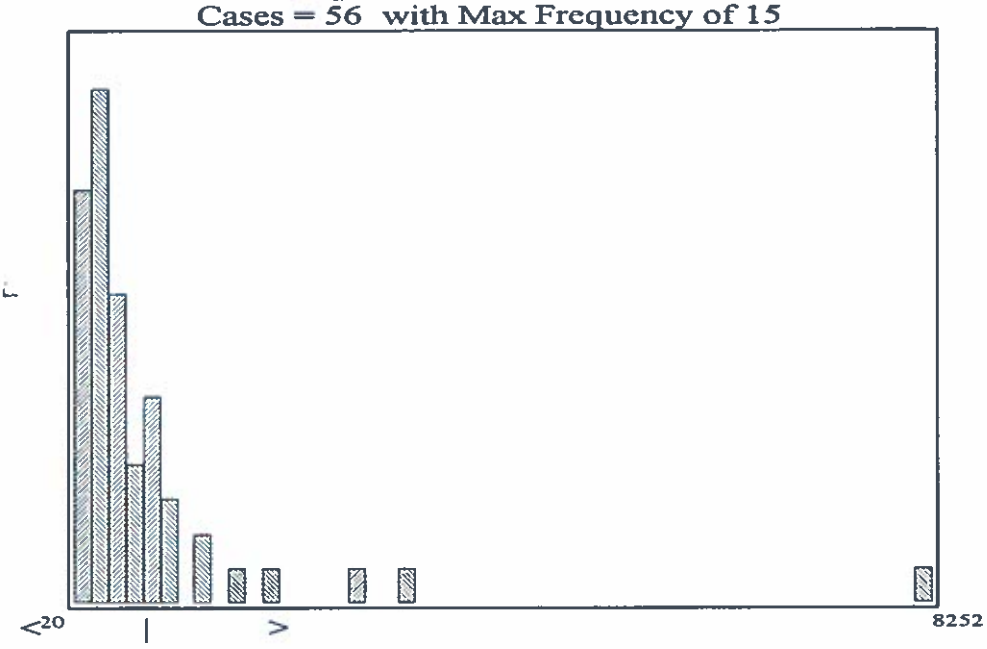
Variable MDUST_B1 has mean = 1212.95 and stdev = 1923.94
Cases = 55 with Max Frequency of 12

TREATMENT



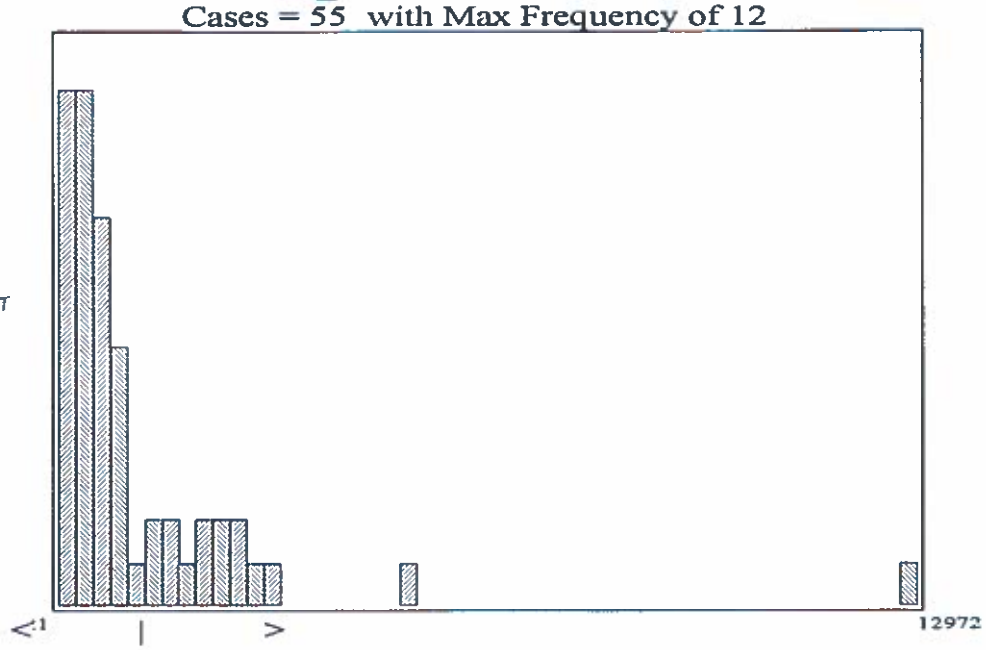
Variable MDUST_B1 has mean = 692.929 and stdev = 1194.23
Cases = 56 with Max Frequency of 15

CONTROL



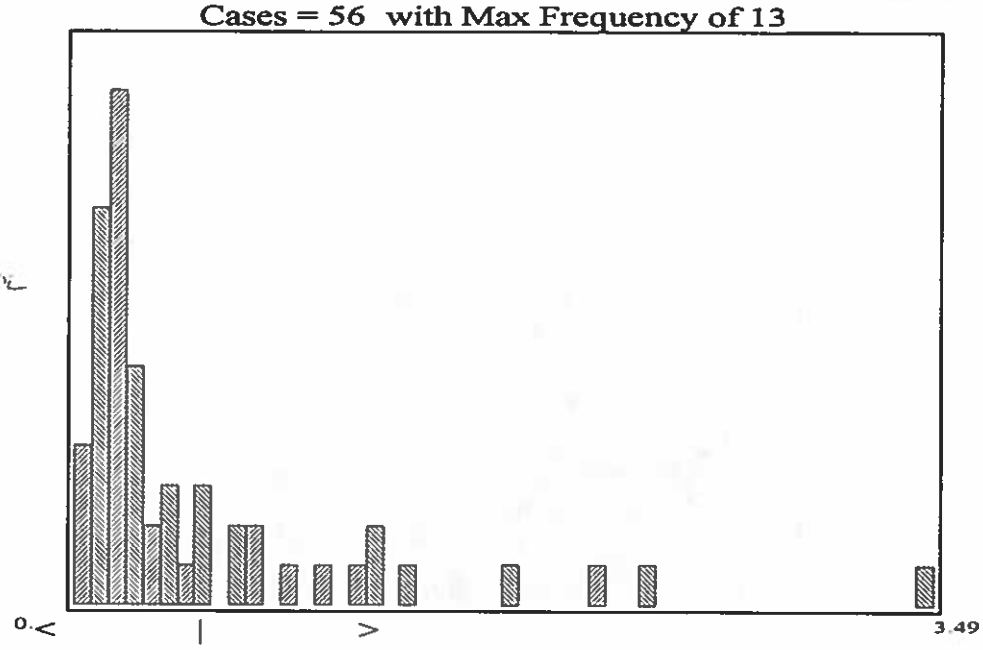
Variable MDUST_B1 has mean = 1212.95 and stdev = 1923.94
Cases = 55 with Max Frequency of 12

TREATMENT



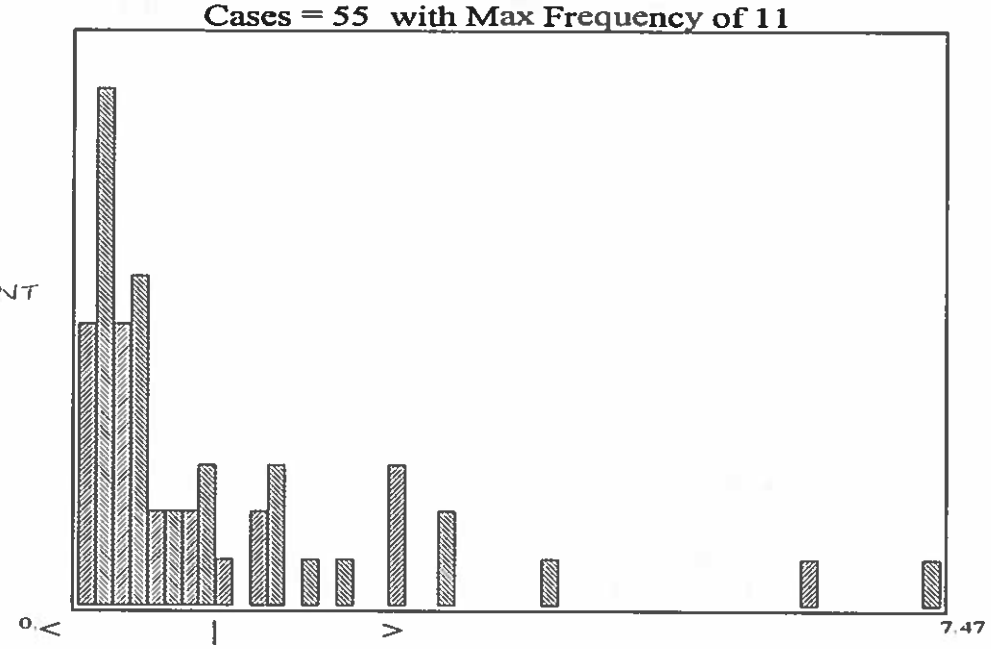
Variable MLEAD_B1 has mean = 0.510536 and stdev = 0.654279
Cases = 56 with Max Frequency of 13

CONTROL



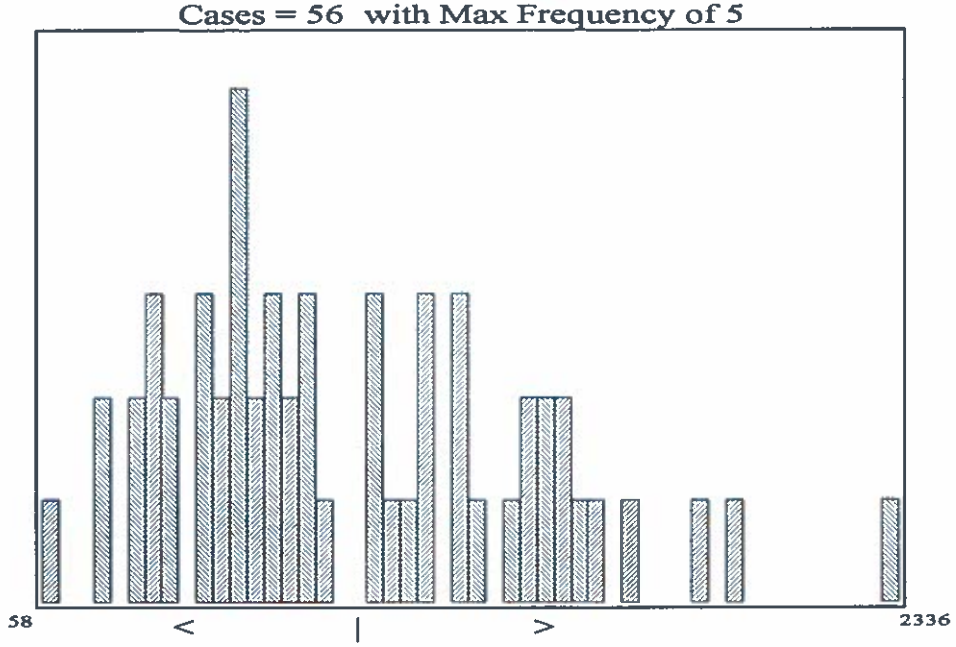
Variable MLEAD_B1 has mean = 1.16218 and stdev = 1.48829
Cases = 55 with Max Frequency of 11

TREATMENT



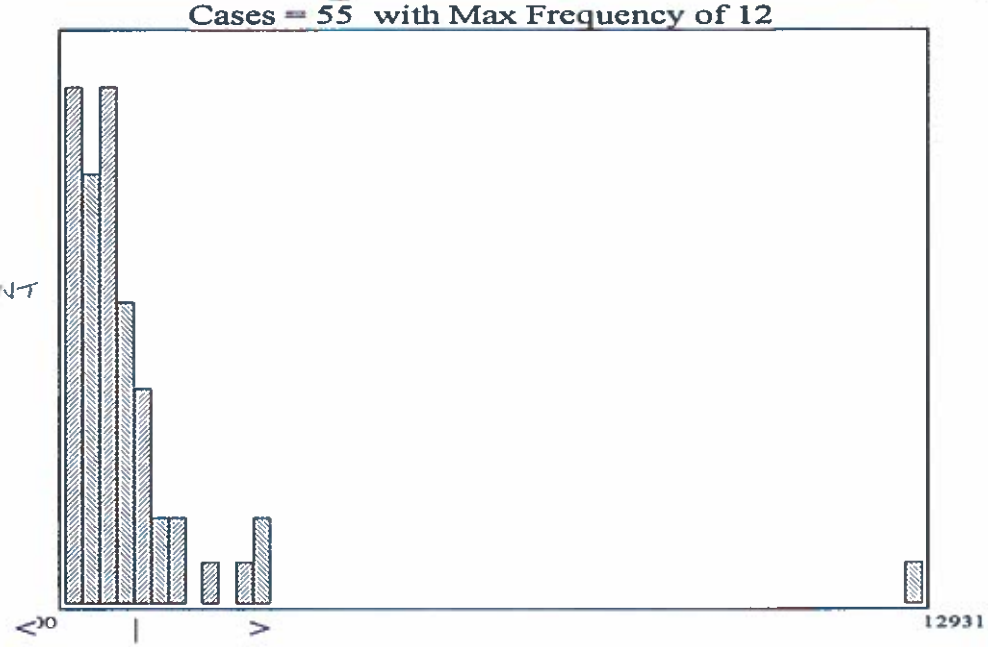
Variable MCONC_B1 has mean = 888.393 and stdev = 481.993
Cases = 56 with Max Frequency of 5

CONTROL

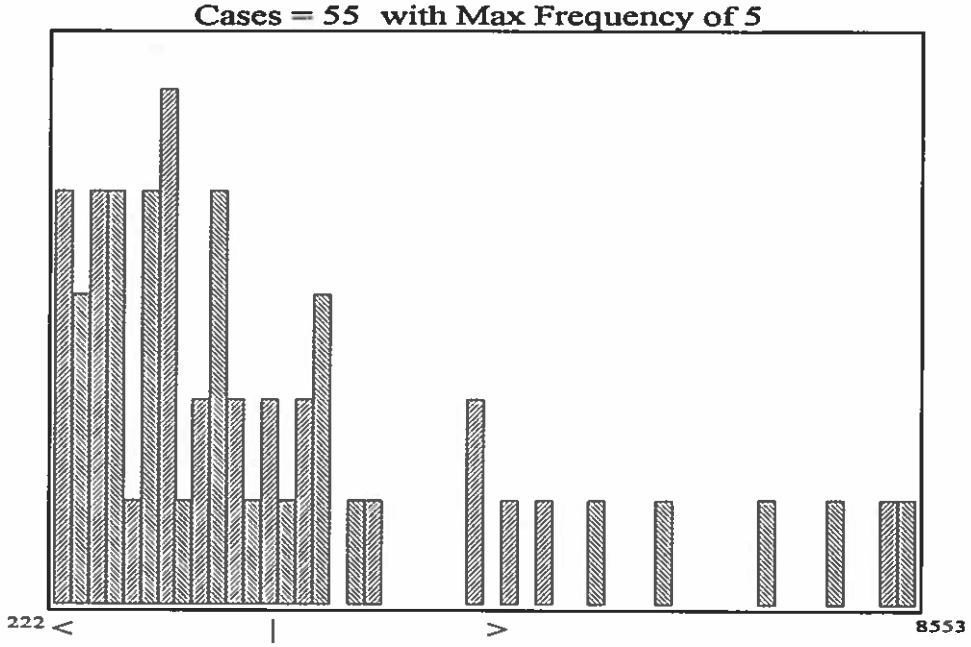


Variable MCONC_B1 has mean = 1301.22 and stdev = 1731.28
Cases = 55 with Max Frequency of 12

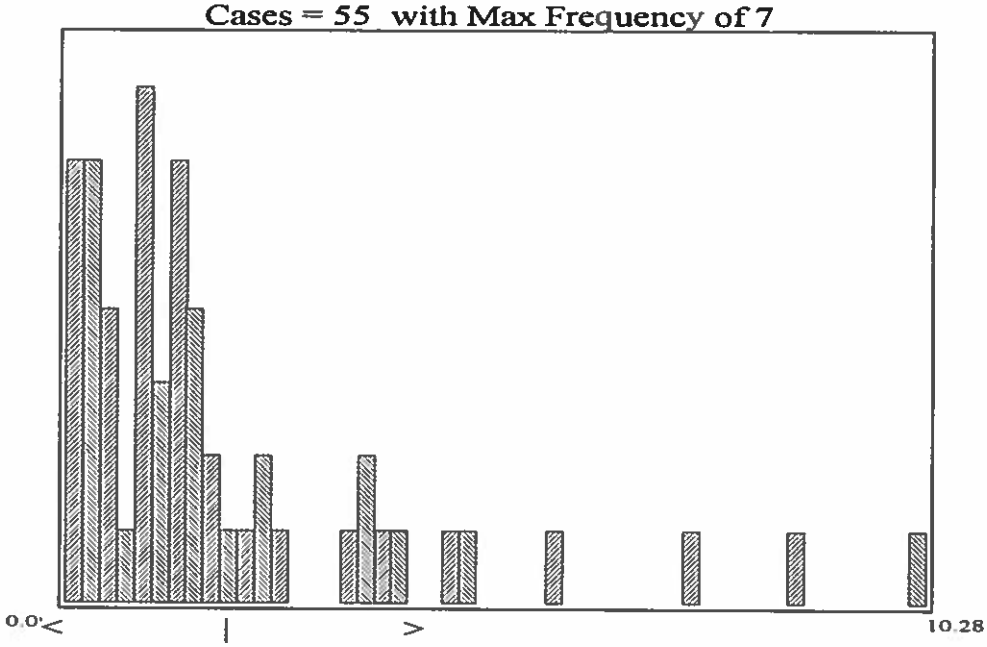
TREATMENT



Variable VDUST1 has mean = 2314.29 and stdev = 2103.32
Cases = 55 with Max Frequency of 5

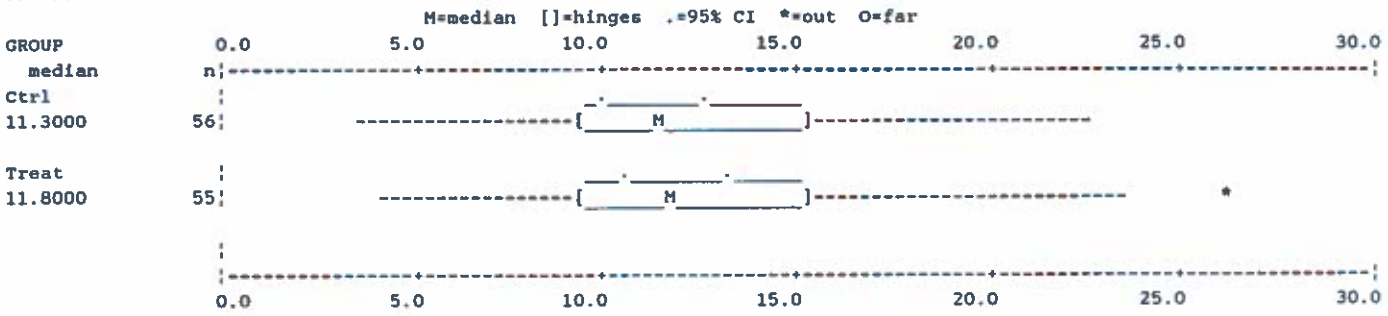


Variable VLEAD1 has mean = 1.96418 and stdev = 2.14507
Cases = 55 with Max Frequency of 7

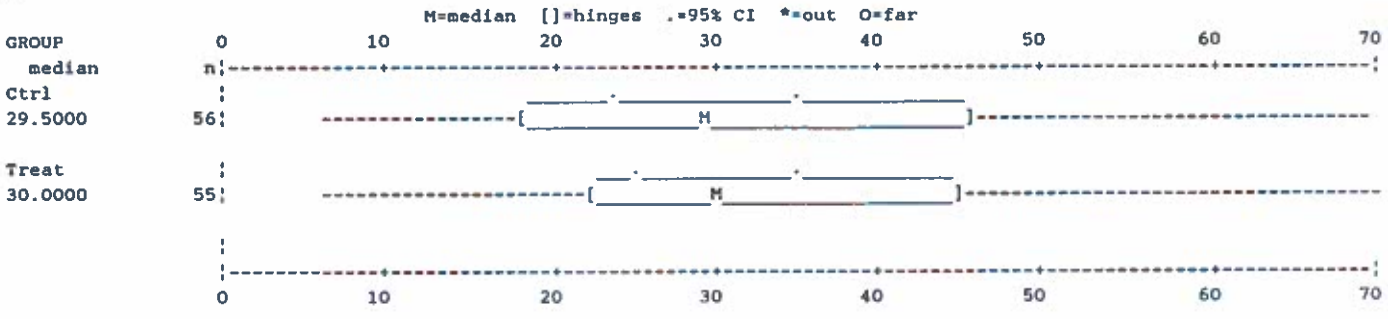


Command: BOX PLOT Missing Value Treatment: Pairwise
Selection: GROUP<>'Blank' and LOST<>'T'

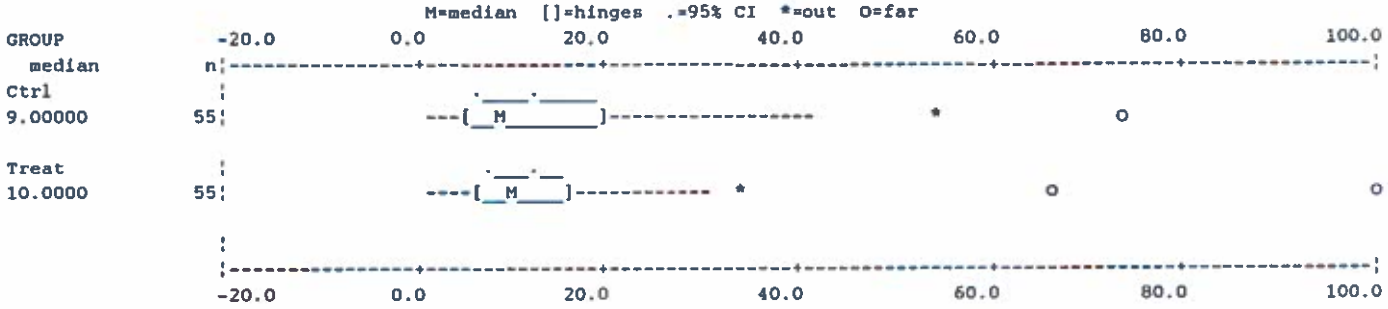
BLOOD1 BY GROUP



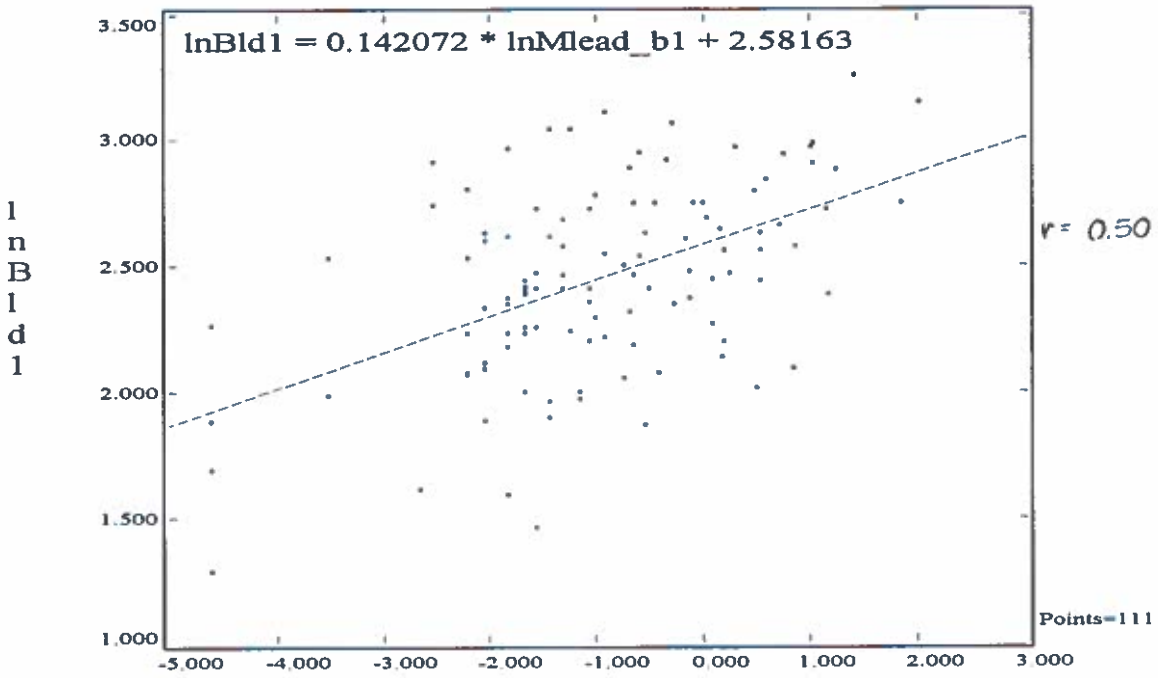
AGE BY GROUP



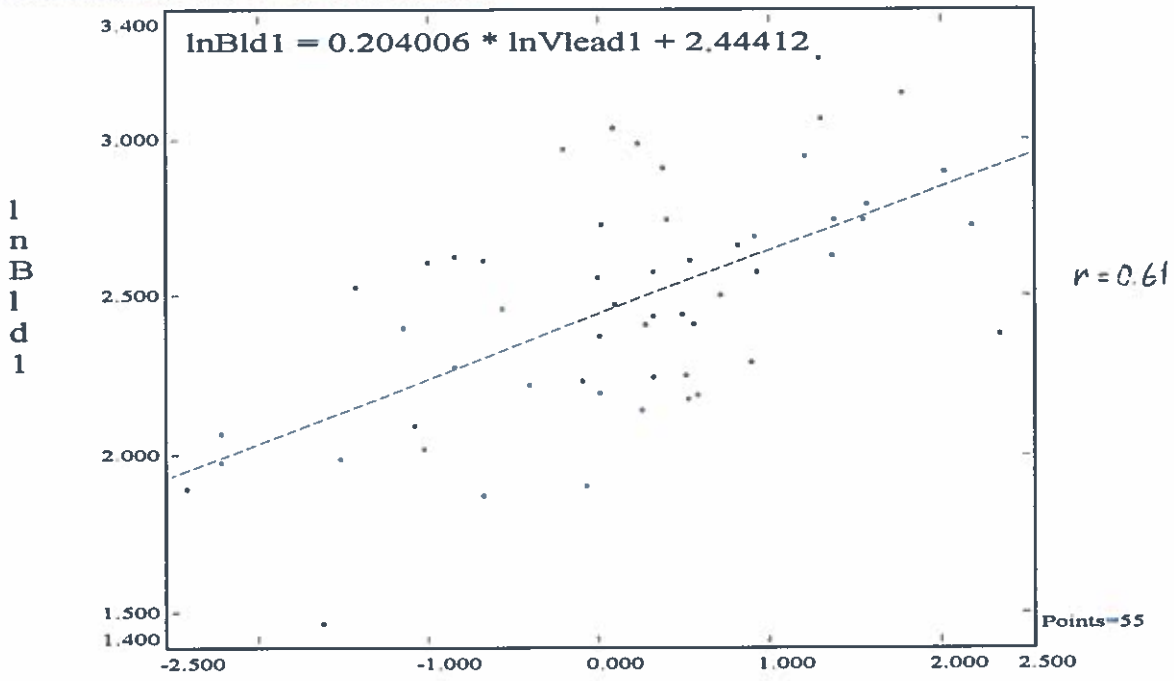
HAND1 BY GROUP



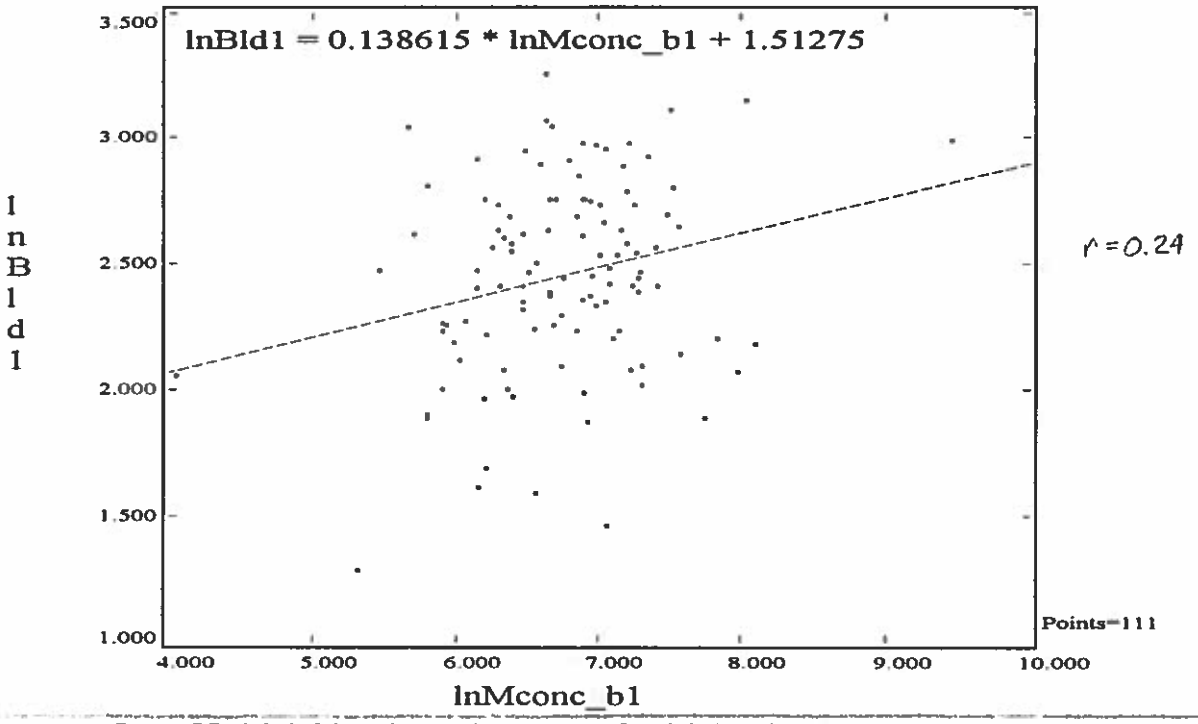
```
Command: BOX PLOT  Missing Value Treatment: Pairwise
Selection: GROUP<>'Blank' and LOST<>'T'

MDUST_B1  BY  GROUP

                                M=median  []=hinges  .=95% CI  *=out  O=far
GROUP              -2000       0         2000        4000        6000        8000        10000       12000       14000
  median          n|----------+---------+----------+----------+----------+----------+----------+----------+----------|
Ctrl               |             ._.
370.500           56|            -[M_]----- *    O   O                          O
                   |
Treat              |              .__.__
616.000           55|            --[M___]--------- **           O                                                  O
                   |
                   |----------+---------+----------+----------+----------+----------+----------+----------+----------|
                   -2000       0         2000        4000        6000        8000        10000       12000       14000

MLEAD_B1  BY  GROUP

                                M=median  []=hinges  .=95% CI  *=out  O=far
GROUP              -1.00   0.00       1.00       2.00       3.00       4.00       5.00       6.00       7.00       8.00
  median          n|----------+----------+----------+----------+----------+----------+----------+----------+----------|
Ctrl               |             ._.__
0.240000          56|          --[M___]-------*    *   O O           O
                   |
Treat              |              .______._______
0.560000          55|          ---[__M__________]------------------        *                          O          O
                   |
                   |----------+----------+----------+----------+----------+----------+----------+----------+----------|
                   -1.00   0.00       1.00       2.00       3.00       4.00       5.00       6.00       7.00       8.00

MCONC_B1  BY  GROUP

                                M=median  []=hinges  .=95% CI  *=out  O=far
GROUP              -2000       0         2000        4000        6000        8000        10000       12000       14000
  median          n|----------+---------+----------+----------+----------+----------+----------+----------+----------|
Ctrl               |                ..-
780.500           56|            ---[M__]----- *
                   |
Treat              |                _._.
990.000           55|             --[__M_]----  *  ***                                                          O
                   |
                   |----------+---------+----------+----------+----------+----------+----------+----------+----------|
                   -2000       0         2000        4000        6000        8000        10000       12000       14000
```



Ln of Initial Blood Lead vs. Ln of Initial Microvac Lead Loading

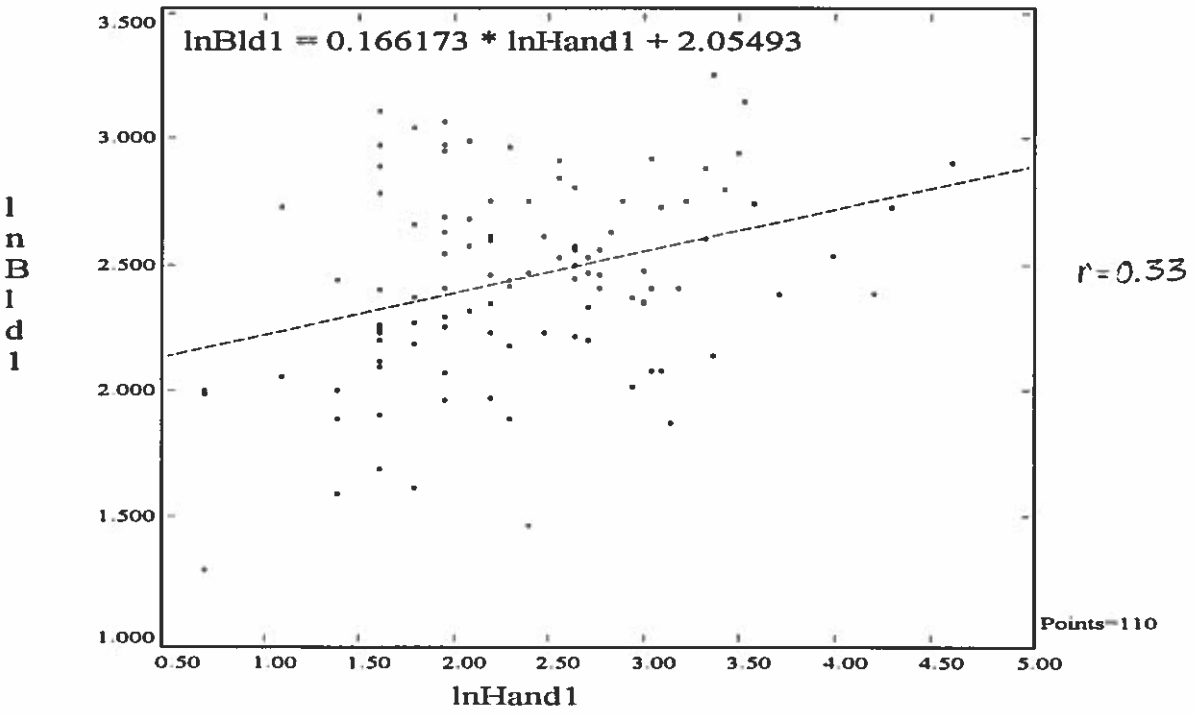


Ln of Initial Blood Lead vs. Ln of Initial HEPA Vac Lead Loading



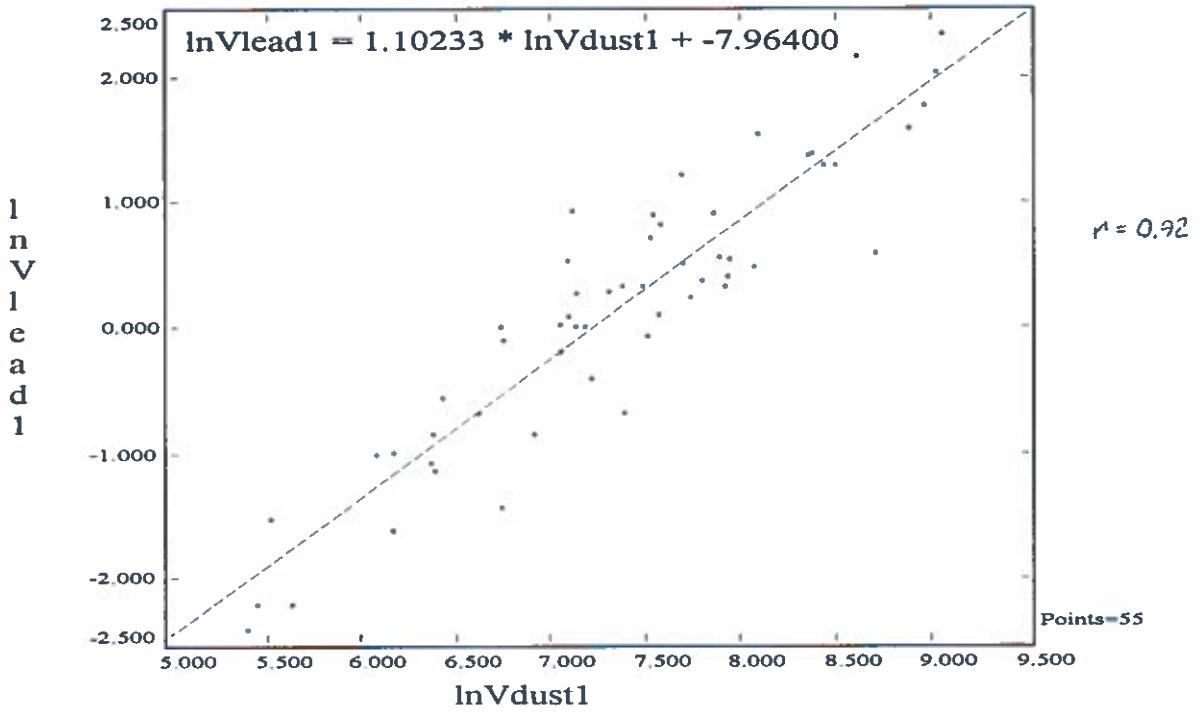
r = 0.24

Ln of Initial Blood Lead vs. Ln of Initial Micro Vac Lead Conc.

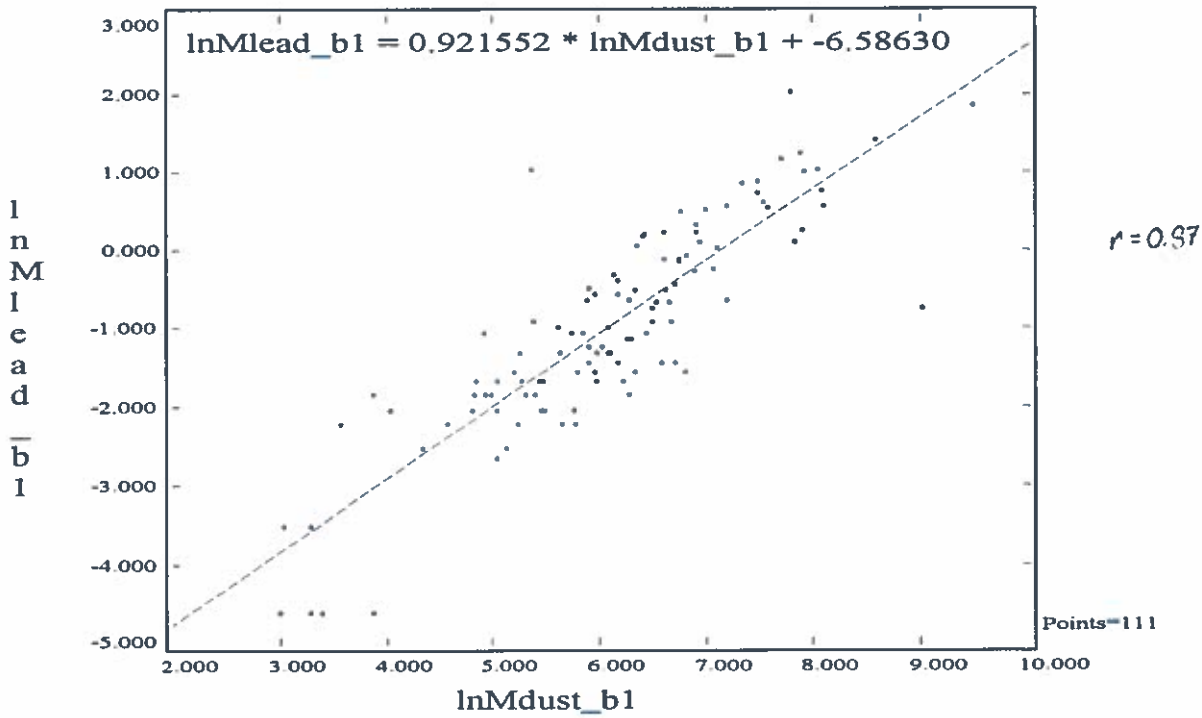


r = 0.33

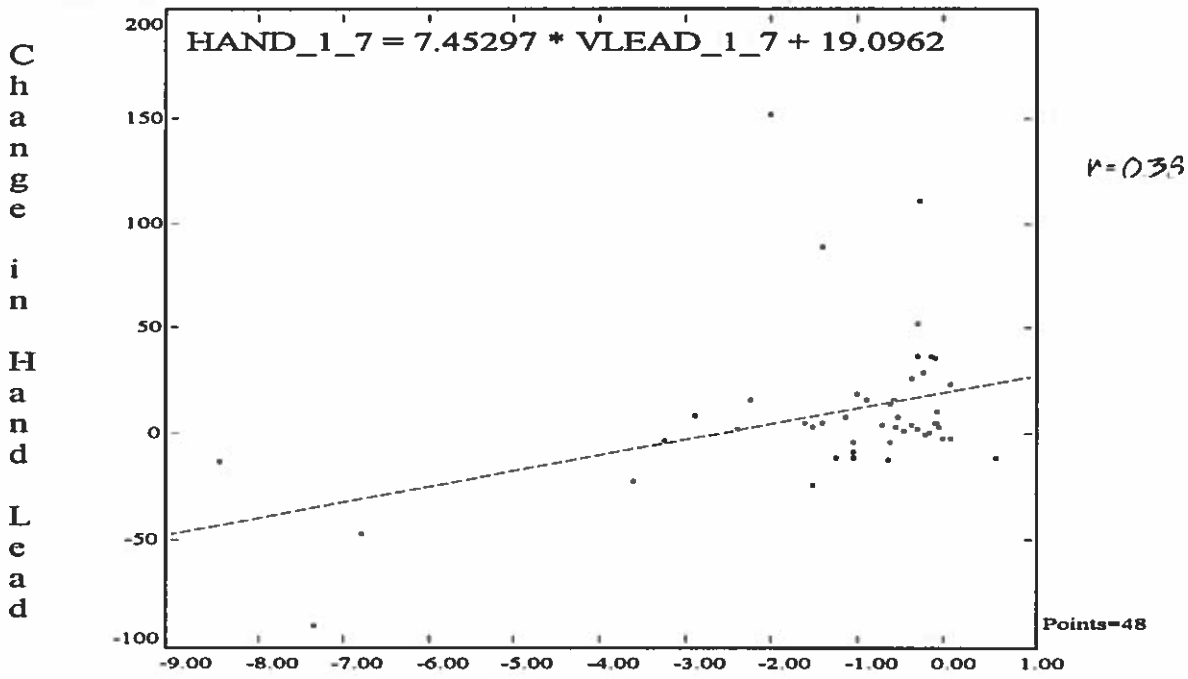
Ln of Initial Blood Lead vs. Ln of Initial Hand Lead



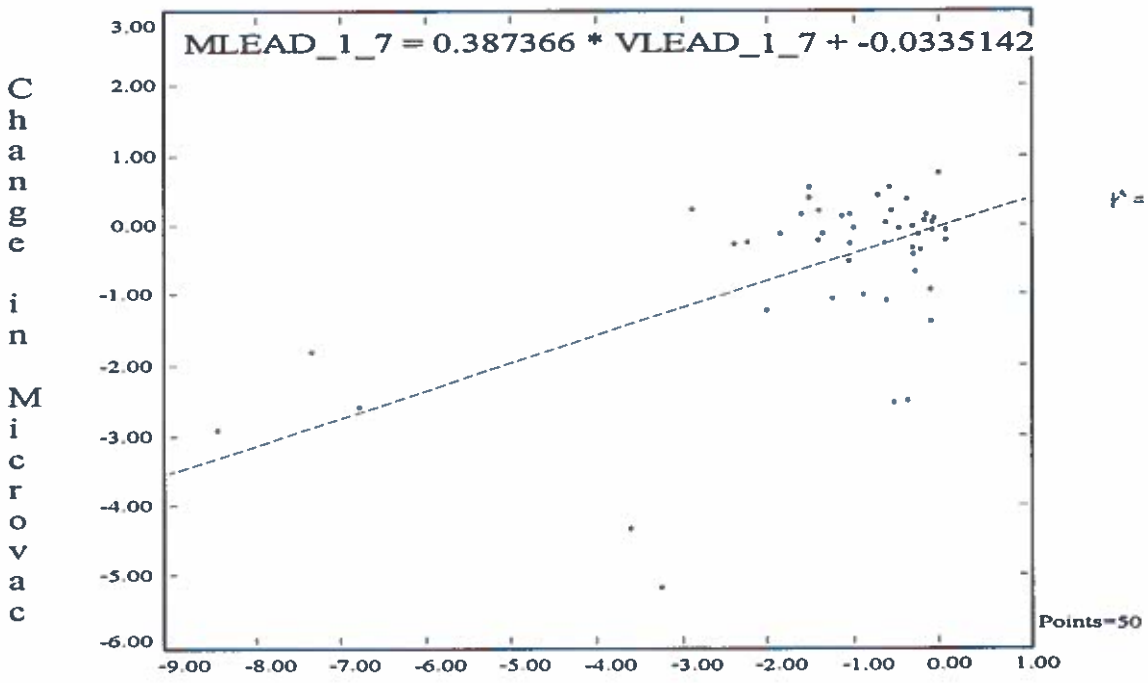
Ln of Initial HEPA Vac Dust Loading vs. Ln of Initial HEPA Vac Lead Loading



Ln of Initial Micro Vac Dust Loading vs. Ln of Initial Micro Vac Lead Loading



Change in HEPA Vac Lead vs. Change in Hand Lead



r = 0.55

Change in Microvac Lead vs. Change in HEPA Vac Lead

TRAIL LEAD PROGRAM

HEPA HOUSE CLEANING PILOT PROJECT

APPENDIX C

Quality Assurance Program

February 1, 1994

Eric White, Environmental Consultant

Appendix C
Quality Assurance/Quality Control Issues

Introduction

Quality Assurance Methods and Procedures

Results

- Micro–vacuum cassettes
  - a) Field Blanks
  - b) Reference Materials
  - c) Duplicate Samples
  - d) Summary/Implications
- Handwipe samples
  - a) Field Blanks
  - b) Summary/Implications
- Vacuum Samples
  - a) Vacuum Bag Analyses
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- Blood Samples
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  - b) Reference Samples
  - c) Check Standards
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Introduction

The term Quality Assurance or Quality Control incorporates those actions taken to ensure that the data that result from a study are accurate, or at least within the realm of possibility, and have not been skewed by sloppy methodology or other factors in the field or laboratory.

There are several sources of error which will lead to inaccurate or unrepresentative data:

1. *Errors in documentation:* the sample analyzed by the laboratory has not been labelled correctly and is not the sample that was taken in the field.

2. *Sample contamination:* sampling materials can be contaminated before sample collection, during collection or after sample collection. If such contamination occurs before the laboratory analysis the analytical results will not represent the environment sampled.

3. *Analytical error or laboratory bias:* Analytical error is when the laboratory makes an error and reports the wrong value for the sample.

A variation of this is laboratory bias, where one laboratory reports results consistently higher or lower than another. To further complicate the situation, laboratory bias can be present at one range of lead values and not at another, for example one laboratory's results will be high for $Pb_{(blood)}$ values less than 10 μg/dL, accurate for $Pb_{(blood)}$ values between 10 and 25 μg/dL, and low for $Pb_{(blood)}$ values above 25 μg/dL.

There are various quality assurance procedures which can detect the occurrence of (or document the absence of) such errors. Documentation errors are investigated by using double entry sample documentation, split samples and field blanks. Analytical results of field blanks, split samples and duplicate samples will show the likelihood of sample contamination. Analytical error can be detected by using split samples, duplicate samples and reference materials. And laboratory bias can be explored by using reference materials and by checking standards through time. These standards should cover a range of values.

It is generally accepted that an appropriate quality assurance level would comprise 10 to 15% of the total analytical effort, that is, 10 to 15% of all the samples submitted for analysis would be for quality assurance purposes.

In the case of environmental samples and analyses, 164 of the 1614 analyses done during the course of this study were for quality assurance purposes. Quality assurance samples comprised 23.8% of all handwipe samples analyzed, 5.5% of all micro–vacuum cassette samples and 4.2% of all vacuum bag samples.

22.0% of the 501 blood samples analyzed in 1992 and 18.6% of the 523 blood samples analyzed in 1993 were for quality assurance purposes.

The distribution of the quality assurance analyses is given in **Table 1**.

Table 1: Distribution of quality assurance samples

Sample type	No. of samples*	Quality Assurance Information procedure	No. of analyses	%
Micro-vacuum cassettes	630	field blanks	25	3.8
		reference samples	5	0.8
		duplicates	6	0.9
Vacuum Bags	495	field blanks	1	0.2
		emptied bag analyses**	6	1.2
		split sample analyses	31	6.3
Handwipe samples	342	field blanks	107	23.8
Environmental Samples	**1467**		**181**	**12.3**
1992 blood samples	501	split samples	75	15.0
		reference samples	17	3.4
		check standards	18	3.6
1993 blood samples	523	split samples	71	13.6
		reference samples	8	1.5
		check standards	18	3.4
Blood Samples	**1024**		**207**	**20.2**
Overall	**2491**		**388**	**15.6**

* these figures include regular samples and quality control samples
* in 6 cases the vacuum bag was submitted for analysis after the sample (contents) had been removed.

Quality Assurance methods and procedures:

The quality assurance methods and procedures used in this study are given in **Table 2.** Please note that only such details of analytical and sampling protocols as are pertinent to Quality Assurance issues are presented. For a more complete description of sampling and analytical protocols the reader is referred to Appendices F and G, respectively.

All quality assurance samples are submitted to the laboratory blind. They are treated as normal samples in all respects and there is no way for the laboratory to know that they are for quality assurance purposes. There are three exceptions to this:

1. split vacuum bag samples:- the laboratory does the sample splitting so they know origins of both portions analyzed.

2. micro-vacuum cassettes:- it is visually obvious when a cassette has not been used to collect a sample - the filter is glaringly clean.

3. 1993 reference blood samples, the reference blood used is cow's blood and both the tubes which contain the blood and the character of the blood itself are different from regular blood samples. However, the laboratory has no way of knowing the established blood lead level of the sample prior to analysis.

Table 2: Quality assurance procedures used in this study.

Procedure	Methodology	Applicable to
Double entry documentation	Each sample number and its relevant documentation (property identification, technician, sample type code, etc) was entered into the data base twice in two separate operations. The two files were then compared and any discrepancies investigated and corrected.	– all sample types
Field blanks	Un–used sampling materials were submitted for analysis as if they were samples	– handwipe samples – micro–vacuum cassettes
Split samples	Vacuum bag splits were made by emptying the contents onto a table, separating them into 4 equal portions and analyzing two of the portions. This was done by the laboratory. It is not possible to split handwipes or micro–vacuum samples.	– vacuum samples
	Blood sample splits were made by drawing sufficient blood to fill two blood sample tubes. The blood was then split between the two tubes, with one tube being sent to the primary laboratory for analysis and the other to the quality assurance laboratory for analysis.	– blood samples
Duplicate samples	The same area was sampled twice, using the same sampling procedure. Each sample was submitted for analysis and the results were compared.	– micro–vacuum cassettes
Reference standards	A measured amount of reference material (dust with a known lead content) was introduced to the sampling medium and submitted for analysis. There is no practicable way of introducing a known amount of a reference material to either handwipe samples or vacuum samples with the facilities available to the Lead Program Office.	– micro–vacuum cassettes
	Commercially available reference blood (cow's of known lead content) samples was submitted (1993 only).	– blood samples
Check Standards	5 ml (or so) of blood was drawn from a volunteer and samples of this blood were submitted weekly throughout the sampling period.	– blood samples

Results

Cominco Analytical Services analyzed all environmental samples from vacuum cycle 1 and cycle 2. All the other samples were analyzed by QuantaTrace Laboratories. All the quality assurance data presented here are from QuantaTrace Laboratories, except for the handwipe blanks. 80 of the handwipe blanks were submitted in cycle 1, and the number of handwipe blanks submitted was reduced from 50% of the sampling effort to 10% as a result of those analyses.

Micro-vacuum cassettes

All micro-vacuum cassettes used in this study were prepared by QuantaTrace Laboratories prior to use. Our preparation protocol specified that the cassettes be washed, air dried, a millepore filter inserted and the assembled cassette weighed – we did not specify drying to constant weight. The cassettes were then shipped to Trail, used for sampling and returned to the laboratory for analysis. At the laboratory, they were re-weighed and the difference between the initial weight and the post-sampling weight was taken to be the weight of the sample collected.

a) Field blanks

25 prepared cassettes were assigned a sample number and submitted for analysis as field blanks.

The limit of detection for lead in micro-vacuum cassette samples is 0.005 mg. The results of analysis of the field blanks were that 24 showed less than detectable amounts of lead and that 1 showed 0.005 mg lead. This indicates that there was no lead contamination occurring and, equally important, that our documentation and sample handling procedures were reliable.

However of more concern was the amount of total dust "found" in these samples. Total dust was reported as 1 mg for 11 samples, and between 3.0 to 180 mg for the remaining 14. (Note: if the weight difference was less than 1 milligram it was reported as 1.0 mg). The geometric mean of all dust values reported was 4.3 mg, with a standard deviation of 35.8 mg. This discrepancy probably results from changes in cassette weight as a result of temperature and moisture content changes of the cassette and the filter between the initial weighing and the final weighing. Each cassette weighs about 8.5 grams (8500 mg).

None of the field blanks were found to have a negative weight, however this is possible. During 1991, Lead Program staff were preparing and weighing the cassettes. Of the 90 entries on two pages (selected at random) of the sample documentation log book from that time, 8 negative values were recorded for sample weight and a further 5 were less than 1 mg.

During the HEPA study 630 micro-vacuum samples were collected. The sample sizes ranged from 1 mg to 2432.3 mg, with an overall geometric mean of 72.3 mg and a standard deviation of 217.5.

The results of the field blank analysis, and review of the 1991 data, indicate that the weighing problems discussed above could influence the analytical results of

small samples. For example, if we assume that the geometric mean of the field blank total dust weight is indicative of the magnitude of error introduced by weighing variability, then that error would be 5.9% of the average sample collected.

This error could be reduced by desiccating the cassette/filter assembly to constant weight prior to weighing during cassette preparation and sample analysis. However there are other possible sources of increased weight between the two weighings, namely, dust or grease accumulating on the outside of the cassette during handling.

b) Reference materials:

We used a commercially available reference material (SRM 1648) with a certified lead content of 6550 PPM. About 50 mg (un-measured) of the material was placed on the filter in an opened cassette, the cassette was then closed and a micro-vacuum sampler was attached and operated for 2 - 3 minutes. The cassette was then given a sample number and submitted for analysis.

The poor results shown in **Table 3** likely result from the weighing problems discussed earlier, rather than from poor performance on the part of QuantaTrace Laboratories.

Table 3: Results of micro-vacuum sample analysis using certified reference material (6550 PPM Lead)

Date	Total Dust (mg)	Lead (mg)	Lead (PPM)	% Difference from 6550 PPM
July 22	95.7	0.010	104	98.4
Aug 4	40.7	0.095	2334	64.4
Aug 10	26.0	0.127	4811	26.5
Aug 17	1.0	0.043	43000	556.5
Aug 27	10.7	0.038	3551	45.8

c) Duplicate samples:

Duplicate samples are two separate samples. Each micro-vacuum cassette sample is a composite of 3 sub-samples, each taken in three different areas of the house. For duplicate samples, each duplicate sub-sample was taken from the same area as the sample sub-sample but separated from it. Generally, both the sample sub-sample and its duplicate sub-sample were taken from an area, then the technician moved to the next area, and so on until all 3 pairs were taken.

Differences between the sample and its duplicate could result from natural variability in the environment, sampling variability, or analytical variability.

The results of 6 duplicate samples are presented in **Table 4.**

Statistically the means of these two groups are not different (Paired t-Test), which is encouraging. However this encouragement must be tempered because of the small sample size and the large relative percent differences. The effect of the

small sample size is to decrease the power of the statistical test, making it less likely to find the group means different. This is compounded by the high variability of the sample contents (reported total dust, lead content and concentration). In other words, if all these values were grouped in a narrow range then the test would be more likely to detect a difference.

Whether the original sample value is larger or smaller than the duplicate value can be different for the various parameters; for example, if the original sample contains more total dust than the duplicate this does not mean that it will contain more lead or that the lead concentration in it will be greater.

Table 4: Results of duplicate millepore samples, including relative percent difference and results of Paired t–Test

dust1	dust2	rel. % diff.	Pb1	Pb2	rel. % diff.	Conc1	Conc2	rel. % diff.
337	516	53.1	0.32	0.56	42.9	946	1086	14.4
677	640	-5.5	0.54	0.69	23.7	798	1081	35.5
106	86	-18.9	0.11	0.1	-10	1005	1118	11.2
331	357	7.9	0.21	0.4	47.5	644	1121	11.2
514	565	9.9	0.64	0.87	26.4	1246	1539	23.5
116	263	126.7	1.36	0.79	-72.2	11697	3002	-74.3
Number of Samples		6			6			6
Average*		37.0			36.8			38.8
Coefficient of Variation**		128.1%			60.3%			74.0%
Probability (t–Test)***		0.170			0.775			0.447

* This is an arithmetic average calculated using the absolute value of the relative percent differences
** This is a measure of the variability within the data set expressed as a percentage of the average
*** This is a statistical measure of the probability that the differences between the means of the two groups is due to chance. Usually if this less than 0.05 then the two groups are accepted to be different.

It is also interesting to note that the differences in lead content of the sample and its duplicate are not any more or less than the differences in total dust and lead concentration. The lead content of the sample would be unaffected by the weighing problems discussed earlier, whereas both total dust and lead concentration would be affected – total dust directly, and concentration because it is calculated using total dust weight.

d) Summary/Implications

These potential weighing errors would create random errors in the concentration and total dust weight data. This error would be equally distributed throughout the data set – i.e., there is no reason that there would be more or less of it in either the treatment or control groups.

Random "noise" in the data set would not affect the differences between the treatment and control groups, however, it would increase the variability within the total

dust and concentration data sets. This would make it more likely that statistical analysis will not find significant differences between the treatment and control groups.

A second implication of the increased variability would be to decrease the strength of correlations between the affected data and other data. For example: this study found that micro-vacuum cassette lead concentration does not correlate well $Pb_{(Blood)}$. This could be a contributing factor to that.

Handwipe samples

Hand wipe field blanks consisted of 6 hand wipes. After the collection of a hand wipe sample, the next 6 wipes were taken, crumpled, placed in a sample bag and assigned a sample number. This was done in the subject's home by the technician.

a) Field blanks

107 hand wipe field blanks were submitted for analysis. 78 of these analyses reported lead content at, or lower than, the Limit of Detection (0.002 mg), the remaining 29 values ranged from 0.003 to 0.019 mg. The overall geometric mean was 0.002 mg with a standard deviation of 0.0024. 95.33% of all results were at or less than 0.005 mg Pb, meaning that there was a 95% chance that any contamination (if there were any) would be equal to or less than 0.005 mg.

This indicates that there was no contamination occurring and, equally important, that our documentation and sample handling procedures for hand wipe samples were reliable.

The overall geometric mean of all hand wipe samples taken during this study was 0.010 mg, ranging from 0.001 to 0.158 mg. The geometric mean lead content of the field blank samples was 0.002 mg. This is the Limit of Detection.

b) Summary/Implications

These results indicate that the handwipe data are reliable and reasonably free from error.

Vacuum Samples

Vacuum bag samples were comprised of all the material collected in the vacuum during a HEPA vacuuming operation. The dust (and whatever else is vacuumed up) is taken from the vacuum bag, placed into a sample bag, assigned a sample number and submitted for analysis. The vacuum bag is not part of the sample.

a) Vacuum Bag Analyses

1 unused vacuum bag and 6 used vacuum bags were submitted for analysis to see how much, if any, dust/lead is retained in the vacuum bag itself. The results of these analyses and the respective sample analyses are given in **Table 5**. The Limit of Detection for vacuum bags is 5 mg lead.

Table 5: Comparison of vacuum bag analyses with the respective vacuum sample analyses

Vacuum Bag Results			Vacuum Sample Results			% in Sample*	
Total Dust (mg)	Lead (mg)	Concentration (PPM)	Total Dust (mg)	Lead (mg)	Concentration (PPM)	Total Dust	Lead
376	2.5	0					
8514	19	2232	64228	78	1214	80.4	88.3
7682	16	2083	75833	91	1200	85.1	90.8
6377	10	1568	20685	21	1015	67.7	76.4
12469	12	962	22035	15	681	55.6	63.9
7820	11	1407	96335	82	851	88.2	92.5
16337	11	673	128375	40	312	78.4	88.7
Average						76	83
Coefficient of Variation						15.8%	13.3%

* calculation: $$\left[\frac{TotalDust_{(sample)}}{TotalDust_{(bag)} + TotalDust_{(sample)}}\right] \times 1$$

The first result indicates that there is no lead in the materials of an unused sample bag.

The subsequent results indicate that although a large proportion (from 10% to 30%) of both the total dust and lead gathered from the houses is retained in the bags, the amount of total dust or lead retained is quite consistent (**Figures 1 and 2**).

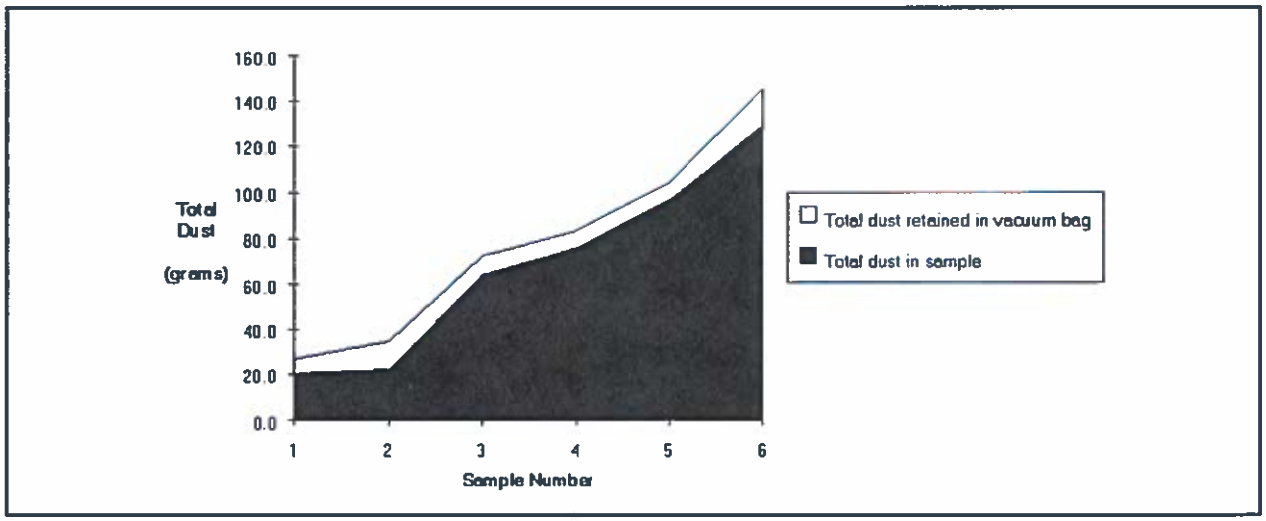

Figure 1: The amount of total dust retained in the vacuum bag relative to the amount of total dust in the sample.

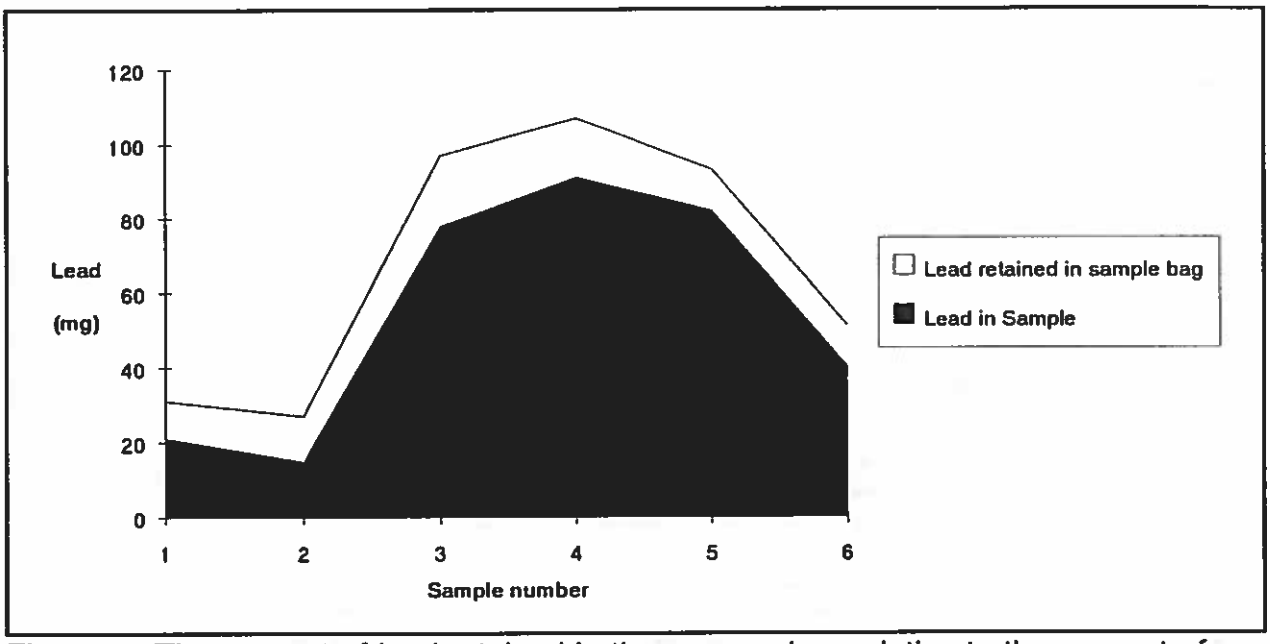

Figure 2: The amount of lead retained in the vacuum bag relative to the amount of lead in the sample

Unlike the previous discussion where the potential inaccuracy was variable, the retention of a consistent portion in the sample bag will not influence the relative ranking of the results. In this study we are looking for a decrease in the amount of lead in the house, a change from one sample to the next. Therefore, we are more interested in the relative amounts of total dust and lead in the samples than the absolute value.

b) Split Samples

The results of split sample analyses are given in **Figure 3**. The average relative percent difference is 11%, with a standard deviation of 9%. The relative percent differences range from 1 to 39%. **Note:** one pair of results were excluded from this analysis because the small size of the numbers (6 & 15) resulted in a very high relative percent difference (150%) although the magnitude of the difference (9 PPM) was quite small.

Statistical analysis of the data showed that if all analyses were repeated, 95% of the results would fall within 19% of the original result.

This wide range probably reflects the heterogeneous nature of dust in a vacuum bag, rather than a deficiency on the part of the laboratory. This degree of uncertainty is acceptable.

These results compare favourably with the results from 1992 split soil sample analyses. In that data, the average relative percent difference was 26% and the standard deviation of the relative percent difference was 29%.

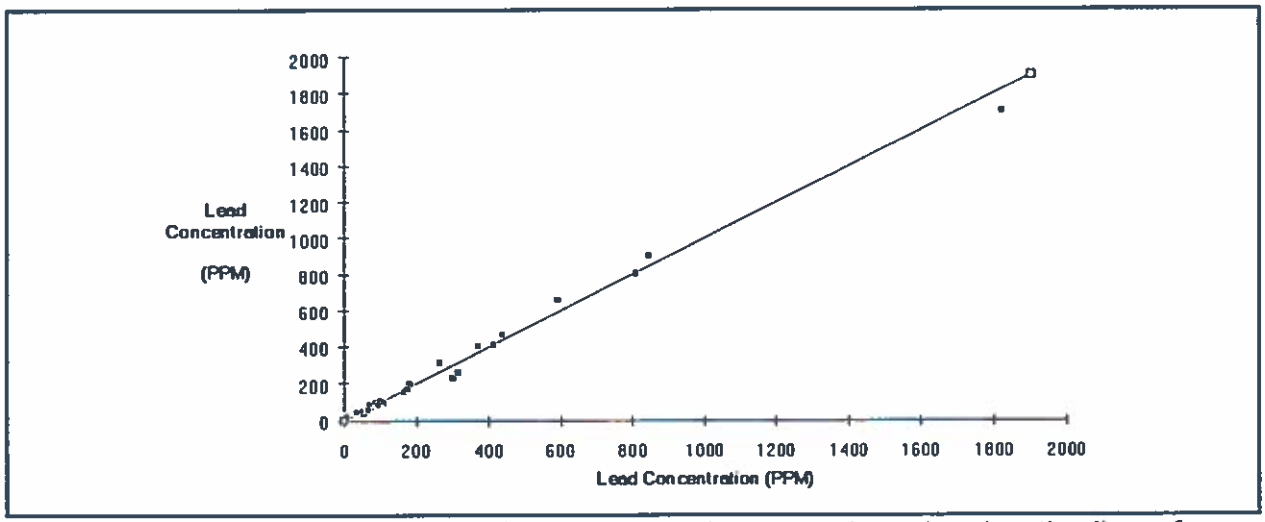

Figure 3: The analytical results of split vacuum bag samples, showing the line of perfect agreement. Both analyses were done by QuantaTrace Laboratories Ltd.

c) Summary/Implications

The analysis of emptied vacuum bags shows that a consistent amount of lead and dust is retained in the vacuum bag. This will not affect the relative ranking of vacuum bag samples. The analysis of split samples shows that the laboratory analysis of vacuum bag dust is reasonably reliable.

Overall, these analyses show that our vacuum bag sample data is reliable.

Blood Samples

In 1992 the primary laboratory for our program was Cominco Analytical Services and the quality assurance laboratory was BC Children's Hospital. In 1993 BC Children's Hospital became our primary laboratory and the University of Alberta Hospital became our quality assurance laboratory.

a) Split Samples

The results of 1992 and 1993 split sample analyses are given in **Figures 4 and 5**. It is apparent from these graphs that for 1992 Cominco Analytical Services tended to report slightly higher readings than did BC Children's Hospital and that for 1993 the University of Alberta Hospital tended to report lower results than did BC Children's Hospital. Statistical analysis of the two groups of results showed that the differences were statistically significant in both years (**Table 6**). At this point we know that the two groups are different relative to each other, but we do not know which laboratory is more accurate.

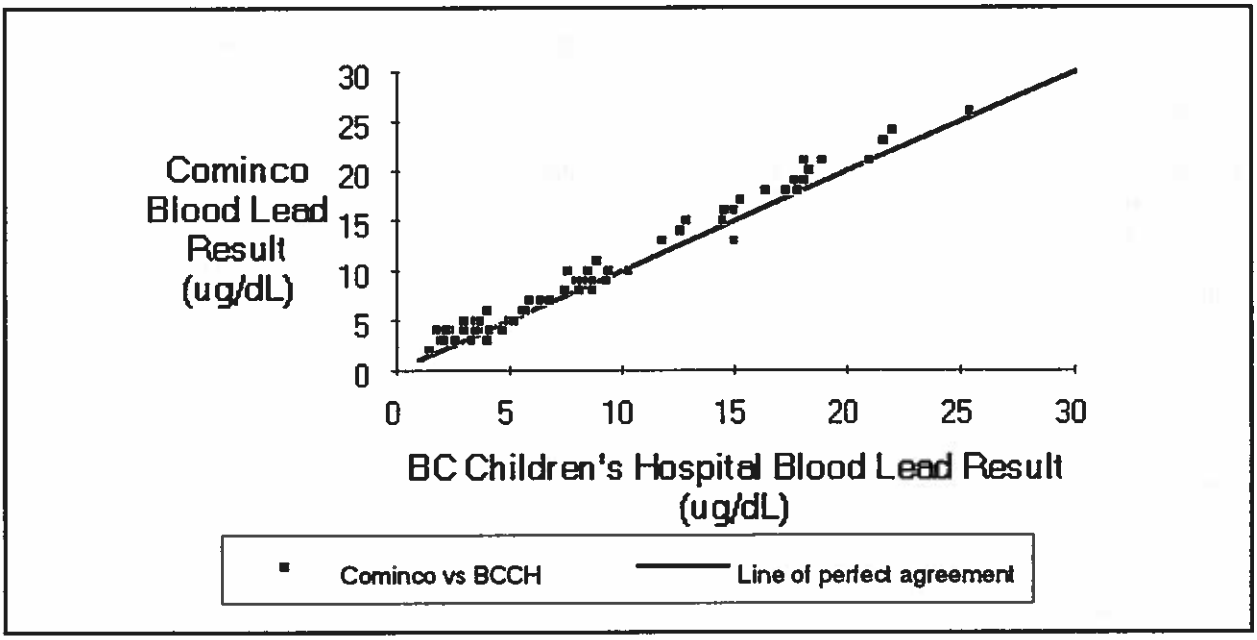

Figure 4: Results of analysis of 1992 quality assurance split blood samples between Cominco Analytical Services and BC Children's Hospital, showing the line of perfect agreement.

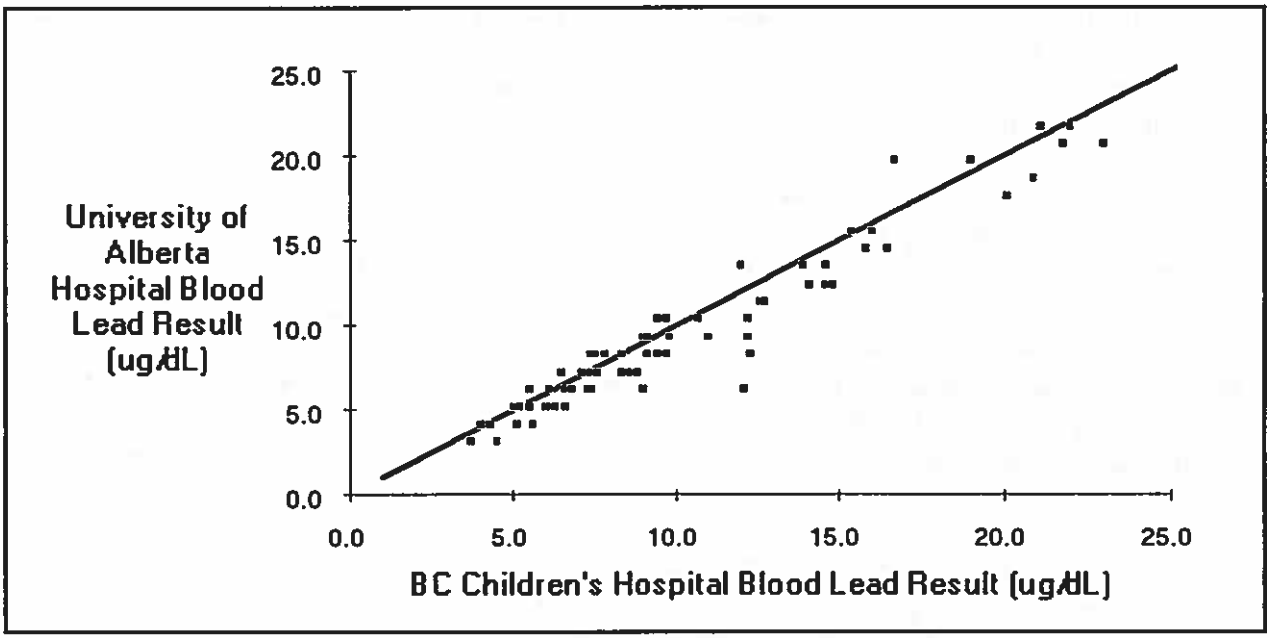

Figure 5: Results of analysis of 1993 quality assurance split blood samples between BC Children's Hospital and University of Alberta Hospital, showing the line of perfect agreement.

Table 6: Statistical analysis of 1992 and 1993 split sample results.

1992	BCCH	CAS	Absolute Differences	Relative % Differences
Average	8.7	9.6	1.0	16.7
Minimum	1.5	2.0	0	0
Maximum	25.4	26.2	2.9	75.9
Coefficient of Variation	72%	68%	290%	104%
95% Confidence Limit			1.4	
Number of pairs of samples		75		
R^2		0.98		
Probability (t–Test)		$3.22 * 10^{-12}$		
1993	BCcH	UofAH		
Average	10.1	9.4	1.1	11.7
Minimum	3.7	3.1	0	0
Maximum	23	21.7	2.9	64.5
Coefficient of Variation	50%	52%	264%	93%
95% Confidence Limit			2.0	
Number of pairs of samples		71		
R^2		0.93		
Probability (t–Test)		$9.89 * 10^{-6}$		

b) Reference Samples

In 1992, the University of Cincinnati supplied the Trail Lead Program with two lots of human blood with stated lead levels of 6.9 µg/dL and 1.6 µg/dL. These values were obtained by isotope dilution mass spectrometry but were not certified and no confidence interval was reported. However, samples of these bloods could be submitted truly blind – the samples were human blood in the appropriate sample tubes.

The information presented in **Table 7** shows that Cominco Analytical Services tended to be marginally high on the lower standard and marginally low on the higher standard, while the opposite was true of BC Children's Hospital. Comparison of the standard deviation of the differences between the two laboratories shows that, although the reported differences between the individual analytical result and the stated value was larger for Cominco Analytical Services results, the variability of those results was less than for BC Children's Hospital results. In other words, Cominco Analytical Services was more precise (likely to get the same answer twice) than was BC Children's Hospital.

The Paired t–Test results indicate that the difference in means between the two laboratories is significant ($p = 0.007$) for the 1.6 µg/dL standard but not for the 6.9 µg/dL standard. The *significant* to *not significant* change from the low standard to the high standard is due to the increased variability of the BC Children's Hospital results for the 6.9 µg/dL standard.

Table 7: Results of statistical analysis of 1992 reference bloods

	Cominco Analytical Services		BC Children's Hospital
1.6 µg/dL standard			
Average	2.1		1.3
Coefficient of Variation	12%		34%
Average difference from stated value	0.5		-0.26
95% Confidence Limit about the difference	0.5		0.9
Number of samples		9	
Probability (t-Test)		0.004	
6.9 µg/dL standard			
Average	6.6		7.1
Coefficient of variation	10%		21%
Average difference from stated value	-0.35		0.24
95% Confidence limit about the difference	1.3		2.9
Number of samples		8	
Probability (t-Test)		0.372	

In 1993 we used commercially available certified reference bloods. These were prepared using cow's blood and came in readily identifiable sample tubes. Thus, while the established lead content of the samples was above reproach, they were not blind samples, as both the character of the blood and the tube it came in were different from a regular sample. However, the laboratory had no way of knowing the established lead content of the blood. We acquired 16 samples at 4 reference values (5.0, 13.5, 30.6 and 54.4 µg/dL), each laboratory received two samples of each value.

Both laboratories tended to reported high results for the 5.0 µg/dL reference blood and both tended to report low results for the higher value reference bloods (**Figure 6**). These results seem to infer that BC Children's Hospital is the more accurate of the two laboratories, although this not a definitive conclusion by any means.

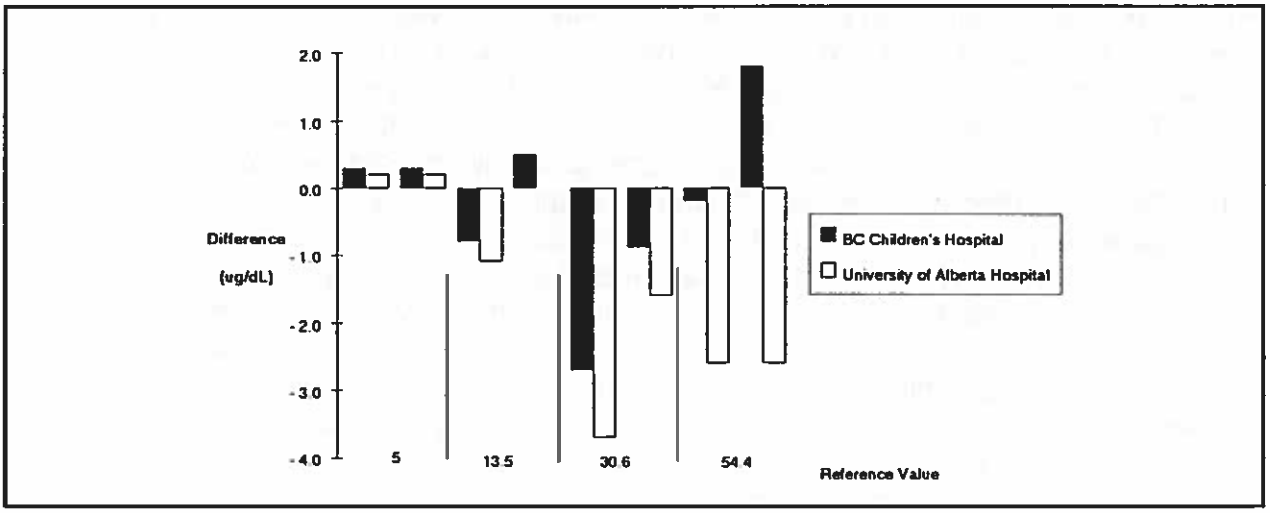

Figure 6: Showing the differences between the analytical result and the reference value for both BC Children's Hospital and the University of Alberta Hospital in 1993.

The average percent difference from the reference value was similar for both laboratories – 4.6% for BC Children's Hospital and 5.4% for the University of Alberta Hospital and the variability of both was also similar – the standard deviation about the average percent difference was 2.58 for BC Children's Hospital and 3.51 for the University of Alberta Hospital. There was no trend toward (or away from) greater error at either high or low reference values (**Figure 7**).

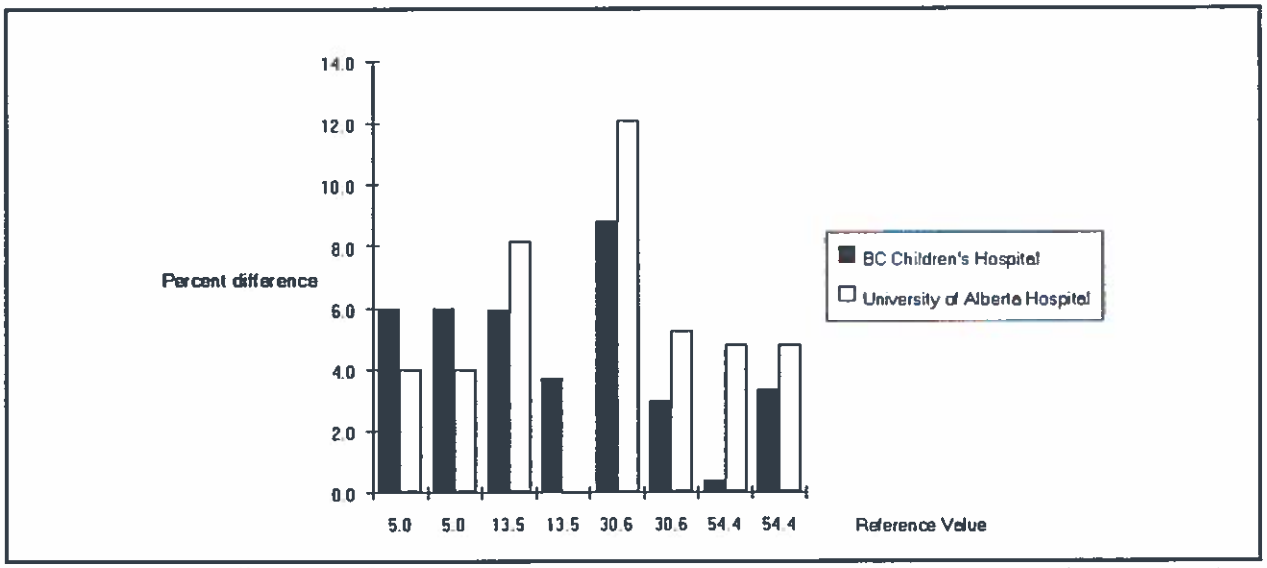

Figure 7: Showing the difference between the analytical result and the reference value as a percentage of the reference value.

c) Check Standards

Check standards were multiple samples of volunteer blood. In 1992 blood was drawn from two people, two or three times during the six weeks of the blood clinic. The overall averages of all analyses for these bloods was 4.0 and 2.7 μg/dL. 18 check standards were submitted in 1992, 12 of the 4.0 blood and 6 of the 2.7 blood.

These analyses produced results that were similar to those from the analysis of reference bloods discussed previously. Cominco Analytical Services results were generally higher than those of BC Children's Hospital, and the differences in means were statistically significant for both bloods (probability$_{(\text{Paired t-Test})}$: 0.008 and 0.0004, respectively). This variability was consistent throughout the study, in other words, neither laboratory gave more (or less) accurate results at any point in the study.

In 1993, sufficient blood was drawn from three volunteers at the beginning of the clinic that one sample of each could be submitted during each or the 6 weeks of the clinic. Thus 18 check standards were submitted in 1993. The overall average of all analyses for these bloods was 4.0, 5.5 and 20.8 μg/dL. The results of statistical analysis of this data is given in **Table 8**.

Table 8: Results of data analysis of check standards for 1993

	BC Children's Hospital	University of Alberta Hospital
4.0 μg/dL Blood		
Number of samples	6	6
Average	4.2	3.8
Coefficient of Variation	13%	19%
95% Confidence limit	0.6	1.0
Probability (Paired t–Test)	0.1502	
5.5 μg/dL Blood		
Number of samples	6	6
Average	5.8	5.2
Coefficient of Variation	8%	18%
95% Confidence limit	0.9	1.8
Probability (Paired t–Test)	0.1303	
20.8 μg/dL Blood		
Average	21.5	20.2
Number of samples	6	6
Coefficient of Variation	5%	8%
95% Confidence limit	2.0	3.3
Probability (Paired t–Test)	0.0521	

These results confirm the tendency of BC Children's Hospital to report higher values than the University of Alberta Hospital as discussed previously. None of the differences between the means are statistically significant. It is interesting to note that the BC Children's Hospital results are less variable than are the University of Alberta Hospital's results.

d) Summary/Implications

In both the 1992 and 1993 analysis of split samples there was excellent correlation between our primary laboratory and our quality assurance laboratory. In both years, insufficient reference blood materials were analyzed to resolve the differences between laboratories. However, the analysis of reference bloods showed that the blood lead levels used in this study were within 1 μg/dL at blood lead values of <10 μg/dL in 1992 and within 1 μg/dL at blood lead values <15 μg/dL in 1993.

Analysis of check standards showed that both laboratories were consistent throughout the study.

The differences discussed above will not affect the results of the study.

TRAIL LEAD PROGRAM

HEPA HOUSE CLEANING PILOT PROJECT

APPENDIX D

Study Protocol

November, 1992

E. White, Environmental Consultant
S. Hilts, Environmental Coordinator

Introduction

The intent of the HEPA house cleaning project is to investigate the potential benefit of providing repeated house vacuuming using HEPA (High Efficiency Particulate Air) vacuums. Rather than performing a one time comprehensive cleaning (with no follow up) a thorough cleaning of all floors with be provided every six weeks for ten months.

The anticipated benefit is prevention of the initial rise in $Pb_{(blood)}$ in very young infants and prevention of a further rise in toddlers. The target population will be children aged 6 to 60 months (as of October, 1992).

An ancillary benefit to the community as a whole will be one of education. The message that lead in house dust must be of primary concern to parents will be reinforced by this work. The Lead Program Office will continue to have 2 HEPA vacuums available to home owners on a no-charge basis throughout the program. These vacuum cleaners have been available to the community since February, 1992 and only 28 families have borrowed them. Of these, only two families have been repeat users.

Strategy

The project will be set up with a subject group and a control group, with approximately 60 homes in each group. The subject group will receive 7 household vacuumings whereas the control group will not. All families will be encouraged to maintain their normal cleaning habits irrespective of HEPA vacuuming.

An $50 grocery voucher will be offered to families in both the treatment and control groups to encourage their participation.

Environmental measures will be gathered 3 times during the course of the project (beginning, middle and end). These environmental measures will be Pb_{hand}, $Pb_{floordust}$ and $Pb_{(vacuum\ bag)}$. The reasons for gathering these measures are as follows:

$Pb_{(hand)}$Hand to mouth activity is generally accepted to be the route by which particulate lead enters the child's body. Therefore high $Pb_{(hand)}$ levels should indicate an increased likelihood of the child ingesting lead.

$Pb_{(floordust)}$ With very young children the most likely means for their hands to become contaminated is by contact with floor dust. With the vacuum service, we can reasonably expect to reduce $Pb_{(floordust)}$ levels, therefore this will be an immediate measure of such a reduction.

$Pb_{(vacuum\ bag)}$ This will demonstrate that we are actually removing lead from the house.

Evaluation

The project will be evaluated three ways: continuously (by determing $Pb_{(vacuum\ bag)}$ with each treatment), at the mid point (by analyzing the $Pb_{(hand)}$, and $Pb_{(floordust)}$ data gathered during the course of the work) and on completion (by analyzing all the data gathered during the project and comparing both subject and control groups).

i) **continuously** – Are we removing lead from the homes? Is there a trend in the lead content of the vacuum bags through the course of the project? These questions can be answered by assessing $Pb_{(vacuum\ bag)}$, a measure of the total lead removed from each home with each vacuuming.

ii) **at midpoint and at completion** – Are we reducing the children's lead exposure? Changes in $Pb_{(hand)}$ and $Pb_{(floordust)}$ levels during the course of the project would indicate a change in the degree of exposure in the project homes. We should be able to differentiate between community wide changes and changes due to our intervention because of the control/subject study design.

   Have we made a difference to the children's $Pb_{(blood)}$ levels? By comparing the changes in $Pb_{(blood)}$ levels of the control children and the subject children after one year we should be able to determine the benefit of this intervention.

Recruitment

In view of the anticipated benefit of this work (preventing an initial or further rise in $Pb_{(blood)}$ rather than lowering an elevated $Pb_{(blood)}$), the project will recruit children between 6 and 60 months of age as of Oct 1992. All of the children involved will be less than 72 months of age in October 1993, the anticipated completion date of the project.

There are approximately 175 families in our current blood screening program with children in this age window. Of these we hope to recruit 60 families into the subject group and 60 into the control group. As previously noted we will offer an incentive to the families in the program. The budget includes $50 per family for this purpose.

Parents with children under 60 months participating in the Sept/Oct 1992 blood screening will be contacted to see if they are willing to participate in the house cleaning program. Children whose parents accept will be stratified by neighbourhood, sorted by blood lead within neighbourhoods, then assigned randomly to treatment and control groups. Approximately 50–60 pairs should be obtained by this procedure.

We had considered offering cleaning to all families with children at 20 μg/dL or higher, simply to avoiding upsetting parents who may feel that the children most in need would be denied a potentially beneficial service. However, if all children over 20 μg/dL were given cleaning, we would be truncating the upper end of blood levels for our study group.

Initial Home Assessment

After recruitment, a home visit will be undertaken. During this visit the purpose of the project can

be explained and any questions that either parent has can be answered.

A floor plan of WHOLE house will be drawn, documenting all the rooms of the house (i.e. whose bedroom, storage area, play room, etc.). The approximate dimensions of floor area each room and the type of floor (carpet or smooth flooring) will be noted.

Rooms to be sampled for $Pb_{(floordust)}$, and the approximate location of the sample point in each room, will be noted on the floor plan at this time. Baseline environmental samples will be collected during the initial vacuuming visit.

There are some areas of the house which will not be vacuumed – garages, workshops, unfinished basements and attics, rooms which are used exclusively for storage – these will be noted on the floor plan.

On completion of the visit, the floor plan and areas included/excluded from vacuuming should be reviewed with the parent.

Cleaning

Each HEPA operator will complete a documentation form at each home. He/she will note the time of arrival and departure, who was home, the address, any unusual occurrences during the vacuuming (especially breakage of any household items). The form **must be completed at the home**.

The vacuum bag must be changed prior to leaving for scheduled cleaning and the vacuum heads and hose must be cleaned. Cleaning will be done with a damp J cloth wrapped around a bottle brush (it will be drawn through the hose using a "drop" cord – a string with a weight).

The home will then be vacuumed, excluding areas noted on the floor plan.

Vacuuming will **in all cases** be done with the NILFISK HEPA units supplied by the Lead Program. There will be no substitutions for any reason with any other cleaning device or technique!

Vacuuming will be done at a rate of 1 ft/second with two passes over the surface (i.e. up and back on same area, not up, move over, then back). This is generally slower than most house vacuuming. The entire floor area which the children **or their toys** have access to will be vacuumed. This will include under sofas, chairs and beds but not under bookshelves, china cabinets, etc.

The vacuum bags will be delivered to the field coordinator or technician at the Lead Program Office for preparation. At the office, vacuum bag contents will be transferred to zip-lock sample bags for transport to the analytical lab. Sample preparation will be performed under ventilated conditions and the technician will wear a respirator and gloves.

The analytical protocol for vacuum bags has been developed at Cominco and will be added to this document later.

Environmental Assessment

Limited environmental assessment of all homes involved will be undertaken at the beginning, at the mid-point and at the end of the project. Measures gathered at each home will include $Pb_{(floordust)}$ (pre-vacuuming and post-vacuuming at subject homes and a single measure at the control homes) and $Pb_{(hand)}$ of the children in the home.

Contents of all vacuum bags will be analyzed for total Pb.

Protocol for gathering $Pb_{(floordust)}$ and $Pb_{(hand)}$ samples is attached to this document.

Final Evaluation

Success/failure judgement of this project will be made on comparison of the change in $Pb_{(blood)}$ of the subject and control children. Blood lead data will be natural log-transformed and a two-tailed t-test used to test for a significant difference in mean change scores.

If the project is successful we would also hope to see a consistent difference between the pre and post vacuuming millepore samples and decrease in $Pb_{(vacuum\ bag)}$ levels through the course of the project. We should also see a difference in the degree of environmental exposure between the control and subject groups.

The relationship between changes in environmental exposure and changes in $Pb_{(blood)}$ will indicate the importance of $Pb_{(floordust)}$ and $Pb_{(hand)}$ in the pathway by which lead reaches a child's blood.

If there is a decrease in $Pb_{(blood)}$ of the treatment group without a concurrent decrease in environmental exposure --- we will have to question our sampling methodology or look closely for some other difference between the two groups.

Study Team

Project Steering Committee (Task Force Technical Committee)

Principal Investigator (Steve Hilts, *B.Sc., P.Geo.*)
Study design, Statistical Analysis, Reporting

Coinvestigator (Eric White, *B.Sc., R.P.Bio.*)
Study design, Quality Assurance

Coinvestigator (Cheryl Yates, *B.Sc.N., R.N.*)
Study design, Biological Monitoring

Epidemiologic Consultant (Clyde Hertzman, *M.D., FRCPC*, UBC Health Care & Epidemiology)

Statistical Consultant (Stephen Marion, *M.D., FRCPC*, UBC Health Care & Epidemiology)

Project Field Coordinator (Ulrike Sliworsky, *B.Sc.*)
initial assessments
project coordination (materials acquisition, etc)
scheduling
quality control
environmental sampling
documentation
data entry

Environmental Sampling Technicians (Dave Limacher, Shelley McIvor, *B.Sc.*, Karen Yuris)
field documentation
pre/post subject group environmental sampling
control group environmental sampling
sample documentation
checking vacuum operator compliance with protocols

Vacuum Operators (Kevin West, Karen Yuris, Donna Huston (spare))
field log
vacuuming according to protocol
vacuum bag sample preparation

Project Recruiter (Carolyn Reynolds, *B.Sc.*)
Recruiting, Scheduling, Data Entry

Phlebotomists (Donna McManus, Shelley Coy)

Database Manager (Leona Powell)

Data Entry Assistant (Michelle Hudon)

TRAIL LEAD PROGRAM

HEPA HOUSE CLEANING PILOT PROJECT

APPENDIX E

Minutes of Technical Committee Meeting

October 13, 1992

Steve Hilts/Eric White
Lead Program Office

TECHNICAL WORKING COMMITTEE TO THE TRAIL COMMUNITY LEAD TASK FORCE

Minutes of Meeting
October 13th, 1992
1:30 - 4:45 p.m.

Place: Meeting Room #1, R.D.K.B. building
Present: Steve Hilts, Terry Oke, Carolyn Reynolds, Ulrike Schneider, Eric White, Cheryl Yates, Dr. Nelson Ames, Sue Jensen, Dr. Clyde Hertzman

Recording Secretary: Michelle Hudon

1. HEPA PROGRAM

Dr. Clyde Hertzman was invited to the meeting to offer consultation on the HEPA program.

Case vs. Control Group: Dr. Hertzman noted that the key to the program is the ability to control who is assigned to each group (case or control). With respect to the groups, it was noted that the strategy must be maximized, ie. ensure that the intervention is done in the case group, but not in the control group. It was noted that two HEPA vacuums are available for loan to the public; hence, Steve Hilts asked what should be done if a control group family would like to borrow a vacuum. Dr. Hertzman suggested making the HEPA vacuums unavailable to the community for the duration of the program. Terry Oke suggested that a stipulation could be made for the control group, indicating that the HEPA vacuum is not available to those families for the duration of the program. In this way, the HEPA vacuums would still be available to the rest of the community.

Once the families agree to participate in the program, the case and control groups should be determined randomly. Eric White asked if a family who initially agreed to participate but refuses after being assigned to the control group should be included in the study. Dr. Hertzman replied that if the purpose is to determine if the program would work under ideal circumstances, then that family would not be included. However, if the purpose is to determine if the program will work under practical circumstances, then that family would be included, as long as the child's blood lead level is available at the end of the program. Also, if a family moves during the program, yet it is possible to collect a blood sample at the end of the program, then that family would be included in the study.

Record Keeping: It was suggested that an initial assessment of housekeeping practices could be done tactfully and discreetly for each family involved in the program. As well, significant events - such as renovations, job changes, type of vacuum used - must be recorded for each family. It was suggested that these questions should be asked at the end of the program so that the control group is not influenced.

Controlling Factors: The controlling factors in the study will be baseline blood lead level, age, neighbourhood, and sex. For matching purposes, the blood lead levels should be within 10% (1 μg/dL) and the ages should be within a few months. However, if matching is not possible, it was noted that the groups can be stratified by blood lead levels. After looking at the data, it was apparent that it would be necessary to sort by the zones (as indicated in the 1989 Lead Study) rather than by neighbourhood. It was noted that it may not be possible to match sexes.

It was agreed that the program will not include the areas of Casino, Waneta, Oasis, and Warfield (zone 1 in the 1989 Lead Study).

Minimum Sample Size: In order to determine the minimum sample size, the net negative change in blood lead mean and the standard deviation were varied to calculate the sample size using the different conditions. With a standard deviation of 3, the following results were computed:

Net Negative Change (μg/dL)	# of Pairs Necessary
1.4	53
1.5	46
1.6	41
2.0	26

It was concluded that, as a worst case scenario, if only 30 pairs were recruited it would still be possible to conduct the study.

Dr. Hertzman noted that in order to recruit the required numbers for the program, it may be necessary to either expand the age window or relax the matching criteria.

Analysis of Data: Dr. Hertzman noted that it will be necessary to analyze the data for those families who are in full compliance, ie. participated in a certain number of the vacuum visits and did not move or renovate, separately from the data for all others.

Dr. Hertzman stated that pairing is recommended to ensure comparability; however, it is also possible to make groups (rather than pairs) comparable but more involved statistics are necessary at the end of the program.

Multi-children Families: It was questioned if more than one child per household could be included in the program. Dr. Hertzman noted that it would be best to include only one child per family; however, if necessary, more than one child could be included as long as the children were randomly assigned to the same group (case/control). If the children were assigned to different groups, then one child would have to be randomly excluded.

Sampling Methods: As children under 6 months of age were proposed for this program, it was noted that it would be necessary to obtain baseline blood lead levels on these children using either fingerprick or heelprick sampling methods. However, it was noted that these children would then need to be re-tested using the same method at the end of the program.

Dr. Hertzman noted that it is possible to exclude children under 6 months from the program without jeopardizing the results and asked if there were any strong feelings as to why these children should be included. Cheryl Yates commented that while in Port Pirie, it was evident that it is most important to prevent the initial rise in blood lead levels; therefore, the HEPA program was established to attempt to prevent these rises in the youngest children.

Because of the difficulties involved with including children under 6 months of age, it was agreed that it would not be feasible to include these children in the study.

Dr. Nelson Ames questioned if the blood lead sampling planned at the midpoint of the study was necessary. It was noted that sampling in the spring would show the seasonal differences in blood lead levels and could indicate that the HEPA vacuuming was more effective at certain times of the year. It was argued that if blood lead levels were down in the spring but back up in the fall, then overall the HEPA program had not made a difference in blood lead levels. Dr. Hertzman suggested that since the costs of winter screening are not worth the benefits gained, the resources could be better utilized for recruiting and keeping the families involved in the program.

2. GOVERNMENTAL LONGITUDINAL STUDY

Dr. Hertzman commented that the federal government is planning to conduct a country-wide longitudinal study on children. The sampling strategy and questionnaire are presently being developed. Dr. Hertzman suggested that the Task Force could "piggyback" on that study and do oversampling of Trail children (funding may be available through Environment Canada). Also, neurobehavioural testing could be done at the same time. In this way, comparisons could be made between Trail children and the rest of the country. Dr. Hertzman will keep the Task Force up-to-date on the study.

3. NEXT MEETING

The next meeting will be held Tuesday October 27, 1992 at 12:00 p.m. in the Board Room at the R.D.K.B. building.

TRAIL LEAD PROGRAM

HEPA HOUSE CLEANING PILOT PROJECT

APPENDIX F

Sampling Protocols

November, 1992

S. Hilts, Environmental Coordinator
E. White, Environmental Consultant
C. Yates, Health Coordinator

Environmental Sampling Protocols for HEPA Project

BEFORE SAMPLING

1. Consult schedule of appointments to find names, addresses and phone numbers for homes to be sampled.

2. Assemble a site file for each home to be sampled. This will include:

    - a sample documentation sheet
    - blank sketch sheets for floor plans

3. One day before the appointment, telephone to confirm. If you are unable to make contact, try again on the day of the appointment. If still unable to confirm the appointment, proceed to the home at the scheduled time. If no one is home, leave the standard note that you called.

4. Assemble a sampling kit with the appropriate amount of the following equipment:

    - plexiglas template for millipore house dust samples
    - pump, tubing and nozzle
    - millipore filter cassettes
    - plastic sample bags
    - hand wipes (one box for cleaning gloves, one for samples & blanks)
    - disposable gloves
    - pens (ball point and felt marker)
    - masking tape
    - site file
    - map of Trail and area
    - note pad
    - notes for missed appointments
    - several copies of each of the 11 brochures

ON ARRIVAL AT THE HOME

1. Identify yourself as an employee of the Lead Program. Ensure that your appearance is neat and your manner friendly and polite at all times.

2. Explain that you will be collecting some carpet dust samples and a hand wipe from the youngest child who was tested in our Fall '92 blood clinic. Ask that the child not wash his/her hands until after you have sampled them, which will be at the end of your visit. Explain that you will need to be directed to the following:

    - the bedroom of the youngest child who was tested in our Fall '92 blood clinic
    - the room which that child uses most for play (e.g. T.V. or family room)
    - the family T.V., if not in same area as above

3. As you go about your sampling, please only answer questions about your activities. Refer all other questions to the program office.

PROTOCOL FOR HOUSE DUST COLLECTION, DOCUMENTATION AND TRANSPORT

(Micro Vac Method)

Site Description

Neatly mark the following on your sketch sheet:

- a floor plan for each level of the house to be sampled
- location of doors, hall ways, stairs
- labels for each room according to their function, using the codes on the back of the documentation sheet
- locations and names of adjacent streets in relation to the house
- identify each house dust subsample site with a letter "H" (for treatment group homes, these will already be marked on the floor plan)

Sample Site Selection

The aim of house dust sampling is to collect the dust which children's hands are most likely to contact.

The sample will be a composite of three areas of carpetted floor, including the subject child's bedroom, his/her major play area and in front of the family TV. For treatment homes, these will have been marked on the floor plan during the initial home assessment.

If the family T.V. is also in the subject child's main play area, or if any of the three target rooms are not carpetted, then sample two or three areas per room, as necessary, to maintain a consistent total of three template placements per composite sample. Note reasons for not sampling the standard rooms.

One filter cassette will be used to collect the sample from the three floor areas. Samples should be taken in the centre of the activity zone in each room/area.

Post vacuuming samples must be taken adjacent to pre vacuuming sampled area, but not overlapping it. The post vacuuming sample must be taken within the same general area of the pre vacuuming sample. For example – don't take one from centre of hall and the other from the clean carpet near the wall.

Only carpetted areas will be sampled.

Individual Sample Documentation

Choose the lab sample number preface (EH81), sample type (HDUSTM), and room use/location code for each sample from the back of the documentation sheet.

Complete the lab sample number by appending the date (yy/mm/dd), followed by your single digit technician ID, then 3 digits identifying the sample. (e.g. EH819208042003 would be the third millipore house dust sample collected by technician number 2 on August 4, 1992.)

Complete the "description" column by writing in a brief description that will complement the room

use/location code selected. Example descriptions are provided on the back of the documentation sheet.

Sample Collection

Dust is collected from a measured area, so that three results are obtained:

Dust loading = mg dust per unit area
Lead loading = mg lead per unit area
Lead concentration = μg/g or ppm lead

A plexiglas template, 25 cm by 25 cm, is used to outline the area to be sampled.

The sampling apparatus is a Bendix Super Sampler (BDX 55-HD) personal air monitoring pump with a 2-piece sampling cassette attached by tubing. The cassette holds one 37 mm diameter 0.8 μ polycellulose acetate filter, plus backing paper. The assembled cassettes have been pre-weighed and numbered.

The pump is equipped with a flow indicator which should be used to monitor a flow rate of 2.5 - 3.0 litres/minute with the sampling train attached. The pump flow rate should be checked as part of the equipment check before each day's sampling. In practice, the flow rate should not change during a day's sampling.

The pump's battery should be allowed to completely discharge and recharge once per week.

To collect a millipore house dust sample:

- Label a millipore filter cassette by affixing a strip of masking tape and writing the lab sample number on it.
- Assemble the pump, tubing, filter cassette and nozzle.
- With the template in place, turn the pump on and check the flow rate.
- Hold the nozzle at a 45° angle to the surface and draw it from one side of the template to the other at about 6 seconds per stroke.
- Repeat the above step in a direction 90 degrees from the initial direction.
- Make a third coverage of the area in the same direction as the first coverage.
- The three passes should take about 8 minutes in total to complete.
- After the third subsample has been collected, disconnect the filter cassette and replace the filter cassette plugs, putting the red one on the top.

During sampling, check the flow metre occasionally to ensure that the filter has not become blocked. If the flow rate drops below 2 litres/minute, replace the cassette, move the template to an adjacent area and start a new sample.

Care should be taken to avoid running the pump when not sampling.

Sample Transport

The samples are placed upright in the manufacturer's boxes for transport. Avoid turning the cassettes over once they have been plugged.

PROTOCOL FOR HOUSE DUST COLLECTION, DOCUMENTATION AND TRANSPORT

(HEPA Vac Method)

Site Description

Neatly mark the following on your sketch sheet:

- a floor plan for each level of the house to be sampled
- location of doors, hall ways, stairs
- labels for each room according to their function, using the codes on the back of the documentation sheet
- locations and names of adjacent streets in relation to the house
- dimensions of accessible floor area in each room (all floor area that can be vacuumed)
- type of floor covering in each room (C=carpet, S=smooth)
- mark areas not to be vacuumed with a yellow highlighter (e.g. garages, workshops, unfinished basement floors, rooms used exclusively for storage and any other rooms which the householders do not want entered)

Sample Site Selection

The aim of house dust sampling by HEPA vac is to collect a sample of dust that is representative of the child's entire indoor living space.. Therefore, all finished floor areas to which children or their toys have access will be vacuumed. This will include under such items as beds, tables, light chairs or sofas but not under such items as bookcases, china cabinets or entertainment units.

Individual Sample Documentation

Choose the lab sample number preface (EH86) and sample type (HDUSTV) from the back of the documentation sheet.

Complete the lab sample number by appending the date (yy/mm/dd), followed by your single digit technician ID, then 3 digits identifying the sample. (e.g. EH869208042003 would be the third HEPA Vac house dust sample collected by technician number 2 on August 4, 1992.)

Sample Collection

The HEPA vacuum is checked before each sampling to ensure that a new bag has been installed and that the vacuum heads and hose have been cleaned. Cleaning of the hose is done by drawing through a damp cloth sewn around a bottle brush

Vacuuming of carpeted areas is performed at a rate of 1 ft./second, with three passes over each area (total of 32 sec/m^2). Smooth surface floors are simply vacuumed at a typical householder's vacuuming rate, ensuring that all floor area is covered.

Sample Transport

The vacuum bag is left in the cannister for transport to the Lead Program Office. At the office, the vacuum bag is carefully removed from the canister and opened under a fume hood. The contents of the vacuum bag are transferred to a standard plastic sample bag for shipment to the lab.

PROTOCOL FOR HAND WIPE COLLECTION, DOCUMENTATION AND TRANSPORT

Collection of hand lead samples will be done as the final task during each home visit. *If the subject child has washed his/her hands recently, or if he/she has come into the house from outside or an unfinshed area, this* ***must*** *be noted in the activities section on the documentation sheet.*

Samples will be collected using commercially available unperfumed "baby wipes".

Each technician will be equipped with two (2) boxes of baby wipes. The first will be designated the non-sample box and will be used for cleaning the technician's gloved hands and equipment. The second will be used for field blanks and sample collection only.

Preparation

- pre-label two samples bags as per the procedure below.
- put on a pair of disposable gloves
- wipe gloved hands using two disposable wipes from the non-samle box of wipes
- dispose of the wipes used for cleaning gloves

Field Blanks

Following the preparation outlined above a field blank will be collected. Six (6) wipes will be removed from the sample container of baby wipes, handled to simulate wiping a child's hands and then placed in a single pre-numbered bag and submitted for analysis. One field blank will be taken at each residence.

Hand Lead Sample

Lead in dust on children's hands is sampled by wiping each hand of the child with three separate baby wipes. All surfaces of the hand (front, back and each finger) up to the wrist, are wiped thoroughly with each of the three wipes. All six wipes from each child are composited in a single pre-numbered zip-lock bag for transport.

Individual Sample Documentation

Choose the lab sample number preface (EH87), sample type (HWIPES), and code for each sample from the back of the documentation sheet.

Complete the lab sample number by appending the date (yy/mm/dd), followed by your single digit technician ID, then 3 digits identifying the sample. (e.g. EH879208042003 would be the third hand wipe sample collected by technician number 2 on August 4, 1992.)

Complete the "description" column by writing in the subject child's name.

The child ID field will be completed later at the office.

BEFORE LEAVING THE HOUSE

- Be sure to thank the householder(s) for participating in the study.
- **Ensure that all samples and equipment are in your sampling kit and that all your documentation is complete.**

TRAIL LEAD PROGRAM

VENOUS BLOOD SAMPLING PROTOCOL

MATERIALS:

- disposable 5 cc syringe
- butterfly infusion set
- sterile gauze pads
- heparinized green top paediatric vacutainer
- lavender top (EDTA) paediatric vacutainer
- red puncture-resistant needle disposal container
- bandaids
- labels
- tourniquet
- cooler
- ice pack
- disposable gloves
- marking pen
- alcohol swab

METHOD:

1) Set up the materials: butterfly needle, syringe, etc.

2) Have the parent sit on the phlebotomy chair with child sitting on parent's lap closest to phlebotomist.

3) Explain the procedure to parent and child (where appropriate).

4) Instruct parent how to hold the child's shoulders, arms and legs in such a way that the child is immobilized (or with a child younger than one year - have infant lie on exam table with assistant restraining both arms and torso).

5) Place the tourniquet on the child's arm to select the best site for venipuncture. Remove the tourniquet.

6) Put on a pair of disposable gloves.

7) Place the tourniquet on the child's arm.

8) Thoroughly clean the venipuncture site with an alcohol swab.

9) Dry the site with gauze.

10) Insert the butterfly needle into the selected vein. When blood enters the tubing, immediately screw the syringe into the end of the butterfly tubing. Slowly draw back on the syringe until sufficient blood is collected. Vacutainers should be filled to at least half full.

If insufficient blood is drawn, dispense blood into green tube (lead) first. Remaining blood could be dispensed into purple vacutainer or capillary tube (only requires .6 ml of blood) for Hgb/Hct.

11) Loosen the tourniquet when the blood is drawing into the syringe well.

12) When sufficient blood has been collected, remove the tourniquet and gently pull out the needle. Place the gauze pad over the venipuncture site and apply pressure. Have the parent continue to apply pressure to the site with the gauze.

13) Insert the butterfly needle into the vacutainer. Rock the vacutainer to mix the blood with the anticoagulant as the blood flows from the syringe into the vacutainer.

14) Dispose of the needle, tubing and syringe in the puncture resistant infectious waste container.

15) Label the tube of blood with the child's I.D. number, date of sampling, and your initials.

16) Place the blood upright at 0 to -4 degrees C until packaging for transport. DO NOT FREEZE THE BLOOD.

17) Inspect the venipuncture site to be sure it has stopped bleeding. Place a band-aid over the site.

SPECIMEN TRANSPORT

1) Place specimens in resealable transport envelopes. One specimen per bag

2) Place bags in rigid cooler with ice packs (again: DO NOT FREEZE). Make sure specimens are well secured in box and cannot roll around. Pack box tightly with styrofoam chips or shredded paper.

3) Enclose lab transfer form with list of blood sample numbers corresponding with labelled blood tubes (this form is signed by lab staff on receipt of samples acknowledging that samples were received intact)

4) Seal cooler securely.

5) Label cooler as follows:

ROOM 2D30
DIVISION OF CLINICAL BIOCHEMISTRY

DEPARTMENT OF PATHOLOGY
BC CHILDREN'S HOSPITAL
4480 OAK STREET
VANCOUVER, BC V6H 3V4
ATTN: BERYL JACOBSON

5) In red lettering, print REFRIGERATE ON ARRIVAL on label

6) Transport samples Monday through Thursday

TRAIL LEAD PROGRAM

HEPA HOUSE CLEANING PILOT PROJECT

APPENDIX G

Analytical Protocols

November, 1992

Cominco Analytical Services
and
British Columbia Children's Hospital

Hand Wipe Samples – Analytical Protocol

1 Place each sample (6 wipes) in a labelled, acid–washed 800 ml beaker.

2. To each sample, add 100 ml of 1M nitric acid prepared with deionized water.

3. Swirl each sample for 10 seconds.

4. Cover each sample with a watchglass and allow it to extract at room temperature for 2 hours.

5. Decant the acid solution from the handwipes into a labelled, acid–washed 250 ml beaker.

6. Add 50 ml of 1M nitric acid to the handwipes in the 800 ml beaker.

7. Swirl the sample for 10 seconds.

8. Decant the acid solution into the same 250 ml beaker to composite the acid rinse.

9. Repeat steps 5, 6 and 7 a second time for a total acid solution of about 200 ml.

10. Cover the samples with a watchglass which is elevated above the beaker rim with glass hooks. (The watchglass must be elevated to prevent "bumping" of the sample during evaporation).

11. Place the samples on a hotplate at about 250°C

12. Evaporate the samples to dryness.

13. Add about 3–5 ml of 1M nitric acid to each sample, rinsing the watchglass and the sides of the beaker.

14. Heat the samples gently on a hot plate at 120 – 150°C to redissolve lead.

15. Filter samples to remove undissolved material, using the following procedures:

    Filtration apparatus:
    - Whatman #54 filter paper
    - Glass funnels
    - 50 ml labelled, acid–washed beakers
    - 1M nitric acid

    a. Fold filter paper and place in funnel. Rinse filter paper and funnel with 1M nitric acid over 50 ml beaker and discard rinse.

    b. Shake each sample very well.

c. Filter each sample in the 50 ml beaker, rinsing tube, paper and funnel with 1M nitric acid.

d. Reduce the volume of acid in the 50 ml beaker to 5 ml on a hotplate (250°C).

16. Transfer the sample with 3 rinses of 1M nitric acid to a labelled, acid–washed 10 ml graduate tube and make up to volume with 1M nitric acid.

17. Shake each sample very well. Transfer each sample to a new, labelled polystyrene test tube with screw cap.

18. Analyze for lead by ICP–AES or flame AAS. Report results in μg Pb/sample.

Millipore Cassette House Dust Samples – Analytical Protocol

Sample Preparation

1. Zero Balance
2. Place millipore cassette sample on balance
3. Record weight of cassette and sample (Weight A)
4. Refer to cassette pre–weight in records (Weight B)
5. Report (Weight B) – (Weight A) as "milligrams total dust"
6. Open cassette and empty sample and membrane filter into 150 mL beaker
7. Rinse sample residue from cassette into beaker with double–distilled H_2O

Total Digest and Analysis

8. Start two reagent blanks
9. Rinse down sides of beakers with double distilled H_2O
10. Add 10 mL of HNO_3 and 2 mL $HCLO_4$ to each sample and blank
11. Place beakers on a padded hotplate (2 pads) and take to dryness – don't bake
12. Remove beakers from hotplate, cool, add 10 mL H_2O and 2.5 mL HNO_3
13. Heat to dissolve salts, cool and dilute to exactly 25 mL in 50 mL polypropylene tubes

14. Analyze samples for Pb by ICP–AES or flame AAS

15. Report Pb as "milligrams lead" to nearest 0.005 mg/sample

Vacuum Bag Samples – Analytical Protocol

1. Personnel from Trail Lead Program to place contents of vacuum bag into a standard plastic bag

2. Sample is forwarded to laboratory

3. At laboratory, tare balance using a blank empty plastic bag

4. Weigh sample and report "milligrams total dust"

5. Select portion of sample for digest and analysis using the following guidelines:

   a) If total weight of sample is less than 50 grams, use whole sample for analysis.

   b) If total weight of sample is greater than 50 grams, then spread whole sample out on a piece of paper (14" x 14") and isolate and remove 1/4 of the sample. Record actual weight of sample to be analyzed and proceed with digestion. This means that for samples ranging in weight from 50 to 195 grams, a minimum of 12 grams and a mazimum of 49 grams will be digested. When total sample weight is greater than 200 grams, then a 50 gram portion will be the maximum taken for digestion.

   Quality Assurance

   In order to determine that the subsample is representative of the original sample:

   Every tenth sample will have duplicate subsamples taken for digest and analysis. The results for both subsamples will be reported.

6. Place the subsample into a 2 litre beaker

7. Add 2 drops of wetting agent (oronite) to prevent foaming (1% solution by weight/volume)

8. Bulk sample to 1 litre with 10% HNO_3

9. Allow to extract lead for two hours with stirring every 15 minutes

10. Filter through a #1 Whatman filter paper until 50 mL of solution are available

11. Analyze for lead using ICP–AES for flame AAS. Report "milligrams lead".

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Improved Sample Preparation for Accurate Determination of Low Concentrations of Lead in Whole Blood by Graphite Furnace Analysis

Beryl E. Jacobson, Gillian Lockitch, and Gayle Quigley

The effect of low concentrations of lead on pre- and post-natal growth and development is a current concern. We describe a simple method of sample preparation for direct determination of lead in whole blood by Zeeman graphite-furnace atomic absorption spectrometry. This procedure improves analytical precision and accuracy of lead determinations at low concentrations as compared with published furnace data. At blood lead concentrations of 0.25, 1.98, and 3.76 μmol/L, within-run CVs were 3.2%, 1.8%, and 1.4% respectively; between-run CVs were 7.3%, 2.9%, and 2.2%. Accuracy, as demonstrated by analytical recovery, ranged from 99% to 102%. Our reproducibility/accuracy score in the 1989 Quebec inter-laboratory comparison program was 96% compared with the target, second best of 66 participating laboratories.

Additional Keyphrases: *atomic absorption spectrometry · toxicology · pediatric chemistry*

Recent publications have focused attention on the adverse effects of blood lead concentrations as low as 0.48 μmol/L (10.0 μg/dL) on physical and nervous system development in the pre- and post-natal period (*1–4*), as well as the influence of chronic low lead exposure on cardiovascular function in adults (*3*). Thus, precise and accurate blood lead measurements are imperative at this potential decision value.

The refinement of analytical techniques over the past decade has increased accuracy in low-concentration blood lead measurement over that reported by Boone et al. (*5*) in 1979. In that study they compared interlaboratory results from the Centers for Disease Control (CDC) with results from a Definitive Method (isotope dilution mass spectrometry). Among the various methods evaluated for lead quantification, graphite furnace atomic absorption spectrometry (GFAAS) did not rank highly in the relative accuracy and precision ratings. In general, at that time, all methods showed a positive bias at low lead concentrations and negative bias at abnormally high values. The overestimation (bias) possibly was the result of contamination and inadequate blank correction. Underestimation could have been due to incomplete recovery in the extraction or concentration steps, and to calibration curvature at lead concentrations erroneously assumed to be within the absolute linear working range. Boone et al. concluded that, except for a narrow analytical region around 1.93 μmol/L (40.0 μg/dL), the average of all methods' results did not provide a reliable estimate of the actual lead concentration in whole blood.

A more recent CDC proficiency summary (November 1989) encouragingly reported an improvement in contributors' analytical accuracy at potential threshold values for lead of 0.72 μmol/L (15.0 μg/dL). However, the acceptable range established by the CDC is ±15% for target values >1.93 μmol/L (40 μg/dL), and ±0.29 μmol/L (6 μg/dL) for values <1.93 μmol/L. At the potential threshold value, this represents an acceptable analytical range of 0.43–1.01 μmol/L (9–21 μg/dL), i.e., a CV of 40%. Even with this broad range of "acceptable" results, our 12-month statistical survey of CDC returns (August 1989 to July 1990) revealed that, of the 130 (SD 6.6) laboratories reporting each month, only 84.4% (SD 3.7%) obtained values within the target range; 10.5% (SD 3.0%) had one of three values outside the target; 3.5% (SD 2.0%) had two of three values outside the target; and 1.7% (SD 0.9%) reported all three results outside the target.

We describe a sample preparation for GFAAS that yielded within-run CVs of 3.2%, 1.8%, and 1.4% at lead concentrations of 0.25, 1.98, and 3.76 μmol/L, respectively, and between-run CVs of 7.3%, 2.9%, and 2.2%. Other studies with GFAAS report between-run precisions of 10–17% at concentrations of ≤0.68 μmol/L (*1*, *6–8*).

Materials and Methods

Instrumentation

We used a Varian SpectrAA-300 atomic absorption spectrophotometer with a Model GTA-96 graphite tube atomizer with Zeeman background correction and a PSD96 programmable sampler (Varian Canada Inc., Georgetown, Ontario). An IBM Personal System/2 Model 30 computer controls the system. SpectrAA software supplied with the instrument was installed on the IBM hard disk. A Varian hollow-cathode lamp for lead was used at a working current of 5 mA, with a 283.3-nm spectral line and 0.5-nm bandwidth. We used pyrolytically coated partition graphite tubes (Varian Canada Inc.) throughout.

Reagents, Standards, and Controls

Nitric acid was either "Aristar" grade (BDH Chemicals, Toronto, Ontario) or "Ultrex" grade (J. T. Baker Chemical Co., Phillipsburg, NJ). Triton X-100 surfactant was from Fisher Scientific, Fair Lawn, NJ; "Antifoam B emulsion" was from Sigma Chemical Co., St. Louis, MO; ammonium dihydrogen phosphate modifier was from Aldrich Chemical Co., Milwaukee, WI. Stock lead atomic absorption standard (Standard Reference

Department of Pathology, British Columbia Children's Hospital, 4480 Oak St., Vancouver, BC, Canada V6H 3V4.
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Material SRM 3128) was from the National Institute of Standards and Technology, Gaithersburg, MD.

"Seronorm" Trace Elements (Whole Blood) controls were obtained through Accurate Chemical and Scientific Corp., Westbury, NY. Three blind controls for whole-blood lead are supplied monthly through the CDC National Blood Lead Proficiency Testing Program, Atlanta, GA. Additionally, groups of three whole-blood blind controls are received bimonthly from the Centre de Toxicologie du Québec (*9*). This interlaboratory comparison program assesses laboratory accuracy and precision as compared with a target; yearly performance summaries include an overall ranking comparing all participants.

Sample Collection and Storage

Venous blood samples were collected into lead-free, navy-blue-top Vacutainer Tubes (no. 6527; Becton Dickinson, Rutherford, NJ) containing sodium heparin. Blood samples from infants and young children were obtained by heel or fingerstick. The first drop of blood was discarded, then a free-flowing sample was collected into a heparinized Microtainer Tube (no. 5969 or 5971; Becton Dickinson). Well-mixed whole blood was analyzed the same day or transferred to lead-free Eppendorf polypropylene micro test tubes (cat. no. 22 36 419-7; Sybron/Brinkmann, Rexdale, Ontario) and stored at −70 °C.

Sequential venous and capillary blood samples were drawn from a group of normal adults and compared to determine the validity of capillary sampling. Also, first-draw and second-draw capillary samples were compared to determine the adequacy of our adopted procedures for avoiding lead contamination during capillary sampling.

Procedures

Contamination control. All reagents, glassware, and sample-collection devices were checked for contamination with lead. Glassware was routinely washed and soaked in two successive dilute nitric acid baths (0.8 mol/L), then thoroughly rinsed in "ultrapure" water obtained from a Barnstead NANOpure II system (Sybron, Boston, MA).

Sample preparation and standardization. We compared various blood dilutions and sample volumes for optimal analytical sensitivity and accuracy. Both Triton dilutions and "protein-free" supernates were tested, with and without addition of inorganic lead, by direct aqueous calibration as well as by standards addition. We adopted the following procedure, which yielded the best accuracy and analytical precision with both fresh blood and lyophilized control material:

Thoroughly mix fresh or thawed whole blood on a rocker (we used an Adams Nutator, Model 1105; Clay Adams, Parsippany, NJ). Dilute the sample 10-fold by combining one volume of blood (from a positive-displacement pipette) with four volumes of sample diluent (2.5 mL of Triton X-100 and 5 mL of Antifoam B per liter of ultrapure water) in an Eppendorf polypropylene micro test tube; then, after complete lysis of erythrocytes, add five volumes of 1.6 mol/L nitric acid. To thoroughly mix the sample, place the sample tube on the rocker while proceeding with the next sample.

Store aliquots of reconstituted lyophilized human whole-blood controls at −70 °C, thaw just before analysis, then process as above. Duplicate sample blanks, substituting ultrapure water for blood, serve as a monitor for lead contamination during the sample preparation procedure. Centrifuge all tubes for 4 min at 9500 × *g*. Transfer the "protein-free" supernates to acid-washed autosampler cups for analysis.

We program the Varian sample dispenser for a normal calibration in the automix mode. Three solutions (each separated by an air slug) are drawn into the sample capillary and dispensed directly into the graphite tube. Total volume dispensed is 25 μL, which includes 5 μL of $NH_4H_2PO_4$ modifer (70 mmol/L in 0.16 mol/L nitric acid); for calibration, 2, 4, 8, 12, or 18 μL of freshly diluted 50 μg/L (0.2413 μmol/L) SRM 3128 lead standard in 0.16 mol/L nitric acid; for whole-blood lead, 10 μL of sample supernate; plus enough 0.16 mol/L nitric acid for a constant 25-μL volume for each calibration or unknown analysis. We adjust the instrument to read zero absorbance with 20 μL of 0.16 mol/L HNO_3 plus 5 μL of $NH_4H_2PO_4$. The calibration graph, automatically computed by the SpectrAA software, shows the precision obtained for replicate measurements. We routinely assay 10 μL of sample supernate; however, 5, 10, 15, or 20 μL can be analyzed, depending on the sensitivity desired. Absorbance readings for the sample blanks should be zero.

Instrument settings. Our furnace temperature program (Table 1) was optimized by the principles of Hedrikx-Jongerius and De Galan (*10*). The inert gas we used was argon. Inclusion of a low gas flow, low-temperature (0.5 L/min, 450 °C) air-ashing step is essential when comparing Triton X-diluted blood with our routine analysis of supernates described above. This step is not required for the routine analysis because progressive accumulation of carbon residues is not a problem.

Table 1. Furnace Settings for Blood Lead Determination

Stage	Temp., °C	Time, s		Gas flow, L/min
		Ramp	Hold	
Dry[a]	75	2.0		3.0
	95	10.0		3.0
	140	25.0		3.0
Ash	300	5.0	5.0	3.0
	450[b]	5.0	7.0	0.5
	450		10.0	3.0
	700	2.0	10.0	3.0
	700		2.0	0
Atomize	2000	0.7	2.0	0
Clean	2500	2.0		3.0
Cool down	40	12.8		3.0

[a] Sample was injected at 70 °C.
[b] Air ash; may be omitted and the 300–700 °C ramp extended from 2.0 to 5.0 s. Argon was the carrier gas for all other steps.

However, we included the step in accumulating the data presented here. Repeatedly we observed a 5% to 7% increase in sensitivity of characteristic mass calculations by including air ashing. The characteristic mass (defined as the mass of element in picograms that produces an absorbance of 0.0044), calculated from the analysis of 200 pg of lead, with and without air ashing, was 4.66 and 4.97, respectively (instrument specification for pure aqueous standard is 5.5).

Accuracy and precision studies. We determined accuracy by analytical recovery analyses and by comparison of our results with the target values established for the CDC Proficiency Testing and the Quebec Interlaboratory Programs. For the recovery experiments, we added 75 μL of inorganic lead to 300 μL of whole blood before processing for analysis as indicated above. We determined within-run and between-run precision by analyzing three concentrations of Seronorm Whole Blood controls.

Results

Standardization and Recovery

Direct aqueous calibration was possible when analyzing "protein-free" supernates; however, results obtained with Triton X-diluted blood were lower and recoveries were poor with this method of calibration (Table 2). When we used the automated standards addition method of calibration for Seronorm I, we determined the lead content of preparation A to be 0.25 μmol/L with a 97% recovery, compared with the direct aqueous calibration value of 0.23 μmol/L and 99% recovery. The lead content of the Triton X dilution (preparation B) by standards addition was 0.20 μmol/L with an 82% recovery, compared with the direct aqueous calibration value of 0.15 μmol/L and 60% recovery.

To confirm the accuracy of direct aqueous calibration analysis with a nonlyophilized sample matrix, we performed additional recovery experiments with human whole blood obtained from the Quebec Control Program (Table 3). Recoveries were excellent (99–101%) over a range of analytical values (0.35–2.40 μmol/L).

Linearity

We examined the sensitivity of our analysis of fresh blood and reconstituted controls from two perspectives: (*a*) by comparison of various original dilutions of sample, and (*b*) by analysis of various volumes of a standard 10-fold sample dilution. The final concentrations of Triton X, Antifoam B, and HNO_3 were maintained; however, the total sample dilution factors were varied, e.g., 2.5, 5, 7.5, 10, 15, and 20. Replicate 10-μL aliquots of "protein-free" supernate were analyzed by direct aqueous calibration. The 2.5-fold sample dilution yielded lower lead concentrations with both fresh and reconstituted blood, indicating matrix suppression of the analyte signal. There was no significant difference between the lead concentrations of all other sample dilutions. Similarly, the analytical sensitivity could be altered by analyzing various volumes of supernate (5, 10, 15, or 20 μL), as long as the sample absorbance fell within the absorbance range of the calibration graph.

By varying the sample dilution and the volume of supernate assayed, an absorbance of 0.19 would correspond to either a blood lead concentration of 0.24 μmol/L (5.0 μg/dL) with the most sensitive combination (20 μL of a fivefold dilution), or a concentration of 2.41 μmol/L (50.0 μg/dL) with the least sensitive combination (5 μL of a 20-fold dilution). Our routine analysis (10 μL of a 10-fold dilution) can accurately quantify low concentrations of lead; an absorbance of 0.19 corresponds to a blood lead of 0.965 μmol/L (20.0 μg/dL). Lead concentrations >4.34 μmol/L (90.0 μg/dL) are easily quantified by analyzing 5-μL aliquots of the same 10-fold dilution of supernate.

Contamination Monitoring and Sample Collection

We monitored blood collection and sample processing equipment, including Vacutainer Tubes, Microtainer Tubes, syringes, Eppendorf tubes, and transfer pipettes for minimum and maximum contamination with lead by overnight soaking with ultrapure water and 0.8

Table 2. Protein-Free Supernates vs Triton-Diluted Whole Blood: Recovery of Added Lead by Direct Aqueous Calibration

		Pb, μmol/L			
Sample	Preparation[a]	Before addition	Total recovered[b]	Expected total[c]	Recovery, %[d]
Normal patient (fresh blood)	A	0.22	1.20	1.20	100
	B	0.16	0.93	1.15	78
Seronorm I (Lyophilized)	A	0.23	1.20	1.21	99
	B	0.15	0.74	1.15	60
Seronorm II	A	1.94	2.60	2.58	102
	B	1.15	1.51	1.95	58

[a] A = "Protein-free" supernate prepared as indicated in *Materials and Methods*. B = 10-fold dilution of whole blood in a final concentration of 1 mL of Triton X-100 and 2 mL of Antifoam B per liter. We analyzed replicate 10-μL aliquots of each preparation.

[b] 75 μL of pure lead standard (5.13 μmol/L) was added to 300 μL of blood.

[c] (300 × "before" value) + (75 × 5.13) = 375 × total expected.

[d] (Total recovered/expected total) × 100.

Table 3. Analytical Recovery of Added Lead

	Pb, μmol/L				
Sample no.[a]	Target	Before addition	Total recovered[b]	Expected total[c]	Recovery, %[c]
168	0.35	0.33	1.26	1.27	99
169	1.20	1.21	1.98	1.97	100
172	2.40	2.42	2.96	2.94	101
174	1.50	1.48	2.19	2.19	100
173	0.38	0.39	1.27	1.28	99

"Protein-free" supernates were prepared as indicated in *Materials and Methods*, and replicate 10-μL aliquots were analyzed directly against aqueous calibration curve.

[a] Human whole-blood samples from the Quebec Toxicology Interlaboratory Comparison Program.

[b] 75 μL of pure lead standard (no. 173 = 4.82 μmol/L; all others = 5.02 μmol/L) added to 300 μL of blood before processing.

[c] See Table 2.

mol/L nitric acid. No significant lead contamination was detected in any of the materials tested (detection limit: 2.6 × SD blank = 0.002 μmol/L), except in the EDTA-containing Vacutainer Tubes and Microtainer Tubes. The absolute lead contamination in these devices was low and variable, ranging from 0.02 to 0.21 μmol/L in the EDTA-containing Vacutainer Tubes and 0.02 to 0.05 μmol/L in the EDTA-containing Microtainer Tubes. To prevent contamination, we collected all blood samples into heparinized containers.

First- and second-draw capillary samples from seven normal subjects indicated no significant difference in lead concentrations: 0.230 (SD 0.101) and 0.233 (SD 0.094) μmol/L, respectively. Regression analysis of the data yielded: capillary no. 2 = 0.019 + 0.930 · capillary no. 1 (r^2 = 0.996). Also, there was no significant difference between results obtained with venous blood [0.211 (SD 0.084) μmol/L] and first-draw capillary blood [0.215 (SD 0.088)] μmol/L from 10 normal subjects. Regression analysis of the data yielded the following: venous = 0.006 + 0.952 · capillary (r^2 = 0.986).

Precision and Accuracy

Data are presented in Table 4 for within-run and between-run precision of analysis, determined with Seronorm Whole Blood controls.

Analytical recovery data (Tables 2 and 3) show that our results compared very favorably with the target values established for both external quality-control programs. Our reproducibility/accuracy score in the 1989 performance summary of the Quebec Toxicology program was 96% compared with the target value, ranking us second of the 66 laboratories participating in lead analysis. Table 5 presents the results of the recent returns from the Quebec and CDC programs.

Reference Intervals

Using the described procedure, we determined the whole-blood lead concentration from 27 healthy, asymptomatic adults, 18 women and nine men. Mean results were 0.18 (SD 0.076) μmol/L (3.7 ± 1.57 μg/dL) for the women and 0.23 (SD 0.086) μmol/L (4.8 ± 1.78 μg/dL) for the men. For the entire group, the mean blood lead concentration was 0.19 (SD 0.081) μmol/L (3.9 ± 1.68 μg/dL).

A recent survey (*11*) of 172 Vancouver children, ages 24 to 36 months, yielded a 95% confidence limit blood lead range of 0.24–0.28 μmol/L (5.0–5.7 μg/dL). The geometric mean and SD were 0.26 ± 0.007 μmol/L (5.3 ± 1.56 μg/dL).

Table 4. Precision of Blood Lead Analysis

Sample	n	Pb, μmol/L Mean	Pb, μmol/L SD	CV, %
Seronorm I				
Within-run	11	0.25	0.008	3.2
Between-runs	24	0.23	0.017	7.3
Seronorm II				
Within-run	11	1.98	0.036	1.8
Between-runs	24	1.96	0.057	2.9
Seronorm III				
Within-run	11	3.76	0.053	1.4
Between-runs	16	3.70	0.081	2.2

Reconstituted aliquots were stored at −70 °C and thawed just before analysis. Lead concentration was determined in "protein-free" supernates as indicated in *Materials and Methods*.

Table 5. Interlaboratory Comparison Programs

Quebec Toxicology Sample no.	Pb, μmol/L Target	Pb, μmol/L Our result	CDC Sample no.	Pb, μg/dL[a] Target	Pb, μg/dL[a] Our result
L-190	0.3	0.30	90Pb-13	8	7.3
L-191	1.20	1.19	90Pb-14	16	14.2
L-192	1.85	1.88	90Pb-15	35	33.5
L-193	2.0	2.00	90Pb-16	41	42.6
L-194	1.2	1.19	90Pb-17	13	12.1
L-195	0.75	0.68	90Pb-18	27	27.1
			90Pb-19	32	32.9
			90Pb-20	10	8.9
			90Pb-21	21	20.2

"Protein-free" supernates were prepared as indicated in *Materials and Methods*; replicate 10-μL aliquots were analyzed directly against aqueous calibration curve.

[a] CDC control target values are reported in μg/dL. 1 μmol/L for lead = 20.7 μg/dL.

Discussion

The effect of sample preparation on blood lead quantification by various methods has been recognized for some time (*12*). In lead determination by GFAAS, various conditions affect analytical sensitivity and accuracy. Previous studies have examined some of these conditions, including sample digestion (*13*), simple sample dilution (*6–8, 14–17*), use of matrix modifiers (*8, 15–17*), and direct aqueous calibration (*6, 16*) or standards addition (*7, 13, 14*) in human or bovine blood. Accuracy and precision data have not always been presented. Delves (*18*) considered it unlikely that direct calibration procedures could be used for routine analysis of blood lead because accurate quantification requires some matching of the standard matrix with the sample. The problems associated with direct analysis of whole blood by GFAAS include imprecise dispensing of whole blood, effect of matrix on analyte sensitivity, incomplete recovery, poor precision, excessive accumulation of carbonaceous residues in the furnace (leading to decreased precision and suppression of the analyte signal, thereby necessitating frequent replacement of furnace tubes), and the difficulty of accurate calibration. Sample digestion with concentrated acids at high temperatures can reduce nonatomic absorption, but this is time-consuming, increases the risk of leeching contamination, and may reduce sensitivity. The method we describe addresses all of the above problems.

Because lead is not associated with serum proteins, deproteinization of lysed whole blood with dilute HNO_3 has the advantages of thermal digestion and none of the disadvantages. Lead is not trapped in the protein pre-

cipitate, as demonstrated by our analytical recovery experiments. Only one additional pipetting step is required in the sample preparation. Reagent blanks monitor possible contamination with lead. Carbon residues do not accumulate in the furnace, so we can generate as many as 300 firings before changing the graphite tube.

Calibration with Zeeman background correction GFAAS deviates from linearity at a lower absorbance than does deuterium background correction because of the anomalous splitting patterns for most elements in a magnetic field. In the standards addition mode of calibration, this phenomenon reduces Zeeman analytical sensitivity. The ability to accurately quantify lead by direct calibration as described is a distinct advantage in terms of analytical simplicity and sensitivity.

Analytical recovery experiments and control program performance confirm that this method of sample preparation and calibration produces accurate and precise data. Reconstituted lyophilized whole-blood controls and fresh blood performed equally well. Simple Triton-diluted blood samples did not compare well; fresh blood results were better than lyophilized controls, whether calibrated directly or by standards addition. Suppression of analyte signal, compared with that for a pure standard, was noted only when total sample dilution was less than fivefold. The ability to analyze a range of volumes of sample supernates without compromising accuracy makes this procedure very flexible in terms of analytical sensitivity.

Lead analysis of capillary blood samples reportedly has a positive bias due to contamination (*16*, *19*). As evidenced by our comparison of venous and capillary blood, and sequential capillary sampling, contamination is not a problem as long as a reasonably careful collection protocol is used.

We agree with Delves (*18*) that matrix suppression of the analyte signal, for a simple 10-fold Triton dilution of blood, warrants matrix matching of the standard curve. The fact that lyophilized controls yielded poorer recoveries than fresh blood against direct calibration is not surprising because of changes in the matrix. Although standards addition improved recoveries with lyophilized controls, recoveries were still low when compared with those for our method of sample preparation with direct calibration. Our method produces sensitive, accurate, and precise analytical data for venous or capillary blood samples.

The data obtained from 172 two- to three-year-old Vancouver children (*11*) reflect a geometric mean one-half that reported in a 1988 survey of urban Ontario school children, ages six years and younger (*20*). We contend that despite improvements in lead analysis, there is still a critical need for greater analytical accuracy and precision at lead values ≤0.48 μmol/L (10.0 μg/dL). Only then can meaningful clinical information be gathered on the effects of low-concentration lead in the developing child.

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