Appendix 20

United States
Environmental Protection
Agency

Child-Specific Exposure Factors Handbook

EPA-600-P-00-002B
September 2002
Interim Report

CHILD-SPECIFIC EXPOSURE FACTORS HANDBOOK

National Center for Environmental Assessment–Washington Office
Office of Research and Development
U.S. Environmental Protection Agency
Washington, D.C. 20460

DISCLAIMER

This interim document has been reviewed in accordance with U.S. Environmental Protection Agency policy and approved for publication. Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

ABSTRACT

Children are often more heavily exposed to environmental toxicants than adults. They consume more food and water and have higher inhalation rates per pound of body weight than adults. Young children play close to the ground and come into contact with contaminated soil outdoors and with contaminated dust on surfaces and carpets indoors. As another example, exposure to chemicals in breast milk affects infants and young children.

Although NCEA has published the Exposure Factors Handbook in 1997 (EPA/600/P-95/002Fa-c), that include exposure factors and related data on both adults and children, the EPA Program Offices identified the need to consolidate all children exposure data into one document. The goal of the Child-Specific Exposure Factors Handbook is to fulfill this need. The document provides a summary of the available and up-to-date statistical data on various factors assessing children exposures. These factors include drinking water consumption, soil ingestion, inhalation rates, dermal factors including skin area and soil adherence factors, consumption of fruits and vegetables, fish, meats, dairy products, homegrown foods, breast milk, activity patterns, body weight, consumer products and life expectancy.

Preferred Citation:
U.S. Environmental Protection Agency (EPA). (2002) Child-specific exposure factors handbook. National Center for Environmental Assessment, Washington, DC; EPA/600/P-00/002B. Available from: National Information Service, Springfield, VA; PB2003-101678 and <http://www.epa.gov/ncea>.

CONTENTS—CHILD-SPECIFIC EXPOSURE FACTORS HANDBOOK

LIST OF TABLES ix
LIST OF FIGURES xxiv
FOREWARD xxv
PREFACE xxvi
AUTHORS, CONTRIBUTORS, AND REVIEWERS xxvii

1. INTRODUCTION 1-1
   1.1. BACKGROUND 1-1
   1.2. PURPOSE 1-3
   1.3. INTENDED AUDIENCE 1-4
   1.4. SELECTION OF STUDIES FOR THE HANDBOOK 1-4
      1.4.1. General Considerations 1-4
   1.5. APPROACH USED TO DEVELOP RECOMMENDATIONS FOR EXPOSURE FACTORS 1-6
   1.6. CHARACTERIZING VARIABILITY 1-8
   1.7. USING THE HANDBOOK IN AN EXPOSURE ASSESSMENT 1-10
   1.8. GENERAL EQUATION FOR CALCULATING DOSE 1-12
   1.9. ADJUSTMENT OF DOSE FROM ADULTS TO CHILDREN 1-15
   1.10. AGE GROUPING 1-17
   1.11. CUMULATIVE RISK 1-19
   1.12. FUTURE OR ONGOING WORK 1-20
   1.13. RESEARCH NEEDS 1-22
   1.14. ORGANIZATION 1-23
   APPENDIX A FOR CHAPTER 1: VARIABILITY AND UNCERTAINTY 1-31
   REFERENCES FOR CHAPTER 1 1-43

2. BREAST MILK INTAKE 2-1
   2.1. INTRODUCTION 2-1
   2.2. STUDIES ON BREAST MILK INTAKE 2-2
      2.2.1. Pao et al., 1980 2-2
      2.2.2. Dewey and Lönnerdal, 1983 2-3
      2.2.3. Butte et al., 1984 2-3
      2.2.4. Neville et al., 1988 2-4
      2.2.5. Dewey et al., 1991a, b 2-4
   2.3. STUDIES ON LIPID CONTENT AND FAT INTAKE FROM BREAST MILK 2-5
      2.3.1. Butte et al., 1984 2-5
      2.3.2. Maxwell and Burmaster, 1993 2-6

CONTENTS (continued)

2.4. OTHER FACTORS 2-6
2.4.1. Population of Nursing Infants 2-6
2.4.2. Intake Rates Based on Nutritional Status 2-8
2.5. RECOMMENDATIONS 2-8
2.5.1. Breast Milk Intake 2-9
2.5.2. Lipid Content and Lipid Intake 2-9
REFERENCES FOR CHAPTER 2 2-20

3. FOOD INTAKE 3-1
3.1. INTRODUCTION 3-1
3.2. INTAKE RATE DISTRIBUTIONS FOR VARIOUS FOOD TYPES 3-3
3.2.1. USDA, 1999 3-3
3.2.2. U.S. EPA, 2000 3-5
3.3. FISH INTAKE RATES 3-7
3.3.1. General Population Studies 3-7
3.3.1.1. U.S. EPA, 1996 3-7
3.3.1.2. Tsang and Klepeis, 1996 3-9
3.3.2. Freshwater Recreational Study 3-10
3.3.3. Native American Subsistence Studies 3-12
3.3.3.1. Columbia River Inter-Tribal Fish Commission (CRITFC), 1994 3-12
3.3.3.2. Toy et al., 1996 3-13
3.3.3.3. The Suquamish Tribe, 2000 3-14
3.4. FAT INTAKE 3-15
3.5. TOTAL DIETARY INTAKE AND CONTRIBUTIONS TO DIETARY INTAKE 3-16
3.5.1. U.S. EPA, 2000 3-16
3.6. INTAKE OF HOME-PRODUCED FOODS 3-17
3.7. SERVING SIZE STUDY BASED ON THE USDA NFCS 3-22
3.8. CONVERSION BETWEEN "AS CONSUMED" AND DRY WEIGHT INTAKE RATES 3-23
3.9. FAT CONTENT OF MEAT AND DAIRY PRODUCTS 3-23
3.10. RECOMMENDATIONS 3-24
APPENDIX A FOR CHAPTER 3: CALCULATIONS USED IN THE 1994–1996 CSFII ANALYSIS TO CORRECT FOR MIXTURES 3-99
APPENDIX B FOR CHAPTER 3 3-101
APPENDIX C FOR CHAPTER 3: SAMPLE CALCULATION OF MEAN DAILY FAT INTAKE BASED ON CDC (1994) DATA 3-112

CONTENTS (continued)

APPENDIX D FOR CHAPTER3 3-113
APPENDIX E FOR CHAPTER 3: STATISTICAL NOTES 3-127
REFERENCES FOR CHAPTER 3 3-129

4. DRINKING WATER INTAKE 4-1
4.1. INTRODUCTION 4-1
4.2. DRINKING WATER INTAKE STUDIES 4-2
4.2.1. U.S. EPA, 2000a 4-2
4.2.2. U.S. EPA, 2000b 4-4
4.3. RECOMMENDATIONS 4-5
REFERENCES FOR CHAPTER 4 4-18

5. SOIL INGESTION AND PICA 5-1
5.1. INTRODUCTION 5-1
5.2. SOIL INTAKE STUDIES 5-1
5.2.1. Binder et al., 1986 5-1
5.2.2. Clausing et al., 1987 5-3
5.2.3. Calabrese et al., 1989 5-4
5.2.4. Davis et al., 1990 5-5
5.2.5. Van Wijnen et al., 1990 5-7
5.2.6. Stanek and Calabrese, 1995a 5-8
5.2.7. Stanek and Calabrese, 1995b 5-10
5.2.8. Thompson and Burmaster, 1991 5-11
5.2.9. Sedman and Mahmood, 1994 5-12
5.2.10. Calabrese and Stanek, 1995 5-13
5.2.11. Calabrese et al., 1997 5-15
5.3. SOIL PICA 5-16
5.3.1. Prevalence 5-16
5.3.2. Pica Among Children 5-18
5.3.2.1. Calabrese et al., 1991 5-18
5.3.2.2. Calabrese and Stanek, 1992 5-18
5.3.2.3. Calabrese and Stanek, 1993 5-19
5.4. RECOMMENDATIONS 5-20
REFERENCES FOR CHAPTER 5 5-39

6. OTHER NONDIETARY INGESTION FACTORS 6-1
6.1. INTRODUCTION 6-1

CONTENTS (continued)

6.2. STUDIES RELATED TO NONDIETARY INGESTION 6-2
6.2.1. Davis, 1995 6-2
6.2.2. Groot et al., 1998 6-5
6.2.3. Reed te al., 1999 6-6
6.2.4. Zartarian et al., 1997 6-7
6.2.5. Stanek et al., 1998 6-8
6.3. RECOMMENDATIONS 6-10
REFERENCES FOR CHAPTER 6 6-18

7. INHALATION ROUTE 7-1
7.1. INTRODUCTION 7-1
7.2. INHALATION RATE STUDIES 7-1
7.2.1. Linn et al., 1992 7-1
7.2.2. Spier et al., 1992 7-2
7.2.3. Adams, 1993 7-3
7.2.4. Layton, 1993 7-4
7.2.4.1. First Approach 7-5
7.2.4.2. Second Approach 7-6
7.2.5. Rusconi et al., 1994 7-6
7.3. RECOMMENDATIONS 7-8
APPENDIX A FOR CHAPTER: VENTILATION RATES 7-22
REFERENCES FOR CHAPTER 7 7-24

8. DERMAL ROUTE 8-1
8.1. INTRODUCTION 8-1
8.2. SURFACE AREA 8-1
8.2.1. Background 8-1
8.2.2. Measurement Techniques 8-2
8.2.3. Body Surface Area Studies 8-3
8.2.3.1. Costeff, 1966 8-3
8.2.3.2. U.S. EPA, 1985 8-3
8.2.3.3. Phillips et al., 1993 8-4
8.2.3.4. Wong et al., 2000 8-5
8.2.4. Application of Body Surface Area Data 8-6
8.3. SOIL ADHERENCE TO SKIN 8-7
8.3.1. Background 8-7

CONTENTS (continued)

8.3.2. Soil Adherence to Skin Studies 8-7
8.3.2.1. Kissel et al., 1996a 8-7
8.3.2.2. Kissel et al., 1996b 8-7
8.3.2.3. Holmes et al., 1999 8-8
8.3.2.4. Kissel et al., 1998 8-9
8.4. RECOMMENDATIONS 8-10
8.4.1. Body Surface Area 8-10
8.4.2. Soil Adherence to Skin 8-11
APPENDIX A FOR CHAPTER 8: FORMULAE FOR TOTAL BODY SURFACE AREA 8-27
REFERENCES FOR CHAPTER 8 8-33

9. ACTIVITY FACTORS 9-1
9.1. INTRODUCTION 9-1
9.2. ACTIVITY PATTERNS 9-1
9.2.1. Timmer et al., 1985 9-1
9.2.2. Robinson and Thomas, 1991 9-2
9.2.3. Wiley et al., 1991 9-3
9.2.4. U.S. EPA, 1992 9-4
9.2.5. Tsang and Klepeis, 1996 9-5
9.2.6. Funk et al., 1998 9-8
9.2.7. Hubal et al., 2000 9-9
9.2.8. Wong et al., 2000 9-9
9.3. RECOMMENDATIONS 9-11
9.3.1. Recommendations for Activity Patterns 9-11
9.3.1.1. Time Spent Indoors Versus Outdoors 9-11
9.3.1.2. Showering 9-12
9.3.1.3. Swimming 9-12
9.3.1.4. Residential Time Spent Indoors and Outdoors 9-12
9.3.1.5. Playing on Sand or Gravel and on Grass 9-13
9.3.2. Summary of Recommended Activity Factors 9-13
REFERENCES FOR CHAPTER 9 9-61

10. CONSUMER PRODUCTS 10-1
10.1. BACKGROUND 10-1
10.2. CONSUMER PRODUCTS USE STUDIES 10-1
10.2.1. Tsang and Klepeis, 1996 10-1
10.3. RECOMMENDATIONS 10-2
REFERENCES FOR CHAPTER 10 10-8

CONTENTS (continued)

11. BODY WEIGHT STUDIES 11-1
11.1. INTRODUCTION 11-1
11.2. BODY WEIGHT STUDIES 11-1
11.2.1. Hamill et al., 1979 11-1
11.2.2. National Center for Health Statistics, 1987 11-1
11.2.3. Burmaster and Crouch, 1997 11-2
11.2.4. U.S. EPA, 2000 11-3
11.3. RECOMMENDATIONS 11-3
REFERENCES FOR CHAPTER 11 11-16

12. LIFETIME 12-1
12.1. INTRODUCTION 12-1
12.2. RECOMMENDATIONS 12-1
REFERENCES FOR CHAPTER 12 12-3

LIST OF TABLES

1-1. Considerations used to rate confidence in recommended values 1-25

1-2. Summary of exposure factor recommendations and confidence ratings 1-26

1-3. Characterization of variability in exposure factors 1-29

1-4. Proposed set of childhood age groups for agency exposure assessments 1-30

2-1. Daily intakes of breast milk 2-10

2-2. Breast milk intake for infants aged 1 to 6 months 2-10

2-3. Breast milk intake among exclusively breast-fed infants during the first 4 months of life 2-11

2-4. Breast milk intake during a 24-hour period 2-12

2-5. Breast milk intake estimated by the Darling Study 2-13

2-6. Lipid content of human milk and estimated lipid intake among exclusively breast-fed infants 2-13

2-7. Percentage of mothers breast-feeding newborn infants in the hospital and infants at 5 or 6 months of age in the United States in 1989, by ethnic background and selected demographic variables 2-14

2-8. Confidence in breast milk intake recommendations 2-16

2-9. Breast milk intake rates derived from key studies 2-18

2-10. Summary of recommended breast milk and lipid intake rates 2-19

3-1. Grain products: mean quantities consumed per individual, by sex and age, 1 day, 1994–1996/1998 3-26

3-2. Grain products: percentages of individuals consuming, by sex and age, 1 day, 1994–1996/1998 3-27

3-3. Vegetables: mean quantities consumed per individual, by sex and age, 1 day, 1994–1996/1998 3-28

LIST OF TABLES (continued)

3-4. Vegetables: mean quantities consumed per individual, by sex and age, 1 day, 1994–1996/1998 3-29

3-5. Fruits: mean quantities consumed per individual, by sex and age, 1 day, 1994–1996/1998 3-30

3-6. Fruits: percentages of individuals consuming, by sex and age, 1 day, 1994–1996/1998 3-31

3-7. Milk and milk products: mean quantities consumed per individual, by sex and age, 1 day, 1994–1996/1998 3-32

3-8. Milk and milk products: percentages of individuals consuming, by sex and age, 1 day, 1994–1996/1998 3-33

3-9. Meat, poultry, and fish: mean quantities consumed per individual, by sex and age, 1 day, 1994–1996/1998 3-34

3-10. Meat, poultry, and fish: percentages of individuals consuming, by sex and age, 1 day, 1994–1996/1998 3-35

3-11. Eggs, legumes, nuts and seeds, fats and oils, sugars and sweets: mean quantities consumed per individual, by sex and age, 1 day, 1994–1996/1998 3-36

3-12. Eggs, legumes, nuts and seeds, fats and oils, sugars and sweets: percentage of individuals consuming, by sex and age, 1 day, 1994–1996/1998 3-37

3-13. Beverages: mean quantities consumed per individual, by sex and age, 1 day, 1994–1996/1998 3-38

3-14. Beverages: percentages of individuals consuming, by sex and age, 1 day, 1994–1996/1998 3-39

3-15. Weighted and unweighted number of observations, 1994–1996 CSFII analysis 3-40

3-16. Per capita intake of the major food groups (g/kg-day as consumed) 3-41

3-17. Per capita intake of individual foods (g/kg-day as consumed) 3-42

LIST OF TABLES (continued)

3-18. Per capita intake of USDA categories of vegetables and fruits (g/kg-day as consumed) 3-44

3-19. Per capita intake of exposed/protected fruit and vegetable categories (g/kg-day as consumed) 3-45

3-20. Per capita distribution of fish (finfish and shellfish) intake by age and gender, as consumed 3-46

3-21. Consumers only distribution of fish (finfish and shellfish) intake by age and gender, as consumed 3-47

3-22. Per capita distribution of fish (finfish and shellfish) intake by age and gender, uncooked fish weight 3-48

3-23. Per capita distribution of fish (finfish and shellfish) intake by age and gender, uncooked fish weight 3-49

3-24. Number of respondents reporting consumption of seafood, by number of servings and source 3-50

3-25. Mean fish intake among individuals who eat fish and reside in households with recreational fish consumption 3-50

3-26. Fish consumption rates throughout year of 194 children ages 5 years and under 3-51

3-27. Mean, 50th, and 90th percentiles of consumption rates for children ages birth to 5 years (g/kg-day) 3-52

3-28. Children's consumption rate (g/kg-day): individual finfish and shellfish and fish groups 3-53

3-29. Children's consumption rate (g/kg-day) for consumers only: individual finfish and shellfish and fish groups 3-54

3-30. Fat intake among children based on data from the Bogalusa Heart Study, 1973–1982 (g/day) 3-55

LIST OF TABLES (continued)

3-31. Fat intake among children based on data from the Bogalusa Heart Study, 1973–1982 (g/kg-day) 3-56

3-32. Mean total daily dietary fat intake grouped by age and gender 3-57

3-33. Per capita total dietary intake 3-58

3-34. Per capita intake of major food groups (g/day, as consumed) 3-59

3-35. Per capita intake of major food groups (g/kg/day, as consumed) 3-61

3-36. Per capita intake of total foods and major food groups, and percent of total food intake for individuals with low-end, mid-range, and high-end total food intake 3-63

3-37. Per capita intake of total foods and major food groups, and percent of total food intake for individuals with low-end, mid-range, and high-end total meat intake 3-65

3-38. Per capita intake of total foods and major food groups, and percent of total food intake for individuals with low-end, mid-range, and high-end total meat and dairy intake 3-67

3-39. Per capita intake of total foods and major food groups, and percent of total food intake for individuals with low-end, mid-range, and high-end total fish intake 3-69

3-40. Per capita intake of total foods and major food groups, and percent of total food intake for individuals with low-end, mid-range, and high-end total fruit and vegetable intake 3-71

3-41. Per capita intake of total foods and major food groups, and percent of total food intake for individuals with low-end, mid-range, and high-end total dairy intake 3-73

3-42. Weighted (w) and unweighted number (uw) of observations (individuals) for NFCS data used in analysis of food intake 3-75

3-43. Consumer-only intake of homegrown foods (g/kg-day), all regions combined 3-76

3-44. Percent weight losses from food preparation 3-77

LIST OF TABLES (continued)

3-45. Quantity (as consumed) of food groups consumed per eating occasion and the percentage of individuals using these foods over a 3-day period in a 1997–78 survey, by age group 3-78

3-46. Mean moisture content of selected food groups expressed as percentages of edible portions 3-80

3-47. Percent moisture content for selected fish species 3-84

3-48. Percentage lipid content (expressed as percentages of 100 grams of edible portions) of selected meat, dairy, and fish products 3-87

3-49. Fat content of meat products 3-92

3-50. Summary of recommended values (g/kg-day) for per capita intake of foods, as consumed 3-93

3-51. Confidence intake recommendations for various foods, including fish (general population) 3-95

3-52. Confidence intake recommendations for fish consumption, recreational freshwater angler population 3-96

3-53. Summary of fish intake rates among Native American children (consumers only) 3-97

3-54. Confidence intake recommendations for fish consumption, Native American subsistence population 3-98

4-1. Estimated direct and indirect community total water ingestion by source for U.S. population 4-6

4-2. Estimate of total direct and indirect water ingestion, all sources by broad age category for U.S. children 4-7

4-3. Estimate of direct and indirect community water ingestion by fine age category for U.S. children 4-8

4-4. Estimate of direct and indirect community water ingestion by broad age category for U.S. children 4-9

LIST OF TABLES (continued)

4-5. Estimate of direct and indirect bottled water ingestion by fine age category for U.S. children 4-10

4-6. Estimate of direct and indirect bottled water ingestion by broad age category for U.S. children 4-11

4-7. Estimate of direct and indirect other water ingestion by fine age category for U.S. children 4-12

4-8. Estimate of direct and indirect other water ingestion by broad age category for U.S. children 4-13

4-9. Chi-square GOF statistics for 12 models, tapwater data, based on maximum likelihood method of parameter estimation 4-14

4-10. P-values for chi-square GOF tests of 12 models, tapwater data 4-14

4-11. Results of statistical modeling of tapwater data (intake rates in dL/kg-day) using 5-parameter generalized F and 2-parameter gamma, lognormal and Weibull models 4-15

4-12. Summary of recommended community drinking water intake rates 4-16

4-13. Confidence in tapwater intake recommendations 4-17

5-1. Estimated daily soil ingestion based on aluminum, silicon, and titanium concentrations 5-23

5-2. Calculated soil ingestion by nursery school children 5-24

5-3. Calculated soil ingestion by hospitalized, bedridden children 5-25

5-4. Mean and standard deviation percentage recovery of eight tracer elements 5-25

5-5. Soil and dust ingestion estimates for children ages 1–4 years 5-26

5-6. Average daily soil ingestion values based on aluminum, silicon, and titanium as tracer elements 5-26

LIST OF TABLES (continued)

5-7. Geometric mean (GM) and standard deviation (GSD) LTM values for children at daycare centers and campgrounds 5-27

5-8. Estimated geometric mean (GM) LTM values of children attending daycare centers according to weather category, age, and sampling period (mg/day) 5-28

5-9. Per child distribution of average (mean) daily soil ingestion estimates by trace for 64 children 5-29

5-10. Estimated distribution of individual mean daily soil ingestion based on data for 64 subjects projected over 365 days 5-30

5-11. Summary statistics and parameters for distributions of estimated soil ingestion by tracer element 5-31

5-12. Positive/negative error (bias) in soil ingestion estimates in the Calabrese et al. (1989) mass-balance study—effect on mean soil ingestion estimate (mg/day) 5-32

5-13. Soil ingestion estimates for the median of best four trace elements based on food/soil ratios for 64 Anaconda children using aluminum, silicon, titanium, yttrium, and zirconium 5-33

5-14. Dust ingestion estimates for the median of best four trace elements based on food/dust ratios for 64 Anaconda children using using aluminum, silicon, titanium, yttrium, and zirconium 5-33

5-15. Daily soil ingestion estimation in a soil-pica child by tracer and by week 5-34

5-16. Ratios of soil, residual fecal, and dust samples in the soil pica child 5-35

5-17. Daily variation of soil ingestion by children displaying soil pica in Wong (1988) . . . 5-36

5-18. Summary of estimates of soil ingestion by children 5-37

5-19. Summary of recommended values for soil ingestion 5-37

5-20. Confidence in soil intake recommendation 5-38

6-1. Extrapolated total mouthing times minutes per day 6-11

LIST OF TABLES (continued)

6-2. Frequency of contacts 6-11

6-3. Prevalence of non-food ingestion/mouthing behaviors by age 6-12

6-4. Average outdoor object mouthing scores for children by age, frequency of sand/dirt play, and general mouthing quartiles 6-15

6-5. Summary of studies on mouthing behavior 6-15

6-6. Summary of mouthing frequency data 6-16

6-7. Summary of recommended values for mouthing behavior 6-16

6-8. Confidence in mouthing behavior recommendations 6-17

7-1. Calibration and field protocols for self-monitoring of activities, grouped by subject panels 7-9

7-2. Subject panel inhalation rates by mean ventilation rate, upper percentiles, and self-estimated breathing rates 7-9

7-3. Distribution of predicted inhalation rates by location and activity levels for elementary and high school students who participated in the survey 7-10

7-4. Average hours spent per day in a given location and activity level for elementary and high school students 7-10

7-5. Distribution patterns of daily inhalation rates for elementary and high school students grouped by activity level 7-11

7-6. Summary of average inhalation rates by age group and activity levels for laboratory protocols 7-12

7-7. Summary of average inhalation rates by age group and activity levels in field protocols 7-12

7-8. Comparisons of estimated basal metabolic rates (BMR) with average food-energy intakes for individuals sampled in the 1977–1978 NFCS 7-13

7-9. Daily inhalation rates calculated from food-energy intakes 7-14

LIST OF TABLES (continued)

7-10. Daily inhalation rates obtained from the ratios of total energy expenditure to basal metabolic rate (BMR) 7-15

7-11. Inhalation rates for short-term exposures 7-16

7-12. Mean, median, and SD of respiratory rate according to waking or sleeping in 618 infants and children grouped in classes of age (breaths/minute) 7-17

7-13. Confidence in inhalation rate recommendations 7-18

7-14. Summary of recommended values for inhalation 7-19

7-15. Summary of arithmetic mean (m^3/hr) of children's inhalation rates by activity level for short-term exposure studies 7-20

8-1. Total body surface area of male children in m^2 8-13

8-2. Total body surface area of female children in m^2 8-14

8-3. Percentage of total body surface area by body part for children 8-15

8-4. Descriptive statistics for surface area/body weight (SA/BW) ratios (m^2/kg) 8-16

8-5. Clothing choices and assumed body surface areas exposed 8-17

8-6. Estimated skin surface exposed during warm weather outdoor play for children under age 5 (based on SCS-I data). 8-17

8-7. Summary of field studies 8-18

8-8. Geometric mean (Geometric Standard Deviations) of soil adherence by activity and body region 8-19

8-9. Summary of groups assayed in round 2 of field measurements 8-20

8-10. Attire for individuals within children's groups studied 8-20

8-11. Geometric means (geometric standard deviations) of round 2 post-activity loadings 8-21

LIST OF TABLES (continued)

8-12. Summary of controlled greenhouse trials, children playing 8-21

8-13. Preactivity loadings recovered from greenhouse trial children volunteers 8-22

8-14. Summary of recommended values for skin surface area 8-22

8-15. Confidence in body surface area measurement recommendations 8-23

8-16. Confidence in soil adherence to skin recommendations 8-24

9-1. Mean time spent performing major activities grouped by age, sex and type of day .. 9-14

9-2. Mean time spent in major activities grouped by type of day for five different age groups 9-15

9-3. Mean time spent indoors and outdoors grouped by age and time of the week 9-16

9-4. Mean time spent at three locations for both CARB and national studies (ages 12 years and older) 9-16

9-5. Mean time spent in various microenvironments grouped by total population and gender (12 years and over) in the national and CARB data 9-17

9-6. Mean time spent in various microenvironments by type of day for the CARB and national surveys (sample population ages 12 years and older) 9-18

9-7. Mean time spent in various microenvironments by age groups for the national and CARB surveys 9-19

9-8. Mean time children ages 12 years and under spent in 10 major activity categories for all respondents 9-20

9-9. Mean time children spent in 10 major activity categories grouped by age and gender 9-21

9-10. Mean time children ages 12 years and under spent in 10 major activity categories grouped by seasons and regions 9-22

9-11. Mean time children ages 12 years and under spent in six major location categories for all respondents 9-23

LIST OF TABLES (continued)

9-12. Mean time children spent in six location categories grouped by age and gender 9-23

9-13. Mean time children spent in six location categories grouped by season and region .. 9-24

9-14. Mean time children spent in proximity to three potential exposures grouped by all respondents, age, and gender 9-25

9-15. Mean time spent indoors and outdoors grouped by age 9-25

9-16. Range of recommended defaults for dermal exposure factors 9-26

9-17. Number of times taking a shower by number of respondents 9-26

9-18. Time spent taking a shower and spent in the shower room after taking a shower by the number of respondents 9-27

9-19. Time spent taking a shower and spent in the shower room immediately after showering 9-27

9-20. Total time spent altogether in the shower or bathtub and in the bathroom immediately after by number of respondents 9-28

9-21. Total number of minutes spent altogether in the shower or bathtub and spent in the bathroom immediately following a shower or bath 9-28

9-22. Number of times hands were washed at specified daily frequencies by the number of respondents 9-29

9-23. Number of minutes spent working or being near excessive dust in the air (mins/day) 9-29

9-24. Number of times per day a motor vehicle was started in a garage or carport and started with the garage door closed by number of respondents 9-30

9-25. Number of minutes spent playing on sand, gravel, dirt, or grass by number of respondents 9-31

9-26. Number of minutes spent playing in sand, gravel, dirt or grass by percentiles 9-31

LIST OF TABLES (continued)

9-27. Number of minutes per day spent playing on grass in a day by the number of respondents 9-32

9-28. Number of minutes spent playing on grass by percentile 9-32

9-29. Number of times swimming in a month in freshwater swimming pool by the number of respondents 9-33

9-30. Number of minutes spent swimming in a month in freshwater swimming pool percentile 9-34

9-31. Range of the average amount of time actually spent in the water by swimmers by the number of respondents 9-34

9-32. Statistics for twenty-four hour cumulative number of minutes spent playing indoors and outdoors by percentiles 9-35

9-33. Statistics for twenty-four hour cumulative number of minutes spent sleeping/napping by percentiles 9-35

9-34. Statistics for twenty-four hour cumulative number of minutes spent attending full-time school by percentiles 9-36

9-35. Statistics for twenty-four hour cumulative number of minutes spent in active sports and for time spent in sports/exercise by percentiles 9-36

9-36. Statistics for twenty-four hour cumulative number of minutes spent in outdoor recreation and spent walking by percentiles 9-37

9-37. Statistics for twenty-four hour cumulative number of minutes spent in bathing by percentiles 9-37

9-38. Statistics for twenty-four hour cumulative number of minutes eating or drinking by percentiles 9-38

9-39. Statistics for twenty-four hour cumulative number of minutes spent indoors at school and indoors at a restaurant by percentiles 9-38

LIST OF TABLES (continued)

9-40. Statistics for twenty-four hour cumulative number of minutes spent outdoors on school grounds/playground, at a park/golf course, and at a pool/river/lake by percentiles 9-39

9-41. Statistics for twenty-four hour cumulative number of minutes spent at home in the kitchen bathroom, bedroom, and in a residence (all rooms) by percentiles 9-40

9-42. Statistics for twenty-four hour cumulative number of minutes spent traveling inside a vehicle by percentiles 9-41

9-43. Statistics for twenty-four hour cumulative number of minutes spent outdoors (outside the residence) and outdoors other than near a residence or vehicle, such as parks, golf courses, or farms by percentiles 9-41

9-44. Statistics for twenty-four hour cumulative number of minutes spent in malls, grocery stores, or other stores by percentiles 9-42

9-45. Statistics for twenty-four hour cumulative number of minutes spent with smokers present by percentiles 9-43

9-46. Gender and age groups 9-43

9-47. Assignment of at-home activities to ventilation levels for children 9-44

9-48. Aggregate time spent (mins/day) at home in activity groups by adolescents and children 9-45

9-49. Comparison of mean time (mins/day) spent at home by gender (adolescents) 9-45

9-50. Comparison of mean time (mins/day) spent at home by gender and age for children 9-46

9-51. Number of person-days/individuals for children in CHAD database 9-47

9-52. Number of hours per day children spent in various microenvironments, by age: average ± SD (percent of children reporting > 0 hours in microenvironment) 9-48

9-53. Average number of hours per day children spent doing various macroactivities while indoors at home, by age (percent of children reporting > 0 hours of microenvironment/macroactivity) 9-49

LIST OF TABLES (continued)

9-54. Respondents with children and those reporting outdoor play activities in both warm and cold weather 9-49

9-55. Play frequency and duration for all child players (from SCS-II data) by percentiles . 9-50

9-56. Hand washing and bathing frequency for all child players (from SCS-II data) by percentiles 9-50

9-57. NHAPS and SCS-II play duration comparison 9-50

9-58. Comparison of NHAPS and SCS-II hand-washing frequencies 9-51

9-59. Confidence in activity patterns recommendations 9-52

9-60. Summary of activity pattern studies 9-57

9-61. Summary of mean time spent indoors and outdoors from several studies 9-58

9-62. Summary of recommended values for activity factors 9-59

10-1. Consumer products commonly found in some U.S. households 10-3

10-2. Number of minutes per day spent in activities working with or near household cleaning agents such as scouring powders or ammonia 10-6

10-3. Number of minutes per day spent using any microwave oven 10-6

10-4. Number of respondents using a humidifier at home 10-6

10-5. Number of respondents reporting that pesticides were applied by a professional at their home by number of times applied over a 6-month period 10-7

10-6. Number of respondents reporting that pesticides were applied by the consumer at home by number of times applied over a 6-month period 10-7

11-1. Smoothed percentiles of weight by sex and age: statistics from NCHS and data from Fels Research Institute 11-4

11-2. Weight in kilograms for males 6 months to 19 years of age by sex and age, U.S. population 1976–1980 11-5

LIST OF TABLES (continued)

11-3. Weight in kilograms for females 6 months to 19 years of age by sex and age, U.S. population 1976–1980 11-6

11-4. Statistics for probability plot regression analyses female's body weights 6 months to 20 years of age 11-7

11-5. Statistics for probability plot regression analyses male's body weights 6 months to 20 years of age 11-8

11-6. Body weight estimates (in kilograms) by age and gender, U.S. population 1988–1994 11-9

11-7. Body weight estimates by age, U.S. population 1988–1994 11-10

11-8. Summary of recommended values for body weight 11-10

11-9. Confidence in body weight recommendations 11-11

LIST OF FIGURES

1-1. Schematic of dose and exposure: oral route 1-13

7-1. 5th, 10th, 25th, 50th, 75th, 90th, and 95th smoothed centiles by age in awake subjects 7-21

7-2. 5th, 10th, 25th, 50th, 75th, 90th, and 95th smoothed centiles by age in asleep subjects 7-21

8-1. Schematic of dose and exposure: dermal route 8-25

8-2. Skin coverage as determined by fluorescence versus body part for adults transplanting plants and for children playing in wet soils 8-26

8-3. Gravimetric loading versus body part for adult transplanting plants in wet soil and for children playing in wet and dry soils 8-26

11-1. Weight by age percentiles for girls ages birth to 36 months 11-12

11-2. Weight by age percentiles for boys ages birth to 36 months 11-13

11-3. Mean body weights estimates, U.S. population, 1988–1994 11-14

11-4. Median body weights estimates, U.S. population, 1988–1994 11-15

Table 2-1. Daily intakes of breast milk

Age	Number of infants	Mean ± SD (mL/day)[a]	Intake Range (mL/day)
Completely breast-fed			
1 month	11	600 ± 159	426–989
3 months	2	833	645–1,000
6 months	1	682	616–786
Partially breast-fed			
1 month	4	485 ± 79	398–655
3 months	11	467 ± 100	242–698
6 months	6	395 ± 175	147–684
9 months	3	< 554	451–732

[a] Data expressed as mean ± standard deviation.

Source: Pao et al , 1980

Table 2-2. Breast milk intake for infants aged 1 to 6 months

Age (months)	Number of Infants	Intake	
		Mean ± SD (mL/day)	Range (mL/day)
1	16	673 ± 192	341–1003
2	19	756 ± 170	449–1055
3	16	782 ± 172	492–1053
4	13	810 ± 142	593–1045
5	11	805 ± 117	554–1045
6	11	896 ± 122	675–1096

Source: Dewey and Lönnerdal, 1983