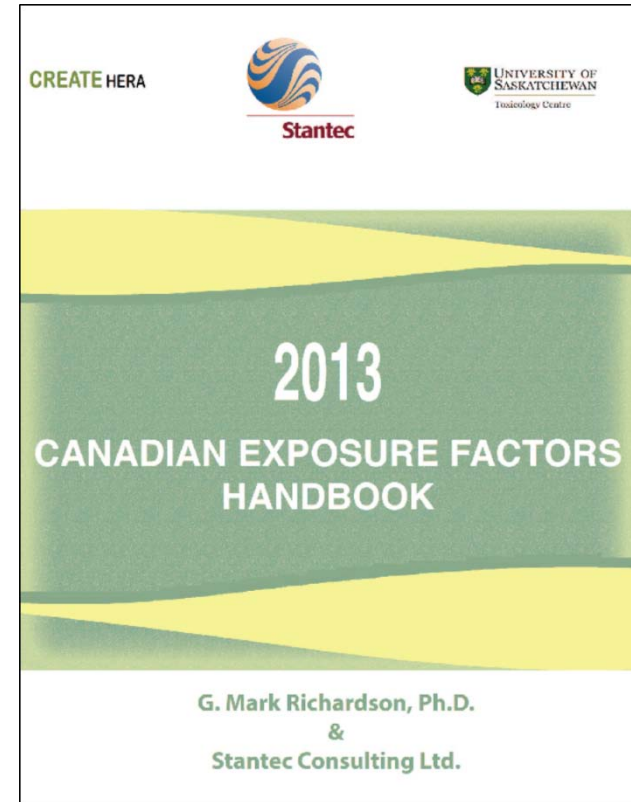


Updated Canadian Human Exposure Factors for Risk Assessment

G. Mark Richardson

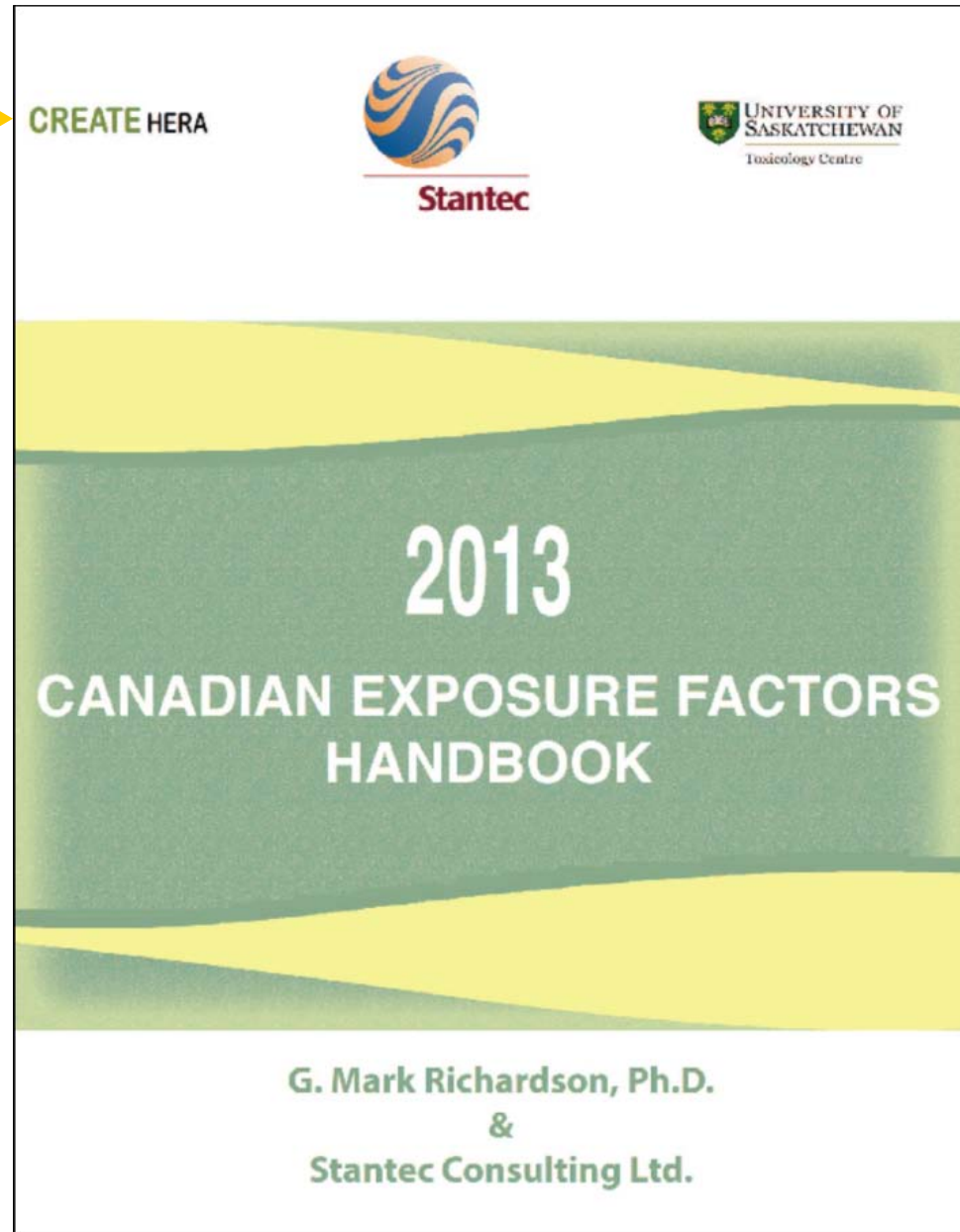


RPIC Federal Contaminated Sites National Workshop

Ottawa, ON, April 2014



Collaborative Research
And Training Experience –
Human and Ecological
Risk Assessment



<http://www.usask.ca/toxicology/docs/cef>

Data to be discussed

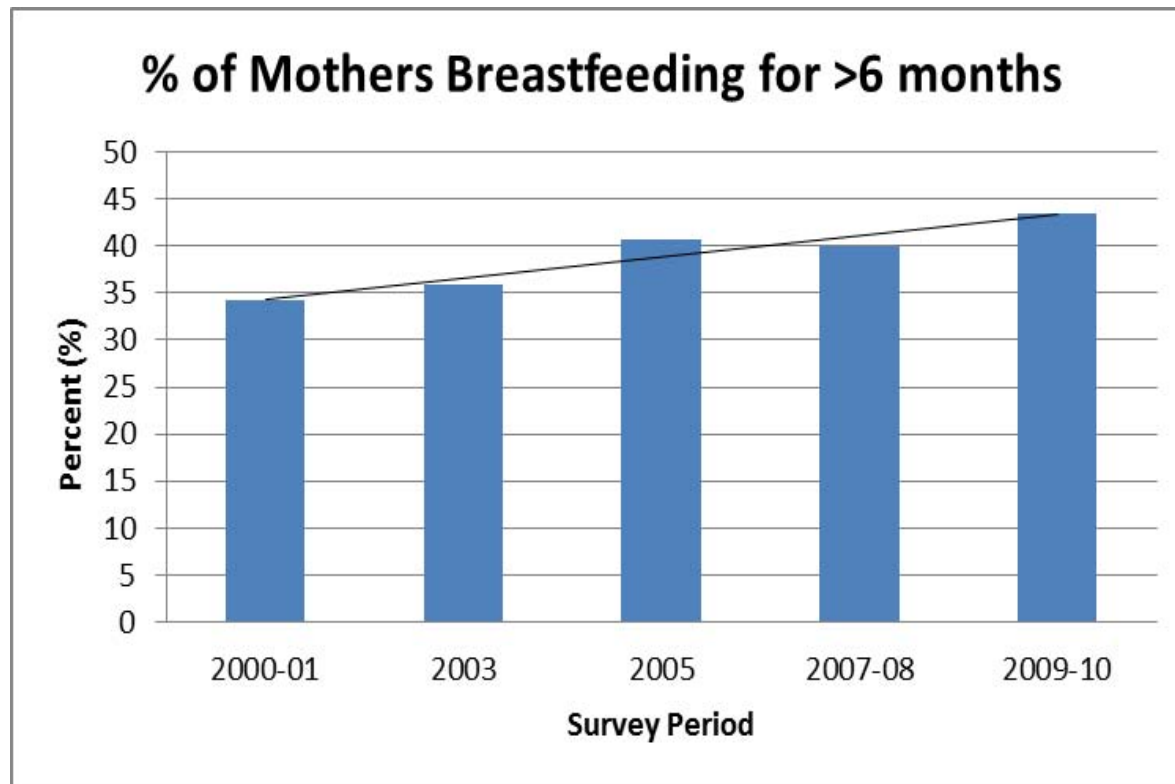
- Age groups
- Life expectancy/average age at death
- Body weight
- Body surface area
- Inhalation rate
- Time-activity
- Soil ingestion rate

Recommended age groups and ranges

“Exposure to environmental substances may change substantially over the course of an individual’s lifetime, as a result of variations in medium-specific intakes, activities and physical attributes with age.” (HC 1994)

Age Group	Unique exposure considerations	HC (1988, 1994) Richardson (1997) HC (2004, 2010, 2012) CCME (2006)	2013 CEFH
Infant	breast feeding	0 to 6 months	0 to 11 months (< 1 year)
Toddler	mouthing behavior	7 months to 4 years	1 to 3 years
Child	institutionalized education (K- gr 5)	5 to 11 years	4 to 11 years
Teen	Between child and adult	12 to 19 years	12 to 19 years
Adult	long term low level exposures; consumer prods	≥ 20 years	20 to 64 years
Senior	Sensitive age grp	60+ years	65+ years

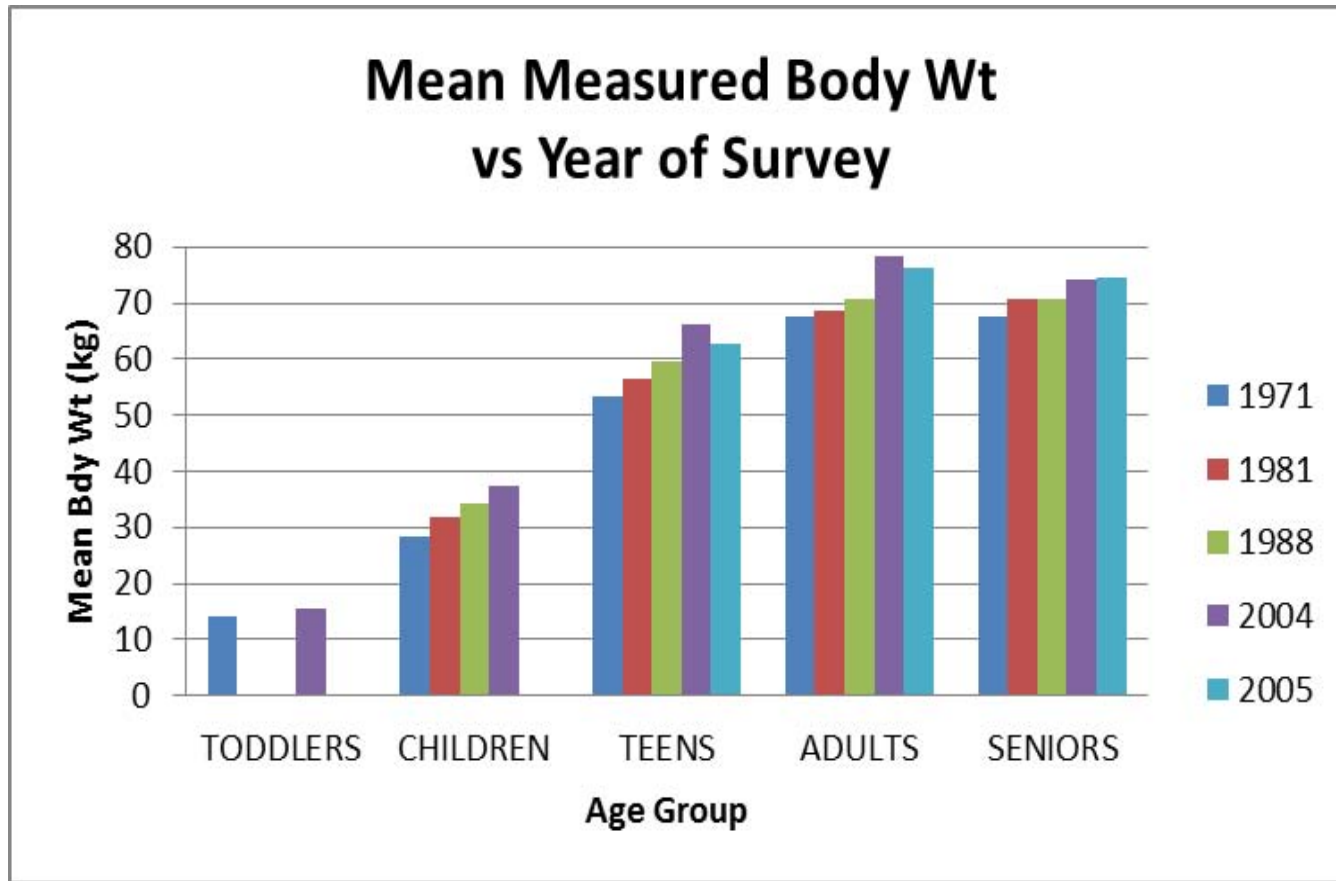
Percent of Canadian mothers with infants who breastfed > 6 months.



Average life expectancy versus average age at death in Canada.

Year	Average life expectancy from birth ^{1,2} (years)	Average life expectancy from age 65 ^{1,2} (years)	Average age at death ³ (years)
1990			70.9
1996-98	78.6	83.2	
1998-2000	79.0	83.5	
2000-02	79.6	83.9	
2002-04	80.0	84.2	
2004-06	80.5	84.7	
2005			74.2
2006-08	80.9	85.0	

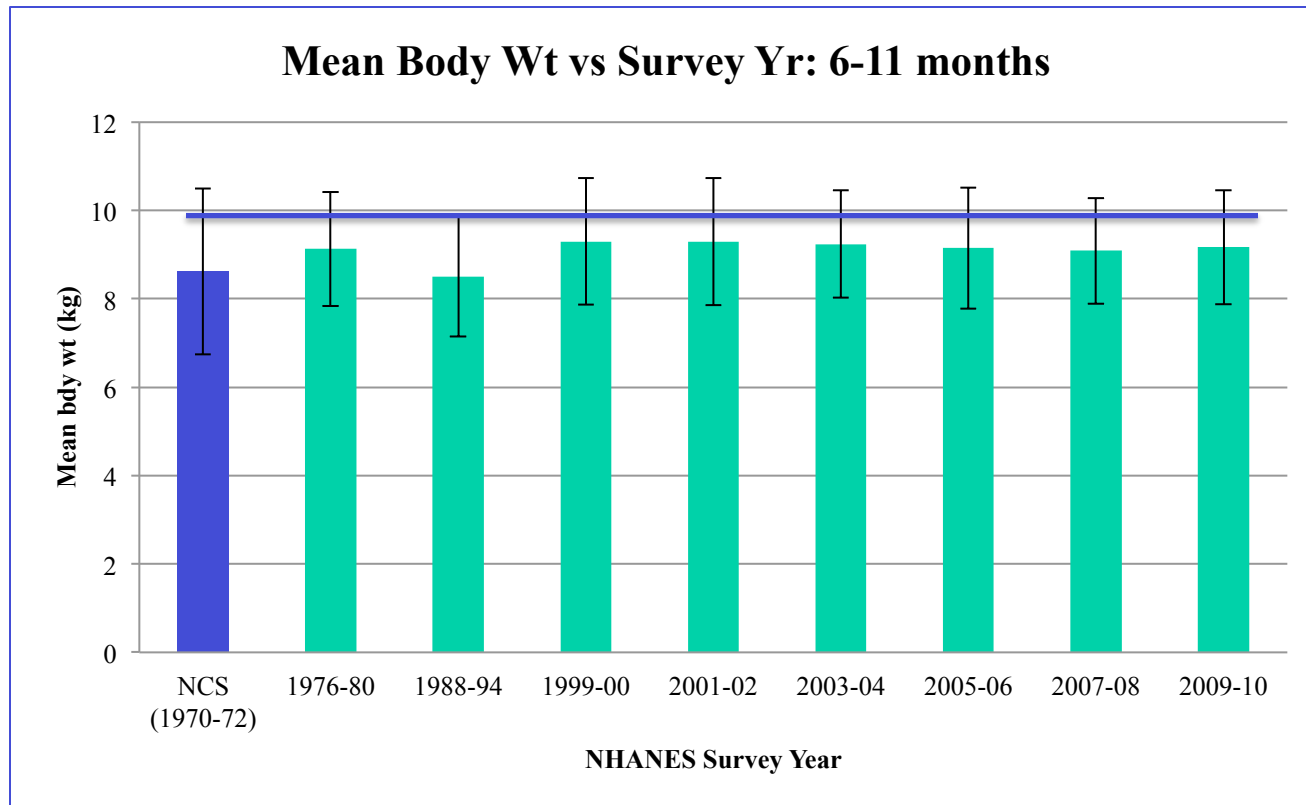
Average body weight is increasing for children, teens and adults



Average body weight is not increasing for infants or toddlers

Error introduced in 1997 Compendium

Mean Infant body weight by year of US NHANES survey

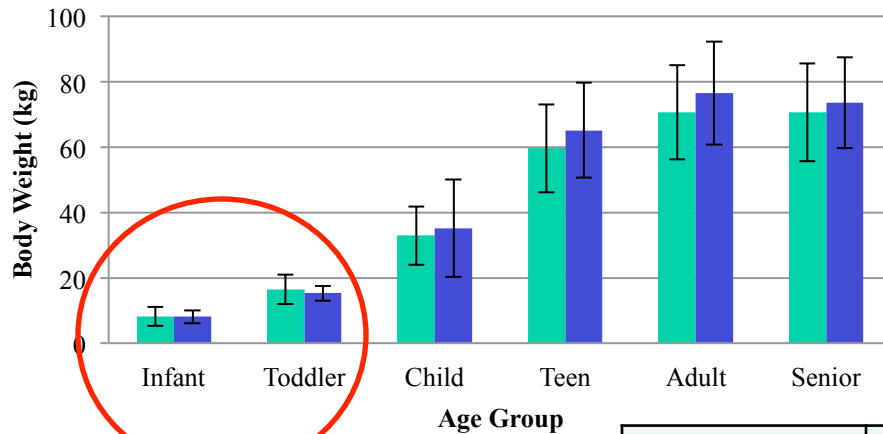


Notes:

1. data for 6 – 11 month olds only, to match minimum age for NHANES II (78-80).

Body wts – 2013 vs 1997

Average Body Weights

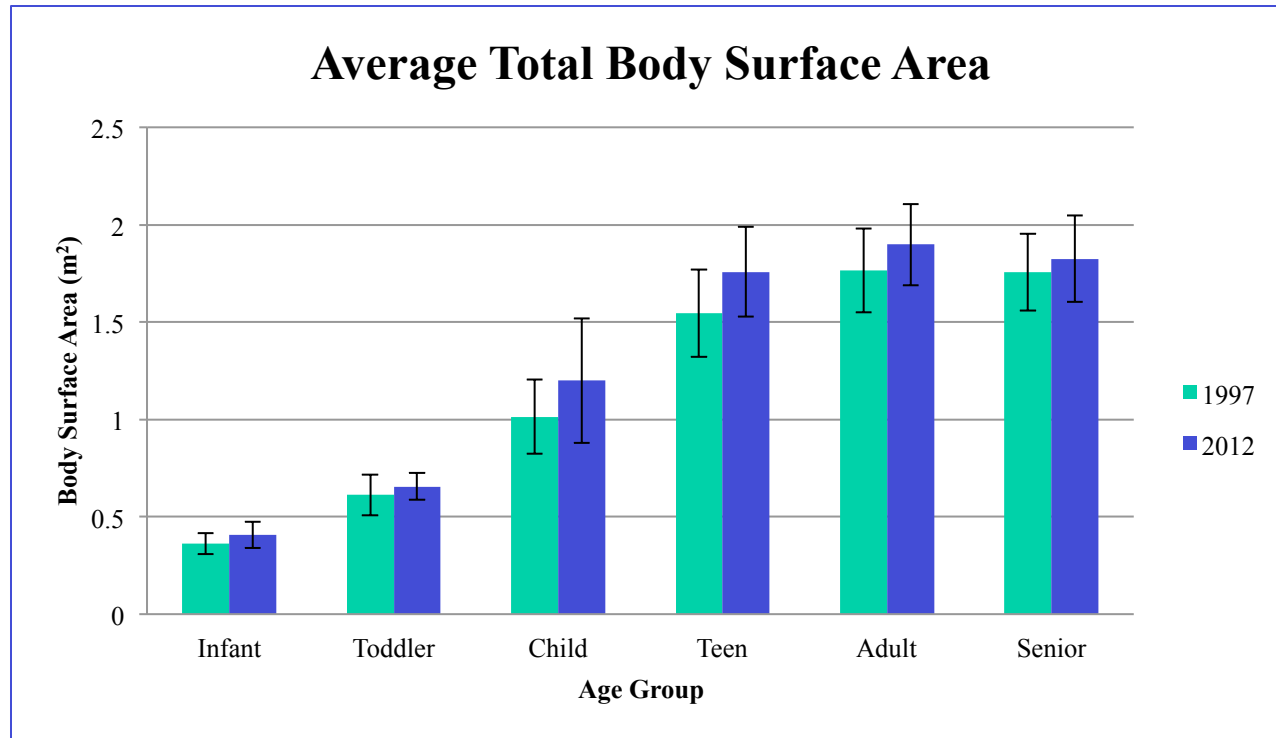


	1997	2013	
		Old ages	New ages
Infant (kg)	8.2	6.9	8.1
Toddler (kg)	16.5	15.2	15.3
Child (kg)	32.9	39.3	35.2
Teen (kg)	59.7	65.2	
Adult (kg)	70.7	76.5	
Senior (kg)	70.6	73.6	

↓ 15.9%

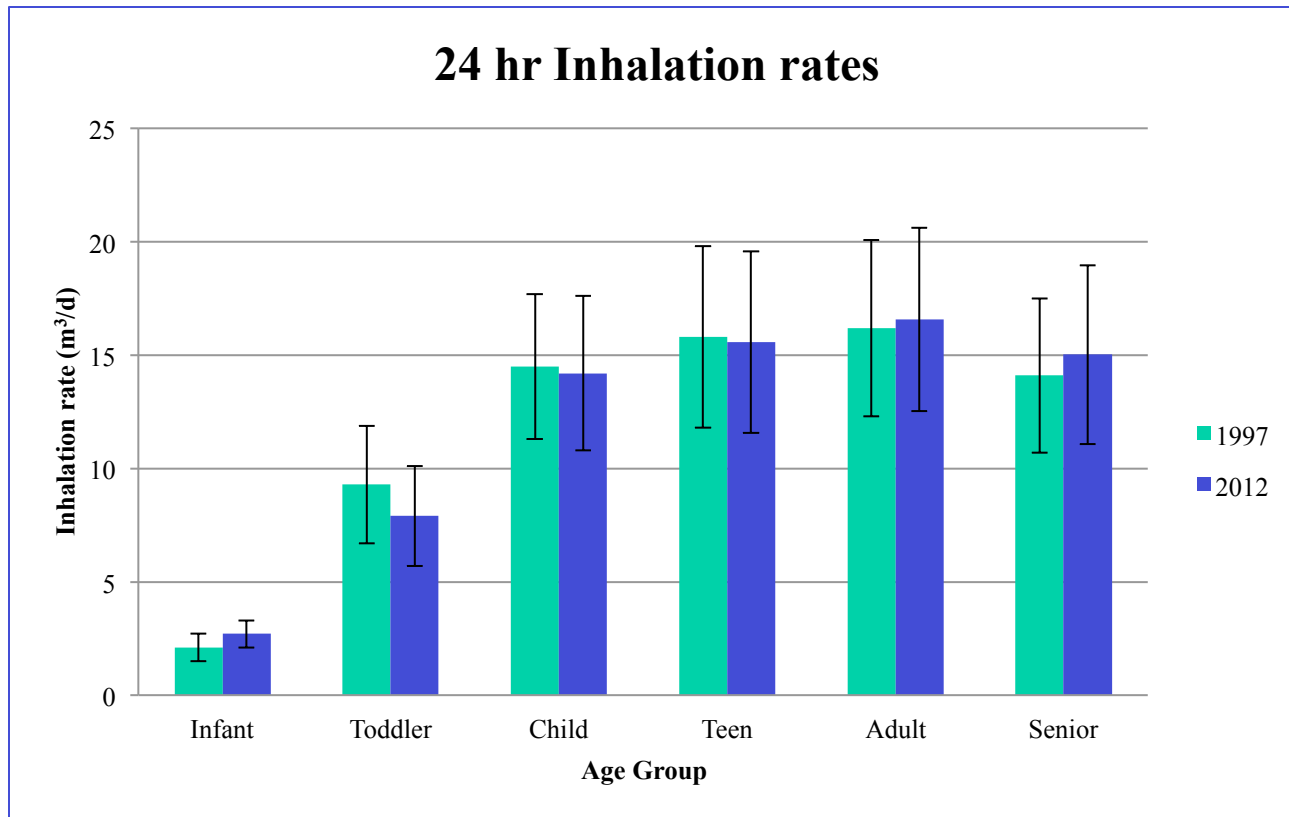
↓ 7.2%

Body surface area – 2013 vs 1997

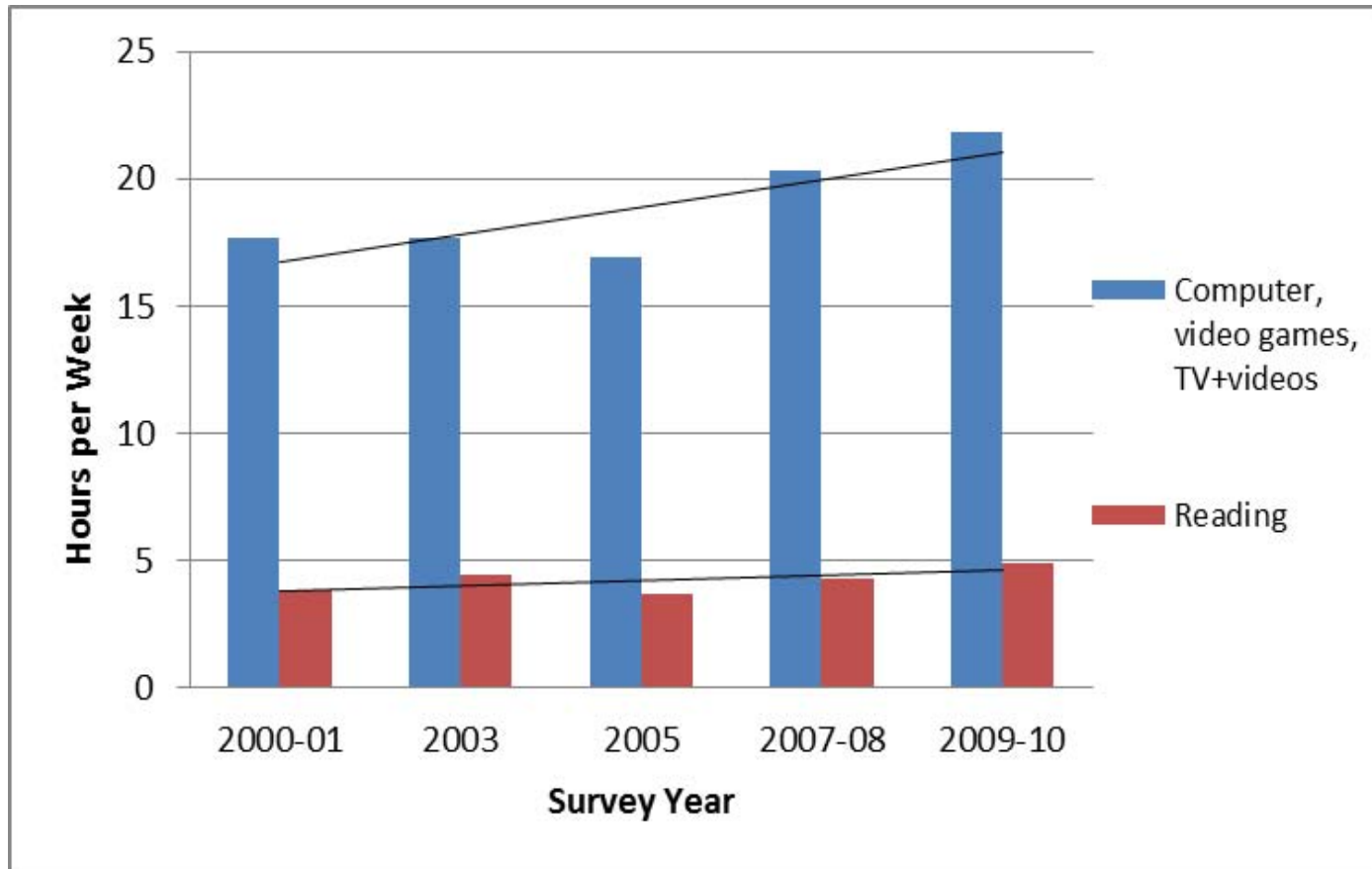


Inhalation rates – 1997 vs 2013

- 1997 inhalation rates based on Allan & Richardson 1998;
- 2013 rates based on Allan et al. 2008, with modifications to reflect altered age ranges for Infants, Toddlers and Children.



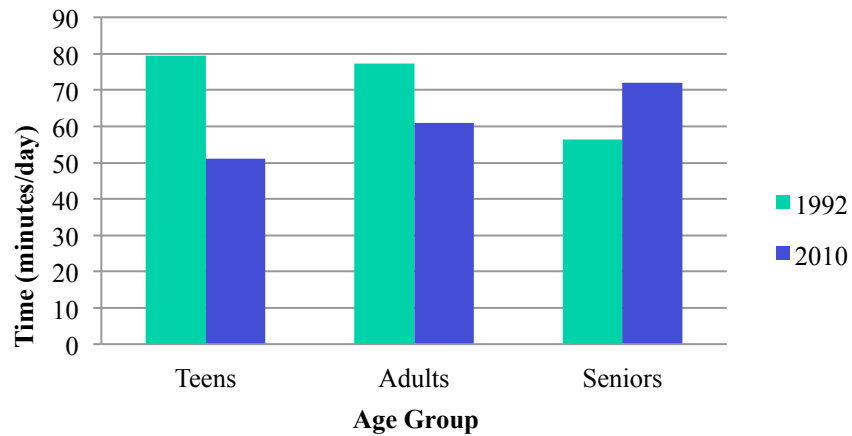
Average reported time spent at indoor sedentary activities - teens



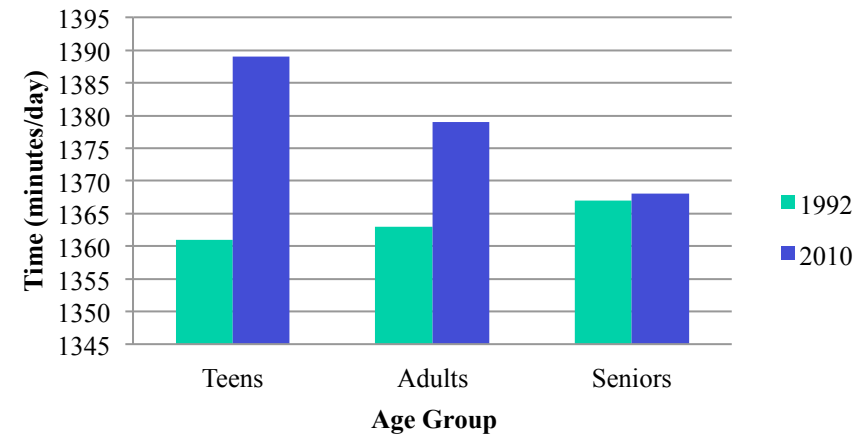
Time in key locations – 2013 vs 1997

(actually 2010 vs 1992)

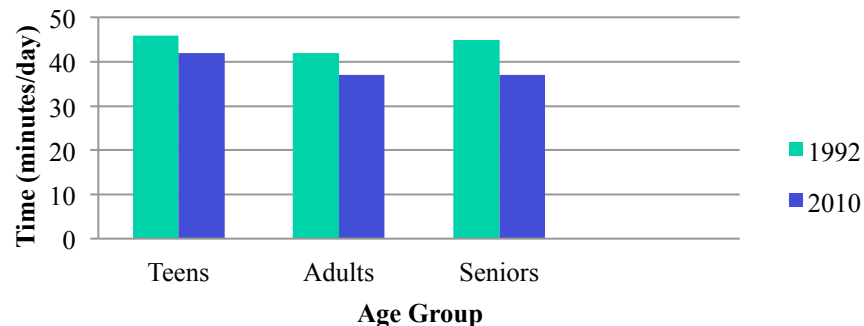
Total time outdoors



Total time indoors



Time washing/dressing



Updated time-activity data

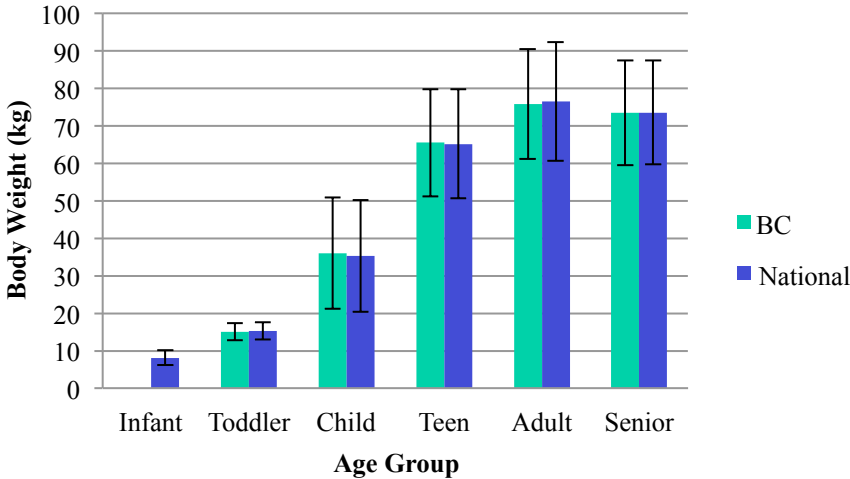
VARIABLE	USE AND EXPLANATION
At Home Indoors (minutes/day)	More accurate data for indoor exposures if CS is residential. Stats for probabilistic RA.
At Home Outdoors (minutes/day)	More accurate data for outdoor exposures if CS is residential. Stats for probabilistic RA.
Elsewhere Outdoors (minutes/day)	More accurate data for outdoor exposures for sites other than residential. Stats for probabilistic RA.
Elsewhere Indoors or in Vehicle (minutes/day)	More accurate data for indoor exposures for sites other than residential. Stats for probabilistic RA.
Total Indoors (minutes/day)	For conservative indoor exposure RAs.
Total Outdoors (minutes/day)	For conservative outdoor exposure RAs.
Washing/Dressing (minutes/day)	Time exposed to water-borne contaminants during bathing/showering.
At Home Indoors Awake (minutes/day)	Time for dermal and ingestion exposure to indoor dust.

Updated time-activity data

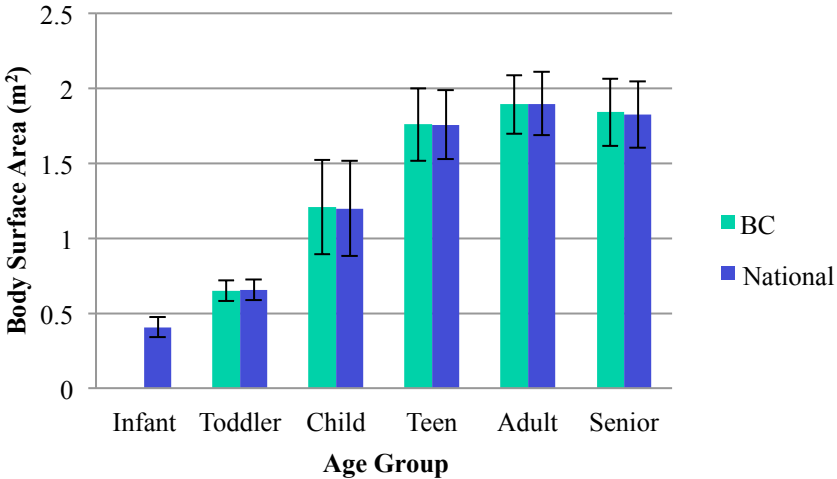
Age Group	Gender	At Home Indoors	At Home Outdoor	Elsewhere Outdoors	Elsewhere Indoors or in Vehicle	Total Indoors	Total Outdoors	Washing/Dressing	At Home Indoors Awake
		Minutes	Minutes	Minutes	Minutes	Minutes	Minutes	Minutes	Minutes
Teens	Female (N = 364)	908 ± 328	11 ± 39	33 ± 114	488 ± 314	1396 ± 122	44 ± 122	52 ± 37	556 ± 140
	Male (N = 397)	892 ± 297	12 ± 43	45 ± 108	491 ± 290	1383 ± 124	57 ± 124	32 ± 29	545 ± 140
	Combined (N = 761)	900 ± 312	12 ± 41	39 ± 111	489 ± 301	1389 ± 123	51 ± 123	42 ± 35	550 ± 140
Adults	Female (N = 6186)	976 ± 303	29 ± 69	24 ± 65	411 ± 305	1387 ± 101	53 ± 101	42 ± 38	481 ± 236
	Male (N = 4804)	901 ± 311	43 ± 95	28 ± 84	469 ± 322	1369 ± 132	71 ± 132	31 ± 34	416 ± 235
	Combined (N = 10990)	943 ± 309	35 ± 82	26 ± 74	436 ± 316	1379 ± 116	61 ± 116	37 ± 37	453 ± 238
Seniors	Female (N = 2139)	1177 ± 265	34 ± 76	19 ± 68	209 ± 249	1386 ± 112	54 ± 112	43 ± 43	654 ± 210
	Male (N = 1500)	1107 ± 277	69 ± 119	29 ± 76	235 ± 258	1342 ± 143	98 ± 143	28 ± 33	601 ± 229
	Combined (N = 3639)	1148 ± 272	49 ± 98	23 ± 72	219 ± 253	1368 ± 128	72 ± 128	37 ± 40	633 ± 220

Average body wt & body surface area – BC vs National

Average Body Weights

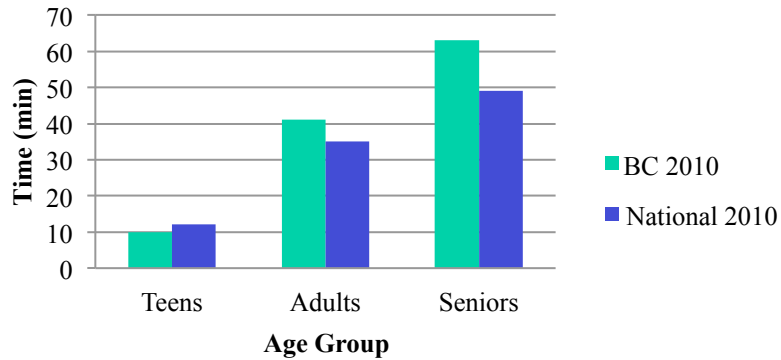


Average Total Body Surface Area

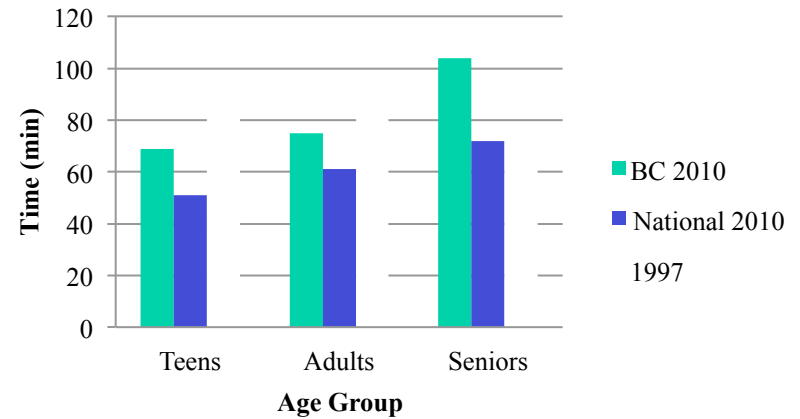


Time-activity - BC vs National

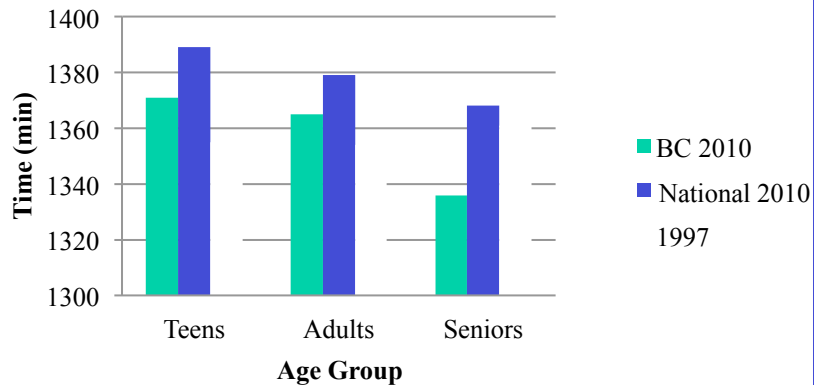
Average Time Outdoors At Home



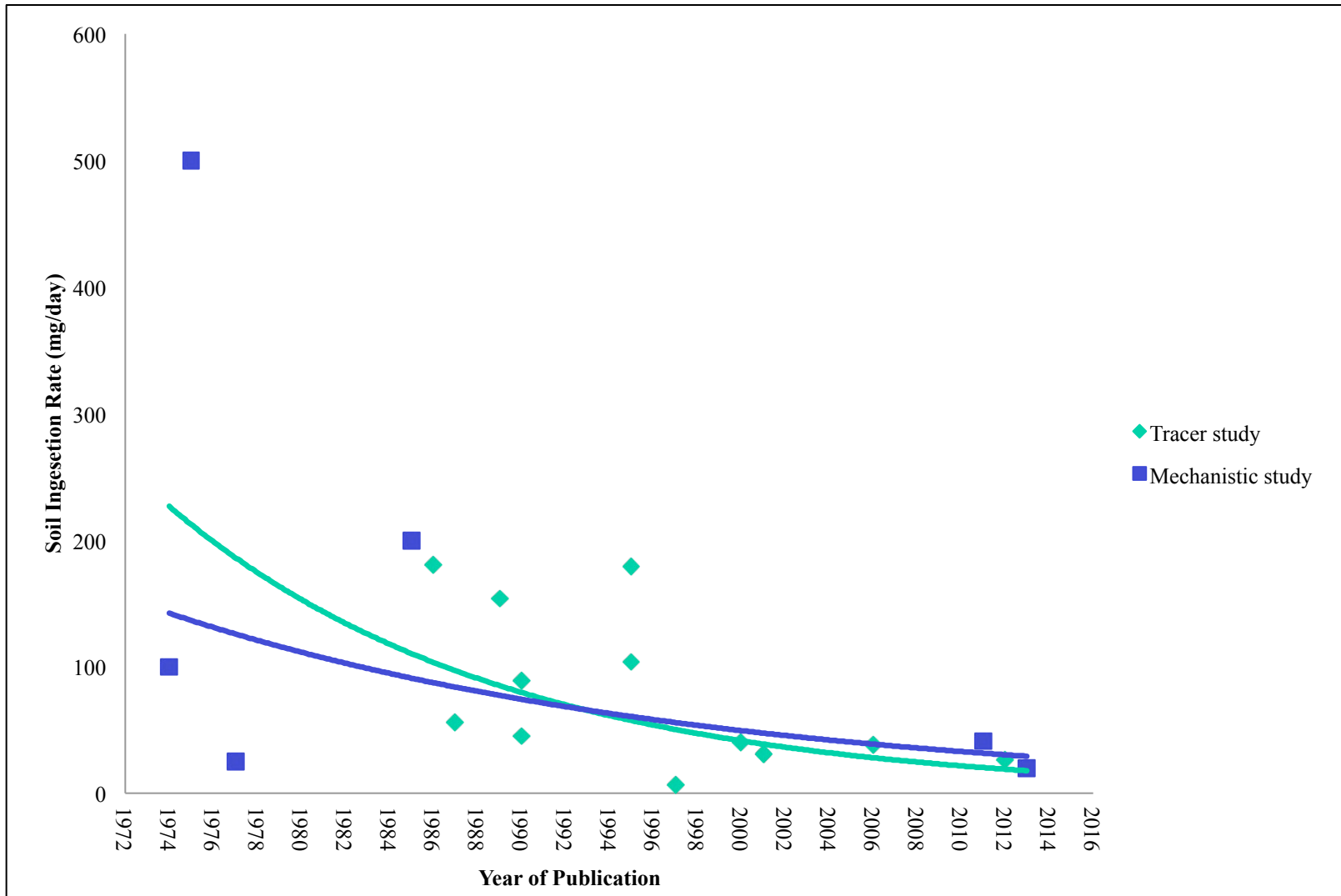
Average Total Time Outdoors



Average Total Time Indoors



Trends in soil ingestion science.



Soil Ingestion rates after Wilson et al. (2013)

Age Group	Outdoor Soil	Indoor Dust
Infant (0 to 6 months)	N/A	36±130
Toddler (7 months to <5 years)	20±26	41±71
Child (5 to <12 years)	23±32	32±59
Teen (12 to <20 years)	1.5±2.6	2.2±3.6
Adult (20 to <60 years)	1.6±2.9	2.6±4.2
Senior (≥60 years)	1.2±2.7	2.6±4.2

Revised exposure factors, based on 'old' age groups.

Table for Infants, Toddlers & Children only.

Age Group and Gender	Body Weight (kg)	Inhalation Rate (m3/day)	Body Surface Areas (m2)					Soil Ingestion Rate (mg/day)	Indoor Dust Ingestion Rate c (mg/day)
			Hand	Forearm	Upper Arm	Lower Arm	Leg		
Infant Sexes combined	6.9 ± 1.6	2.18 ± 0.59	0.362 ± 0.054	0.055 ± 0.018	0.091 ± 0.016	0.025 ± 0.004	0.032 ± 0.004	N/A	36 ± 130
Toddler (7 mo to <5 yr)									
Female	14.8 ± 3.1	7.76 ± 1.97	0.658 ± 0.065	0.118 ± 0.009	0.184 ± 0.021	0.047 ± 0.004	0.046 ± 0.003		
Male	15.6 ± 3.2	8.85 ± 2.25	0.686 ± 0.069	0.082 ± 0.010	0.193 ± 0.022	0.049 ± 0.005	0.047 ± 0.004		
Combined	15.2 ± 3.2	8.31 ± 2.19	0.672 ± 0.068	0.099 ± 0.020	0.189 ± 0.022	0.048 ± 0.005	0.046 ± 0.003	20 ± 26	41 ± 71
Child (5 to <12 yr)									
Female	38.9 ± 15.3	13.85 ± 3.14	1.232 ± 0.313	0.187 ± 0.032	0.383 ± 0.110	0.086 ± 0.020	0.067 ± 0.011		
Male	39.7 ± 16.1	15.21 ± 3.44	1.248 ± 0.324	0.171 ± 0.054	0.389 ± 0.114	0.087 ± 0.021	0.070 ± 0.015		
Combined	39.3 ± 15.7	14.52 ± 3.38	1.240 ± 0.319	0.179 ± 0.046	0.386 ± 0.112	0.087 ± 0.021	0.068 ± 0.013	23 ± 32	32 ± 59

Questions?