Recent Soil Intake Studies

1) Garlock, TJ; Shirai, JH; Kissel, JC. (1999) Adult responses to a survey of soil contact-related behaviors. J Expo Anal Environ Epidemiol 1(2):134-142.

2) Wong, EY; Shirai, JH; Garlock, TJ; et al. (2000) Survey of selected activities relevant to exposures to soils. Bull Environ Contam Toxicol 65(4):443-50.
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3) Wong, EY; Shirai, JH; Garlock, TJ; et al. (2000) Adult proxy responses to a survey of children's dermal soil contact activities. J Expo Anal Environ Epidemiol 10 (6 Pt 1):509-517.
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Garlock, TJ; Shirai, JH; Kissel, JC. (1999) Adult responses to a survey of soil contact-related behaviors. J Expo Anal Environ Epidemiol 1(2):134-142.

In order to better assess dermal exposures, a telephone survey instrument was developed to collect information from 901 private residences on certain behaviors relevant to dermal contact with soil and dust. The survey was called the Soil Contact Survey (SCS). Using random digit dialing, the Gilmore Research Group interviewed two separate populations during the summer of 1996. One sample consisted of residents within a 50 mile radius of the Hanford Nuclear Reservation in Washington and Oregon. The second sample was designed to be a national population sample. Each of these samples consisted of approximately 450 respondents, who identified themselves as being 18 years of age or older. The survey response rate was 61% of the households in the national sample and 70% of the households in the Hanford Nuclear Reservation sample (Table 1). These response rates were significantly different. Each interview lasted approximately 11 minutes. SPSS statistical software was used to conduct the statistical analyses.

The survey contained five major sections. The first section solicited information from adults on the incidence and frequency of participation for the last year (warm and cold weather months) in gardening, other yard work, outdoor team sports, and home projects involving digging. The respondents were also asked to recall the clothing usually worn while they participated in these activities and when they bathed or washed their hands following the activities. Percentages for the amount of total skin area potentially exposed to soil during the above activities were assigned using the clothing choices reported. The assumed percentages for exposed body surface areas assigned to each clothing choice are reported in Table 2.

In the second section of the survey, adults in households containing children less than 18 years of age provided information on the behavior of children, ages 5 to 17, in warm weather months. The researchers asked for information on the participation of children in outdoor play on bare soil, gardening or yard work, and organized outdoor team sports. The respondents were asked to describe the clothing worn by the children while they participated in these activities.

The third section of the survey solicited information on dermal exposure to soil resulting from employment. Researchers asked respondents if any adult household member worked in 1) farming or truck gardening, 2) professional gardening, landscaping or nursery work, or 3) outdoor construction involving digging or trenching. Researchers also asked respondents to provide information on the duration of the involvement on any of the above activities, the type of clothing worn, and post-activity hand washing and bathing.

The fourth section solicited information on the type of floor coverings in the residence, the presence of pets, and whether or not shoes were worn in the house. In the fifth section, respondents provided demographic data regarding their age, race, gender, socioeconomic status, level of education, type of dwelling, and proximity to the center of the city (Table 3). The largest percentage of respondents in both the Hanford and national samples identified themselves as white; however, statistically significant differences were observed between the two sample populations within four of the survey categories:

- the Hanford sample contained significantly more white respondents than the national sample;
- the national sample contained significantly more black respondents than the Hanford sample;
- the Hanford sample contained significantly more occupants of single-family residences than the national sample;
- and the Hanford sample contained significantly more respondents residing in small towns or rural areas than the national sample.

Table 4 summarizes participation rates for several selected activities for both the Hanford sample and the national sample. For both samples, the activity "yard work other than gardening" was the most common (77% for the Hanford sample, and 57% for the national sample). Statistically significant differences were found between the two sample populations for participation rates in all of the activities except team sports. In addition, significantly more respondents in the national sample reported participating in only one activity than respondents in the Hanford sample (Table 5).

Table 6 presents the 5th, 50th, and 95th percentiles of estimates of the percent of skin area exposed for each of the activities in both warm and cold weather months. It can be seen that the amounts of skin area exposed during each of the activities was much higher in the warm months than in the cold months for both sample populations. The only significant difference between the Hanford and national samples was the estimated percent of skin area unclothed in "other yard work" in cold-weather months. The duration of three of these activities (gardening, other yard work, and team sports) in both cold and warm months are presented in Table 7; for the remaining activity (home repair/digging), respondents were only asked to report the activity frequency in days/season (Table 8).

Table 9 presents bathing and hand washing patterns for the respondents participating in these activities. The table presents comparisons between both of the samples in the interval from the end of each activity until both hand washing and bathing. For hand washing, the only significant difference between the Hanford and national samples was for home repair/digging (12% more in the national sample reported washing their hands right away). For bathing, the national sample reported significantly more within an hour of yard work and home repair/digging than the Hanford sample.

Table 10 compares selected demographic data obtained by this survey to 1990 U.S. census data for the Hanford and national survey populations.

In dermal pathway exposure assessment a default estimate of 25% skin exposed is often used by risk assessors. However, median warm weather estimates of skin exposure during each of the activities presented in Table 6 exceed 25% in each case. In addition, exposure assessors often must decide whether to use exposure values specific to the population being studied or other data drawn from a separate population. In this study, the Hanford and national samples differed in reported participation in yard work other than gardening, gardening, and home construction or repair with digging.

A limitation of this study is that it is based on recall data. However, the data are captured over the period of one year. In addition, data are provided for national estimates. Since dermal exposure to soil is assumed to continue until the soil is removed from the skin, data provided in Table 9 on bathing and hand washing patterns are very useful.

Table 1. Survey Response Rates

Interview Result	Hanford (%)	National (%)	Difference (%)	*p*-Value[a]
Completed	70.5	61.4	9.1	<0.001
Refused	19.2	28.9	-9.7	
Unavailable	6.8	7.9	-1.1	
Terminated	3.5	1.8	1.7	

a Comparison of Hanford and National responses by chi-square test of 2x4 contingency table.

Source: Garlock, et al., 1999.

Table 2. Assumed Body Surface Area Percentages

Clothing Response	Area Assumed Exposed	Percent[a] of Total Adult Body	
		M	F
Long pants		0	0
Short pants	lower ½ of thigh + upper ½ of lower leg	16	16
Long sleeves		0	0
Short sleeves	forearms	6	6
No shirt (males)	3/4 trunk + arms	41	–
Halter (females)	½ trunk + arms	–	31
High socks		0	0
Low socks	1/4 lower leg	3	3
No socks	bottom half of lower leg	6	6
Shoes		0	0
No shoes or sandals	feet	7	7
Gloves		0	0
No gloves	hands	5	5
Hat or no hat	1/3 head for face	3	3
Maximum exposure		78	68
Unexposed		22	22

a After Anderson et al. (1985).

Source: Garlock, et al., 1999.

Table 3. Demographic Comparison of Sample Populations

Category	Hanford	National	Difference	*p*-Value[a]
Gender				
Male	45	50	-5	0.19
Female	55	50	5	
Age				
18 to 24	7	13	-6	0.08
25 to 34	20	19	1	
35 to 44	26	23	3	
45 to 54	17	16	1	
55 to 64	14	14	0	
≥65	16	14	2	
Percent who report their ethnicity as...				
White	89	81	8	<0.001
Black	<1	10	-10	
Asian	<1	2	-2	
Native American	3	1	2	
Other	6	5	0	
Percent who also describe themselves as Hispanic:				
	8	8	0	>0.20
Percent who report their residential area as...				
Urban	13	22	-9	<0.001
Suburban	10	29	-19	
Small town	45	30	15	
Rural	31	17	14	
Percent who report their type of residence as...				
SFD[b]	82	76	6	0.002
Duplex/triplex	3	5	-2	
Apt/condo	8	14	-6	
Other	7	5	2	
Percent who report their level of education as...				
High school	39	41	-2	0.005
Trade school	3	5	-2	
Some college	35	25	10	
4-Year degree	13	18	-5	
Some graduate	1	2	-1	
Graduate degree	8	8	0	

a Comparison of Hanford and National responses by chi-square tests of contingency tables.
b Single-family dwelling.

Source: Garlock, et al., 1999.

Table 4. Reported Adult Participation Rates

Activity	Hanford Doers (%)	National Doers (%)	Difference (%)	*p*-Value[a]
Gardening	65	52	13	<0.001
Other yard work	77	57	20	<0.001
Repair/digging	30	18	12	<0.001
Team sports	18	19	-1	>0.20
Any activity	89	79	10	<0.01

a Comparison of Hanford and National responses by chi-square tests of contingency tables.

Source: Garlock, et al., 1999.

Table 5. Number of Selected Activities Reported

Number of Activities	Hanford Doers (%)	National Doers (%)	Difference (%)	*p*-Value[a]
1	26	42	-16	<0.001
2	41	37	4	
3	26	18	8	
4	7	4	3	

a Comparison of Hanford and National responses by chi-square test of 2x4 contingency tables.

Source: Garlock, et al., 1999.

Table 6. Estimated Skin Exposure Among Doers

Activity/Season	Skin Area Exposed (%)								
	Hanford				National				
	n	5th Percentile	Median	95th Percentile	*n*	5th Percentile	Median	95th Percentile	*p*-Value[a]
Gardening									
Cold months	36	3	3	14	31	3	8	33	>0.2
Warm months	273	9	33	68	211	3	33	69	>0.2
Other yard work									
Cold months	112	3	3	12	73	3	3	31	0.02
Warm months	329	8	31	68	245	8	33	68	>0.2
Team sports									
Cold months	20	3	8	30	26	3	8	33	>0.2
Warm months	77	14	33	68	71	14	33	43	>0.2
Repair/Digging									
Cold months	33	3	3	14	15	3	3	14	>0.2
Warm months	112	6	28	67	65	9	28	67	>0.2

a Comparison of Hanford and National sample responses by Wilcoxon rank sum test.

Source: Garlock, et al., 1999.

Table 7. Reported Activity Duration Among Doers of Three Activities

Activity/Season	Activity Duration (hrs/month)								p-Value[a]
	Hanford				National				
	n	5th Percentile	Median	95th Percentile	n	5th Percentile	Median	95th Percentile	
Gardening									
Cold months	33	1	4	17	33	1	9	74	0.009
Warm months	274	2	17	87	207	2	13	65	>0.2
Other yard work									
Cold months	108	1	4	22	76	2	9	65	0.0001
Warm months	333	3	13	65	246	3	13	65	>0.2
Team sports									
Cold months	19	4	17	45	28	1	13	78	0.17
Warm months	79	4	17	89	73	3	17	79	>0.2
Totals[b]									
Cold months	129	1	6	31	106	2	9	130	0.001
Warm months	378	4	27	126	337	4	22	108	0.013

a Comparison of Hanford and National sample responses by Wilcoxon rank sum test.
b Totals for doers of any of gardening, other yard work, and outdoor team sports only (does not include home repair with digging).

Source: Garlock, et al., 1999.

Table 8. Reported Activity Frequency Among Home Repair/Digging Doers

Season	Activity Frequency (event days/season)								
	Hanford				National				
	n	5th Percentile	Median	95th Percentile	*n*	5th Percentile	Median	95th Percentile	*p*-Value[a]
Cold months	33	1	4	24	14	1	3	35	>0.2
Warm months	109	1	6	31	60	1	4	28	>0.2

a Comparison of Hanford and National sample responses by Wilcoxon rank sum test.

Source: Garlock, et al., 1999.

Table 9. Reported Bathing and Hand Washing Patterns

	Hanford	National	Difference	*p*-Value[a]
All Activities - Percent Who Report Washing Hands Right Away				
Gardening	95	99	-4	0.11
Yard work	94	97	-3	0.18
Team sports	72	79	-7	>0.20
Repair/digging	85	97	-12	0.01
After Gardening - Percent Who Report Bathing...				
Within 1 hour	34	41	-7	0.13
Later same day	56	53	3	
Next day	8	5	3	
After Yard Work - Percent Who Report Bathing...				
Within 1 hour	39	55	-16	<0.001
Later same day	53	42	11	
Next day	8	3	5	
After Sports - Percent Who Report Bathing...				
Within 1 hour	41	49	-8	>0.20
Later same day	54	43	11	
Next day	2	3	-1	
After Home Repair/Digging - Percent Who Report Bathing...				
Within 1 hour	35	53	-18	0.03
Later same day	54	46	012	
Next day	2	1	4	

a Comparison of Hanford and National responses by chi-square tests of contingency tables.

Source: Garlock, et al., 1999.

Table 10. Comparison of SCS and U.S. Census Demographic Data

Category	Hanford[a] Census Data	Hanford SCS	*p*-Value[c]	National[b] Census Data	National SCS	*p*-Value[c]
Gender						
Male	50	45	>0.20	49	50	>0.20
Female	50	55		51	50	
Age Ranges (years)						
18-24	13	7	<0.01	14	13	0.02
25-34	22	20		23	19	
35-44	21	26		20	23	
45-54	14	17		14	16	
55-64	11	14		11	14	
>65	18	16		17	14	
Race						
White	82	89	<0.01	80	81	0.17
Black	1	<1		12	10	
Asian/Pacific Isle	1	<1		3	2	
Native American	2	3		1	1	
Other	13	6		4	5	
Ethnic Background						
Latino/Hispanic	17	8	>0.20	9	8	>0.20

a The Hanford census data sample was 21.2% of the entire population of the eight counties included in the Soil Contact Survey
b The National census data sample was 15.5% of the entire U.S. population.
c Comparison of SCS and U.S. census samples of chi-square tests of contingency tables.

Source: Garlock, et al., 1999.

Wong, EY; Shirai, JH; Garlock, TJ; et al. (2000) Survey of selected activities relevant to exposures to soils. Bull Environ Contam Toxicol 65(4):443-50.
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Wong et al. (2000) presented selected data gathered in the 1996 Soil Contact Survey (SCS-I) that are of potential interest to exposure assessors, but that have not yet been incorporated in soil contact rate estimations. The SCS-I collected data on multiple activities relevant to the evaluation of residential exposure to soil, in order to provide insight into behaviors relevant to exposure to dust and soils that are not currently well characterized in literature. In this paper, selected data were presented on:

- the frequency of consumption of homegrown produce,
- the frequency of shoe removal prior to residence entry,
- the type of floor covering,
- the presence of indoor/outdoor pets,
- the occurrence of bare yard soil, and
- residential proximity to vacant lots or fields.

The consumption of home grown produce is of concern because local soil contamination may lead to elevated exposures, and shoe removal has been hypothesized to reduce soil track-in. Type of floor coverings may also be important in assessing exposure to dust, as carpets appear to act as storage reservoirs for pertinent contaminants. Pets with access to both the outdoors and indoors may accumulate soil and dust in their fur and assist children with access to soil by digging up dirt outdoors. The occurrence of bare soil in yards provide easy access to soil, and residential proximity to vacant lots represents another opportunity for exposure to bare soils.

The SCS-I was administered using a computer-assisted telephone instrument (CATI) in the summer of 1996. Random digit dialing was used to attempt to obtain a nationally representative sample. A total of 450 households was surveyed on behavior that could potentially lead to dermal soil exposure. Respondents were required to be 18 years old or older. The survey was comprised of questions regarding the residential activities of both adults and children, as well as clothing and bathing choices. Statistical analyses were performed using SPSS for Windows, version 8.0. Chi-square contingency tables were used to compare demographic characteristics and to test for trends in participation in one or more of the selected activities.

Table 1 shows the consumption of homegrown fruits and vegetables. Almost 50% of the households sampled reported gardening, and three-quarters of these gardening households reported eating homegrown produce. Most of the households that ate homegrown produce reported eating at least two types of produce (55%), while 44% only ate homegrown produce within one of the three categories on the survey. Regular shoe removal prior to entry to the residence was reported by about 40 percent of all respondents

(Table 2). Carpets and rugs were the dominant floor covering in about two-thirds of the households. As shown in Table 3, almost half of the households with children respondents reported to have bare spots in their yards; the majority reported a vacant lot or field within walking distance of the home. Indoor/outdoor dogs and cats were reported by about one-third of the households (Table 4). The authors compared shoe removal and pet ownership because both may influence the track-in of outdoor soil. Table 5 presents the co-occurrence of shoe removal and indoor/outdoor pets. No significant trend was found in this comparison, although about one-third of respondents reporting regular removal of shoes prior to entry also reported the presence of a pet with access to both indoors and outdoors. In addition, no significant trend was found when shoe removal habits were compared with floor coverings, suggesting that the decision to remove shoes on entry is independent of floor covering (Table 6).

The benefit of this research is that it addresses concerns that probabilistic exposure and risk assessments lack the knowledge of correlation among exposure variables. The authors therefore focused on patterns of consumption of multiple forms of homegrown produce and the apparent independence of shoe removal and either pet ownership or floor covering.

Table 1. Consumption of Homegrown Fruits and Vegetables

Response	n	%[a]	% National[b]
Tree fruit only	7	3.2	1.6
Root vegetables only	2	0.9	0.4
Other vegetables only	64	29.2	14.2
Tree fruit & root vegetables	1	0.5	0.2
Tree fruit & other vegetables	13	5.9	2.9
Root & other vegetables	41	18.7	9.1
Tree fruit, root & other vegetables	36	16.4	8.0
None of the above	55	25.1	12.2
Total	**219**	**100.0**	**48.7**

[a] Percent of gardeners (n = 219).

[b] Percent of total sample (n = 450).

Source: Wong et al., 2000.

Table 2. Home and Family Characteristics

Response	N	%
Shoe Removal		
Regular removal of shoes at entry	175	38.9
Street shoes regularly worn indoors	209	46.4
Both/varies	65	14.4
Don't know/refused	1	0.2
Total	**450**	**100.0**
Primary Floor Covering		
Area rugs	26	5.8
Wall-to-wall carpeting	273	60.7
Bare wood	57	12.7
Equal rugs/carpet and bare wood	82	18.2
Other	8	1.8
Don't know/refused	4	0.9
Total	**450**	**100.0**

Source: Wong et al., 2000.

Table 3. Children's Potential Access to Soil[a]

Response	n	%	% National[b]
Bare Soil in Yard			
Yes	80	44.7	17.8
No	97	54.2	21.6
Don't know/refused	2	1.1	0.4
Total	**179**	**100.0**	**39.8**
Vacant Lots or Fields Within Walking Distance			
Yes	114	63.7	25.3
No	63	35.2	14.0
Don't know/refused	2	1.1	0.4
Total	**179**	**100.0**	**39.8**

[a] Asked only of households with children under 18 (n = 179).

[b] Percent of all households (n = 450).

Source: Wong et al., 2000.

Table 4. Pets Which Spend Time Both Inside and Outside the Home

Response	n	% of Category	% National[a]
Presence of Indoor/Outdoor Pets			
At least one I/O dog	111	54.7	24.7
At least one I/O cat	35	17.2	7.8
I/O cat(s) and dog(s)	17	8.4	3.8
Pets, but always indoors	22	10.8	4.9
Pets, but always outdoors	18	8.9	4.0
No pets	246	–	54.7
Don's know/refused	1	–	0.2
Total	**450**	**100.0**[b]	**100.0**
Number of Indoor/Outdoor Dogs			
One	86	67.2	19.1
Two	29	22.7	6.4
Three	8	6.3	1.8
Four	2	1.6	0.4
Five	2	1.6	0.4
More than five	1	0.8	0.2
Total	**128**	**100.0**[c]	**28.4**
Number of Indoor/Outdoor Cats			
One	36	69.2	8.0
Two	7	13.5	1.6
Three	5	9.6	1.1
Four	3	5.8	0.7
Five	1	1.9	0.2
More than five	0	0.0	0.0
Total	**52**	**100.0**[d]	**11.6**

[a] Percent of national sample (n = 450).

[b] Percent of households with pets (n = 203).

[c] Percent of households with indoor/outdoor dogs (n = 128).

[d] Percent of households with indoor/outdoor cats (n = 52).

Source: Wong et al., 2000.

Table 5. Co-Occurrence of Shoe Removal and Indoor/Outdoor Pets

Indoor/Outdoor Pets	Removal of Shoes										
	Yes			No			Mixed Behavior			DK/R[b]	
	n	% Doer	% Nat.[a]	n	% Doer	% Nat.	n	% Doer	% Nat.	n	Total n
At least one I/O dog	39	22.3	8.7	51	24.4	11.3	21	32.3	4.7		111
At least one I/O cat	15	8.6	3.3	15	7.2	3.3	5	7.7	1.1		35
I/O cat(s) and dog(s)	6	3.4	1.3	11	5.3	2.4	0	0.0	0.0		17
Pets, but always indoors	9	5.1	2.0	8	3.8	1.8	5	7.7	1.1		22
Pets, but always outdoors	6	3.4	1.3	10	4.8	2.2	2	3.1	0.4		18
No pets	100	57.1	22.2	114	54.5	25.3	32	49.2	7.1		246
Don't know/refused	0			0			0			1	1
Total	**175**	**100.0**	**38.9**	**209**	**100.0**	**46.4**	**65**	**100.0**	**14.4**	**1**	**450**

[a] Percent of national sample (n = 450).

[b] Don't know/refused.

Source: Wong et al., 2000.

Table 6. Co-Occurrence of Shoe Removal and Floor Covering

Primary Floor Covering	Removal of Shoes										
	Yes			No			Mixed Behavior			DK/R[b]	
	n	% Doer	% Nat.[a]	n	% Doer	% Nat.	n	% Doer	% Nat.	n	Total n
Area rugs	12	6.9	2.7	9	4.3	2.0	5	7.7	1		26
Wall-to-wall carpeting	104	59.4	23.1	130	62.2	28.9	39	60.0	8.7		273
Bare wood	23	13.1	5.1	28	13.4	6.2	6	9.2	1.3		273
Equal carpet/wood	33	18.9	7.3	35	16.7	7.8	14	21.5	3.1		82
Other	3	1.7	0.7	4	1.9	0.9	1	1.5	0.2		8
Don't know/refused	0			3	1.4	0.7	0			1	4
Total	**175**	**100.0**	**38.9**	**209**	**100.0**	**46.4**	**65**	**100.0**	**14.4**	**1**	**450**

[a] Percent of national sample (n = 450).

[b] Don't know/refused.

Source: Wong et al., 2000.

Wong, EY; Shirai, JH; Garlock, TJ; et al. (2000) Adult proxy responses to a survey of children's dermal soil contact activities. J Expo Anal Environ Epidemiol 10 (6 Pt 1):509-517.
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Wong et al. (2000) reported selected results from two national telephone surveys, the Soil Contact Survey I (SCS-I) and II (SCS-II). The first survey, SCS-I, was conducted in 1996 and primarily addressed adult behaviors. SCS-II was administered between October 1998 and April 1999, and was designed to provide information on children's outdoor activities. This paper specifically focused on children's dermal contact with soil, reporting the data on the usual clothing worn by children for outdoor, warm-weather activities from SCS-I, and the data on children's dermal soil contact activities from SCS-II.

Both surveys were conducted using a computer-assisted telephone instrument (CATI), and random digit dialing was used to attempt to obtain a nationally representative sample. Respondents were required to be 18 years of age or older; and each adult served as a surrogate for a randomly chosen child within the household under the age of 18. For households with more than one child, each was assigned a random number, and the child with the highest random number was chosen for the survey. Statistical analyses were performed using SPSS for Windows, version 8.0. Chi-square contingency tests were used for comparisons.

SCS-I was administered to approximately 450 adults, resulting in a child population of 211, and had several sections, including a section pertaining to children's clothing choices for outdoor activities during warm weather months, and a section on household demographics.

To provide a base, SCS-II was initially administered to randomly chosen households until the sampling target of 500 adults had been exceeded. Oversampling for children was then conducted in additional households, until the child (by proxy) sampling target of 500 had also been exceeded. During the oversampling portion of the survey, questions on adult activities were skipped, but demographic data were still collected. A total of 680 households with children were included in SCS-II: 549 completed responses in the SCS-II base survey (197 respondents with children) and 483 completed child (by proxy) responses in the SCS-II oversample. SCS-II was broken into four main sections: 1) introductory material describing the purpose of the survey; 2) questions relating to adult activities, including time to the next shower, bath or hand wash after outdoor activities; 3) questions relating to children's activities; including the frequency of bathing and hand-washing; and 4) demographic data.

Three-quarters (73.5%) of the SCS-II respondents reported that the child in their household played outdoors on bare dirt or mixed grass/bare dirt, and the majority (57.8%) of these children played outdoors in both seasons (Table 1). The play frequency and duration of play for all children reported to play outdoors is shown in Table 2. The median frequency of outdoor play was 7 and 3 days/week in warm and cold weather, respectively. The median outdoor play duration was 3 hours/day in warm weather and 1 hour/day in cold weather. Of the children reported not to play outdoors, most were $\leq$ 1 year or $\geq$ 14 years of age, regardless of gender (Figures 1 and 2).

Hand washing for children that played outdoors, was reported to occur four times per day (median

frequency) in both cold and warm weather (Table 3). The frequency of bathing for these children was reported to be seven times per week, also in both cold and warm weather.

Based on reported clothing choices for children's outdoor activities during warm weather from SCS-I, a distribution for exposed body surface areas was generated (Table 4). Table 5 shows the mean, median, and arithmetic standard deviation for skin area exposed, based on clothing choice, for play, gardening/yardwork, and organized team sports. The lowest estimates for skin area exposed were for organized team sports, due to a higher fraction of that group reporting wearing shoes and high socks.

A limitation of this study is that it was based on recall data, sometimes about activities in prior seasons; an additional possible source of error is the use of surrogate or proxy respondents for data on the activities of children in their household.

Table 1. Number and percentage of respondents with children and those reporting outdoor play[a] activities in both warm and cold weather

	Respondents with children	Child players[a]		Child non players		Warm weather player[b]	Cold weather player	Player in both seasons
	n	n	%	n	%	n	n	(%)
SCS-II base	197	128	65.0	69	35.0	127	100	50.8
SCS-II oversample	483	372	77.0	111	23.0	370	290	60.0
Total	680	500	73.5	180	26.5	497	390	57.4

[a] "Play" and "player" refer specifically to participation in outdoor play on bare dirt or mixed grass and dirt.

[b] Does not include three "Don't know/refused" responses regarding warm weather play.

Source: Wong et al. (2000).

Table 2. Play frequency and duration for all child players from SCS-II

	Cold weather			Warm weather		
	Frequency (days/week)	Duration (hours/day)	Total (hours/week)	Frequency (days/week)	Duration (hours/day)	Total (hours/week)
n	372	374	373	488	479	480
5th percentile	1	1	1	2	1	4
50th percentile	3	1	5	7	3	20
95th percentile	7	4	20	7	8	50

Source: Wong et al. (2000).

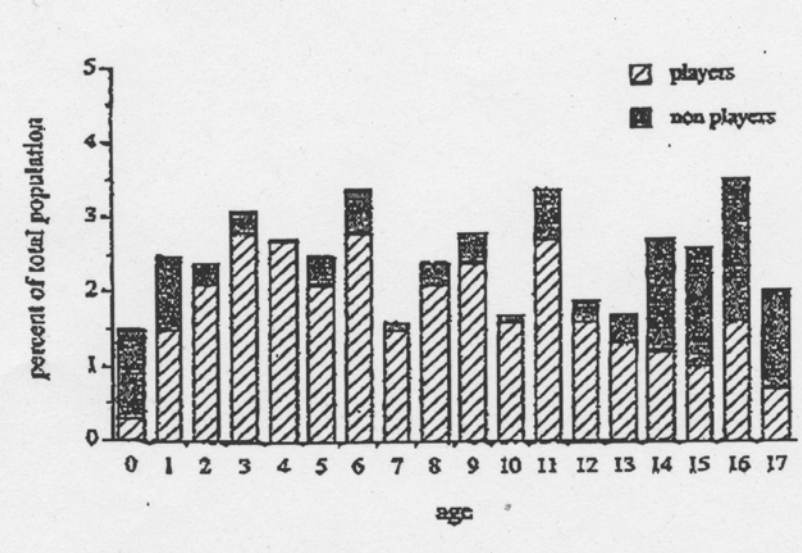

Figure 1. Age breakdown of female children reported to play (player) or not play (non player) outdoors on bare dirt or mixed grass and bare dirt surfaces from SCS-II.

Source: Wong et al. (2000).

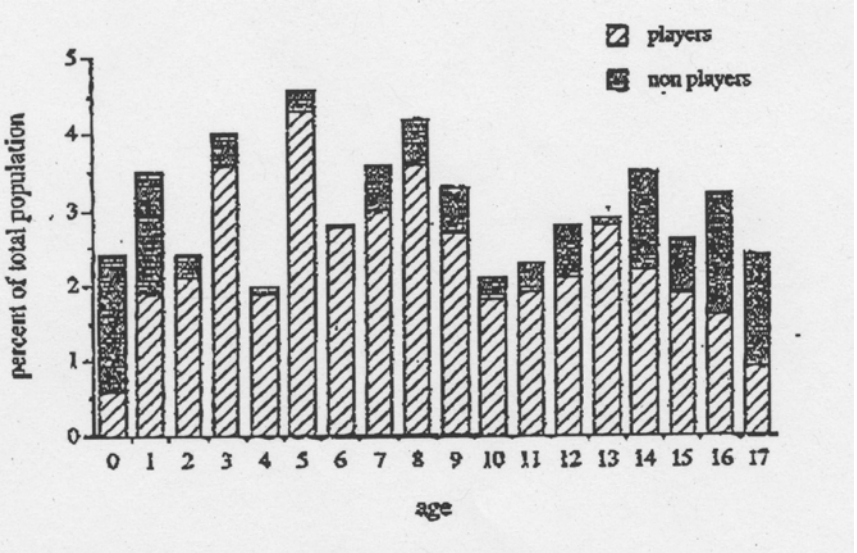

Figure 2. Age breakdown of male children reported to play (player) or not play (non player) outdoors on bare dirt or mixed grass and bare dirt surfaces from SCS-II.

Source: Wong et al. (2000).

Table 3. Hand washing and bathing frequency for all child players from SCS-II

	Cold weather		Warm weather	
	Hand washing (times/day)	Bathing (times/week)	Hand washing (times/day)	Bathing (times/week)
n	329	388	433	494
5th percentile	2	2	2	3
50th percentile	4	7	4	7
95th percentile	10	10	12	14

Source: Wong et al. (2000).

Table 4. Clothing choices and assumed body surface areas exposed

Clothing response	Area assumed exposed	% of total body surface area[a]	
		Male	Female
Long pants		0	0
Short pants	lower ½ thigh and upper ½ of lower leg	13	13
Long sleeves		0	0
Short sleeves	forearms	6	6
No shirt (males)	3/4 trunk and arms	38	n/a
Halter (females)	½ trunk and arms	n/a	30
High socks		0	0
Low socks	1/4 lower leg	3	3
No socks	bottom half lower leg	6	6
Shoes		0	0
No shoes or sandals	feet	7	7
Gloves		0	0
No gloves	hands	6	6
Hat or no hat	1/3 head for face	5	5
Maximum exposure		75	67

[a] After U.S. EPA (Environmental Protection Agency). (1985) Development of statistical distributions or ranges of standard factors used in exposure assessments. Office of Health and Environmental Assessment, Washington, D.C., NTIS PB85-242667.

Source: Wong et al. (2000).

Table 5. Estimated skin surface exposed during selected warm-weather outdoor activities, based on expressed clothing choices from SCS-I

	Skin area exposed (% of total)		
	Play[a]	Gardening/yard work[b]	Organized team sports[c]
Mean	38.0	33.8	29.0
Median	36.5	33.0	30.0
SD	6.0	8.3	10.5

[a] Age group = <5 years; n = 41 (14 male, 22 female, 5 not recorded).

[b] Age group = 5-17 years; n = 47 (11 male, 18 female, 18 not recorded).

[c] Age group = 5-17 years; n = 65 (25 male, 13 female, 27 not recorded).

Source: Wong et al. (2000).